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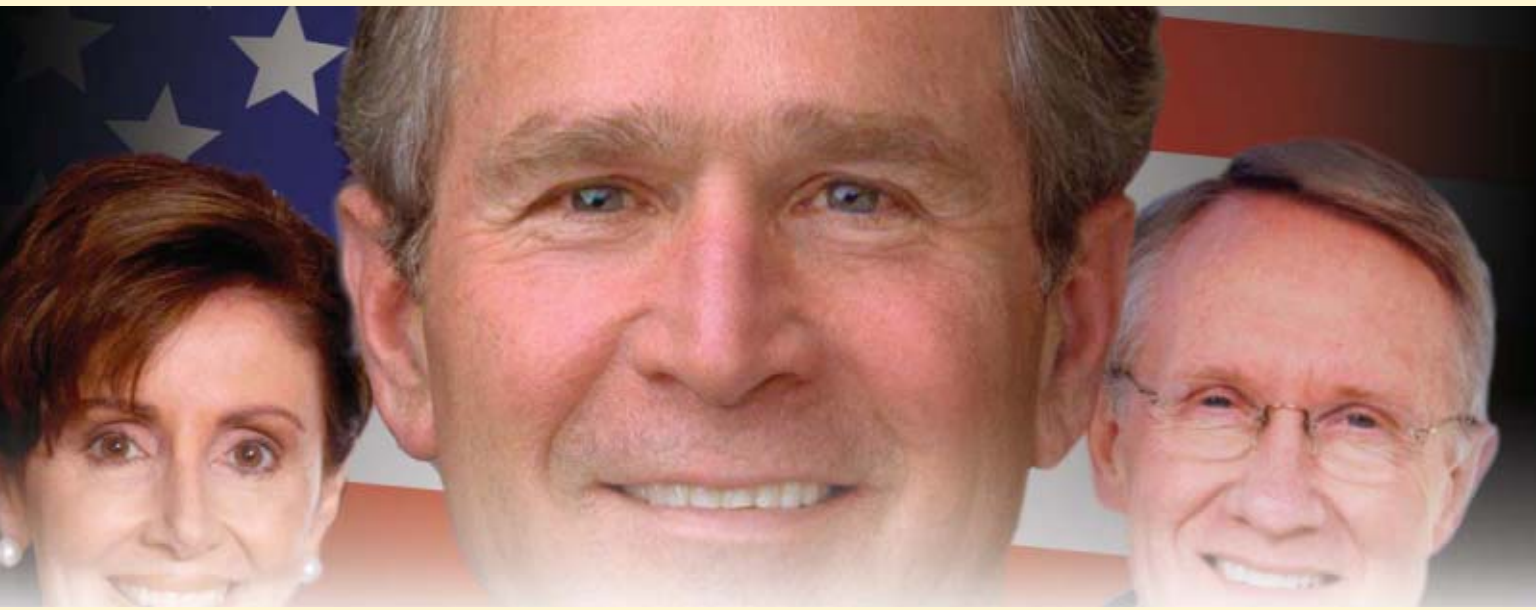
US Energy Politics

Undiscovered oil potential still large off West Africa
North Sea data yield insight on fatigue life of drill pipe
Study tests accuracy of methods that estimate hydrate formation
ROV, dive data show postconstruction epifaunal health

OIL&GAS JOURNAL®

Jan. 8, 2007
Volume 105.2

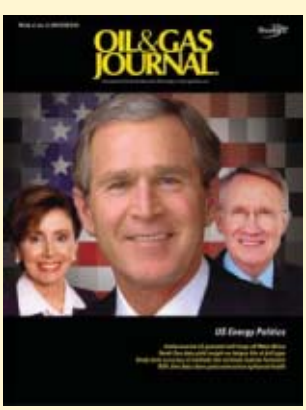
US Energy Politics



Regular Features

Cover

New faces in congressional leadership positions mean new opposition to energy and other initiatives by US President George W. Bush following Democratic victories in elections last November. Shown with Bush here are Rep. Nancy Pelosi (D-Calif.), incoming speaker of the House of Representatives, and Sen. Harry Reid (D-Nev.), new Senate majority leader. The US Energy Politics special report, beginning on p. 18, tells what's ahead.



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Jan. 8, 2007

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General Interest — Quick Takes

Clarke resigns as BLM director

US Bureau of Land Management Director Kathleen Clarke resigned to rejoin her family in Utah, Sec. of the Interior Dirk A. Kempthorne said on Dec. 28.

Clarke, who became BLM director on Jan. 2, 2002, was the first woman to head the DOI agency, which manages 258 million acres of federal land and 700 million acres of subsurface mineral resources.

Prior to her federal appointment, Clarke was executive director of Utah's Department of Natural Resources. During 1987-93, she worked for then-Rep. James V. Hansen (R-Ut.) as constituent services director and executive director of the federal lawmaker's Ogden, Utah, office.

There was no indication when Clarke will be leaving or who will run BLM until her successor is nominated, confirmed by the US Senate, and sworn in.

MMS begins environmental review of Sale 181 area

The US Minerals Management Service will begin the necessary environmental reviews of about 580,000 acres in the eastern Gulf of Mexico opened for oil and gas leasing by legislation signed by President George W. Bush on Dec. 20, the Department of the Interior agency said.

MMS will immediately begin an environmental review of the so-called Sale 181 area, comprised of 2 million acres in the central GOM as well as 580,000 acres in the eastern gulf, which are 125 miles from Florida's coastline and west of the US Military Mission Line, MMS Director Johnnie Burton said on Dec. 21.

Public meetings will be held in Florida and other involved states as part of the environmental review, she indicated. The 2 million acres in the central gulf were reviewed in a November 2006 draft environmental impact statement and will be offered in federal Outer Continental Shelf Lease Sale 205, scheduled early this fall.

A second sale area to the south and in deeper water, comprised of about 5.8 million acres, will come under environmental review later, Burton said.

EPA issues final oil spill prevention rule

The US Environmental Protection Agency has issued a final rule on oil spill prevention, control, and countermeasures (SPCC) that will provide compliance alternatives for some facilities.

The new SPCC rule provides streamlined options for specifically qualified facilities and exemptions from the regulations for certain vehicle fuel tanks and other onboard bulk oil storage containers.

EPA indicated that mobile refuelers also are exempt from the sized secondary containment requirements for bulk storage containers under the final rule, which also removes requirements for animal fats and vegetable oils pertaining to onshore and offshore oil production, drilling, and workover facilities.

In the final rule, EPA said it extended the compliance date for farms to either prepare and implement new SPCC plans or amend existing plans until the agency publishes a specific rule addressing how farms should be regulated under the SPCC rule.

EPA also proposed extending the compliance deadline for facilities other than farms to July 1, 2009, to give the covered entities time to implement the modifications. The latest rule does not remove the requirement for facilities in operation before Aug. 16, 2002, to develop, implement, and maintain an SPCC plan under regulations in effect at that time, EPA emphasized.

Gazprom's Sakhalin-2 buyin to offset damage

OAO Gazprom Deputy Chief Executive Alexander Medvedev said Dec. 28 that a portion of the $7.45 billion his firm spent to acquire a controlling stake in the Sakhalin-2 oil and gas project would go toward correcting alleged environmental damage caused by the development (OGJ Online, Dec. 21, 2006).

"All environmental issues will be agreed within the framework of a commission that will be set up by the Ministry of Natural Resources and Sakhalin Energy shareholders, including Gazprom," Medvedev said.

"We naturally valued potential expenditure for environmental compensation when the cost of our entry (into Sakhalin Energy) was being agreed," he said.

Medveev said a preliminary March 2007 deadline had been set for Gazprom to pay the $7.45 billion for its stake in Sakhalin Energy, the project's operator, a joint venture of Royal Dutch Shell PLC, Mitsui & Co., and Mitsubishi Corp.

He said the agreement is expected to be completed no later than February and that payment for Gazprom's participation in the venture is due no later than the end of the first quarter. ✦

Exploration & Development — Quick Takes

Total has sixth oil discovery off Angola

Total E&P Angola, in participation with state-owned Sonangol EP, has made a new oil discovery with its Salsa-1 well, the sixth exploration well drilled on Block 32 in ultradeep water off Angola.

Salsa-1, drilled in the southeastern portion of the block in 1,806 m of water, tested 3,686 b/d of oil from a Miocene reservoir. The well is located 15 km southwest of the Mostarda-1 discovery, which tested 5,347 b/d of 30° gravity oil from one interval (OGJ, Feb. 20, 2006, Newsletter).

Complementary technical studies are under way to evaluate the

Industry Scoreboard

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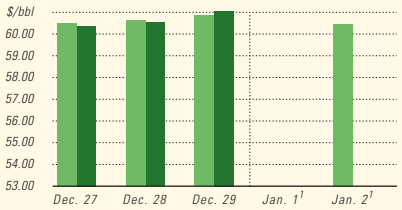
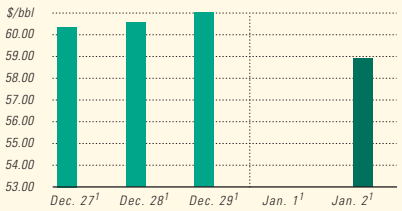
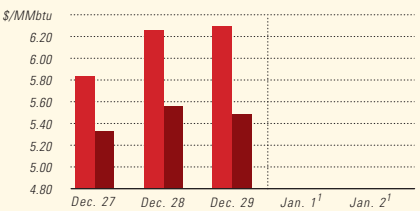


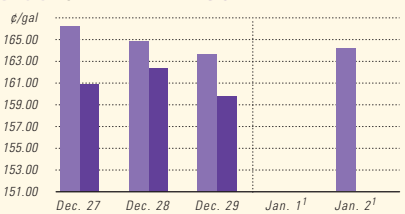
WTI CUSHING / BRENT SPOT



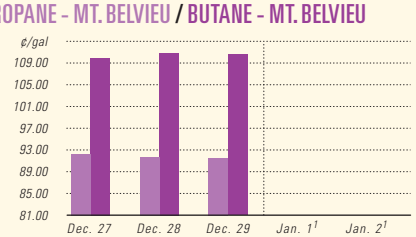
NYMEX NATURAL GAS / SPOT GAS - HENRY HUB



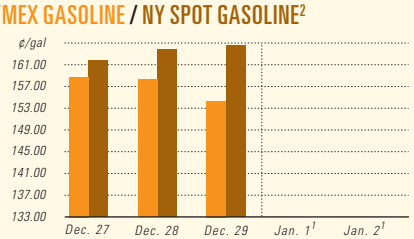
IPE GAS OIL / NYMEX HEATING OIL



PROPANE - MT. BELVIEU / BUTANE - MT. BELVIEU



NYMEX GASOLINE / NY SPOT GASOLINE[2]



[1]Not available.
[2]Nonoxygenated regular unleaded.

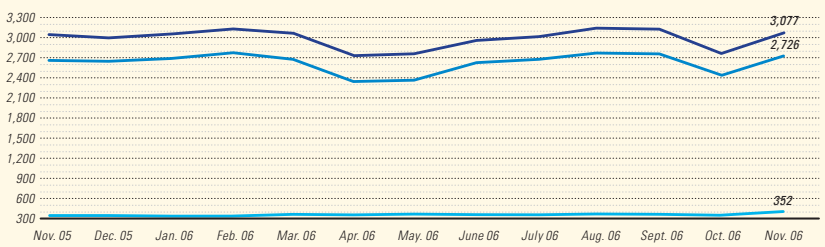
US INDUSTRY SCOREBOARD — 1/8

Latest week 12/22	4 wk. average	4 wk. avg. year ago[1]	Change, %	YTD average[1]	YTD avg. year ago[1]	Change, %
Demand, 1,000 b/d						
Motor gasoline	9,852	9,257	6.4	9,834	9,157	7.4
Distillate	4,266	4,279	–0.3	4,165	4,118	1.1
Jet fuel	1,638	1,727	–5.1	1,607	1,679	–4.3
Residual	536	1,015	–47.2	709	920	–22.9
Other products	5,195	5,031	3.3	4,971	4,925	0.9
TOTAL DEMAND	21,488	21,309	0.8	21,287	20,799	2.3
Supply, 1,000 b/d						
Crude production	5,306	4,953	7.1	5,141	5,179	–0.7
NGL production	2,306	1,494	54.4	2,243	1,717	30.6
Crude imports	9,624	10,040	–4.1	10,196	10,074	1.2
Product imports	3,067	3,612	–15.1	3,406	3,588	–5.1
Other supply[2]	1,140	1,130	0.9	1,096	1,162	–5.6
TOTAL SUPPLY	21,443	21,228	1.0	22,082	21,720	1.7
Refining, 1,000 b/d						
Crude runs to stills	15,177	15,043	0.9	15,151	15,220	–0.5
Input to crude stills	15,493	15,249	1.6	15,570	15,479	0.6
% utilization	89.4	89.0	—	90.4	90.4	—

Latest week 12/22	Latest week	Previous week[1]	Change	Same week year ago[1]	Change	Change, %
Stocks, 1,000 bbl						
Crude oil	319,341	321,473	–2,132	323,482	–4,141	–1.3
Motor gasoline	201,229	199,821	1,408	202,504	–1,275	–0.6
Distillate	137,797	135,212	2,585	129,487	8,310	6.4
Jet fuel	38,013	38,359	–346	41,336	–3,323	–8.0
Residual	44,996	44,354	642	37,900	7,096	18.7
Futures prices[3]						
Light sweet crude, $/bbl	62.99	62.08	0.91	58.04	4.95	8.5
Natural gas, $/MMbtu	7.87	7.50	–0.63	13.83	–6.96	–50.3

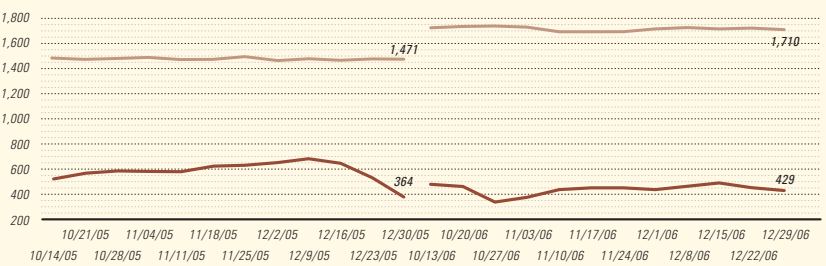
[1]Based on revised figures. [2]Includes other hydrocarbons and alcohol, refinery processing gain, and unaccounted for crude oil.
[3]Weekly average of daily closing futures prices.

BAKER HUGHES INTERNATIONAL RIG COUNT: TOTAL WORLD / TOTAL ONSHORE / TOTAL OFFSHORE



Note: Monthly average count

BAKER HUGHES RIG COUNT: US / CANADA



Note: End of week average count

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test results. Further exploration drilling also is under way and more is planned across the block.

Interest holders in Block 32 are Total 30%, Marathon Oil Co. 30%, Sonangol 20%, Esso Exploration & Production Angola (Overseas) Ltd. 15%, and Petrogal 5%.

Anadarko to explore block off Mozambique

Anadarko Petroleum Corp. has signed a contract with Mozambique for exploration and production of a block in the Rovuma basin in northeastern Mozambique.

Anadarko was awarded the 2.64 million-acre block, known as Offshore Area 1, earlier this year in Mozambique's second licensing round.

The block includes about 90,000 onshore acres and extends offshore 35 miles eastward in water as deep as 6,000 ft. It borders Tanzania to the north and extends southward about 100 miles.

Only two wells have been drilled in the area, said Bob Daniels, Anadarko senior vice-president of worldwide exploration.

The contract commits Anadarko to a 5-year initial exploration term, with options to extend that phase for 3 years, and permits a 30-year production term following any commercial discoveries.

Anadarko was awarded the block on the basis of a work commitment to acquire 2D and 3D seismic and drill seven wells during the initial exploration term.

"Through our regional evaluation and analysis of existing seismic data covering most of the block," Daniels said, "we have already identified multiple leads across an area equivalent in size to 460 typical Gulf of Mexico lease blocks."

Anadarko will operate the block initially with a 100% working interest.

Woodside has gas discovery in Libya

Woodside Energy (NA) Ltd., a subsidiary of Woodside Petroleum Ltd. and operator of the NC210 Block in the Murzuq basin in Libya, has made a gas discovery with its C1-NC210 exploration well on the block, said Repsol YPF, a joint venture partner.

The well, 1,000 km south of Tripoli and 150 km south of producing Al Wafa gas field, was drilled under an exploration and production-sharing agreement with National Oil Corp. Libya. TD is 808 m. Wireline logs indicate the potential for several hydrocarbon-bearing zones.

An initial production test of the Devonian Awaynat Wanin formation confirmed the presence of a gas column and flowed at 5.7 MMscfd through a 72/64-in. choke. Calculated absolute open flow is 10.7 MMscfd.

The Carboniferous Mrar M7 reservoir flowed 5.8 MMscfd of gas on test through a 72/64-in. choke. CAOF is 13 MMscfd.

Interests in the well are Woodside Energy 45%, Repsol Exploración Murzuq SA 35%, and Hellenic Petroleum SA 20%.

Statoil discovers dry gas off eastern Venezuela

Statoil ASA has found dry gas within three intervals drilled in its Cocuina-2X exploration well on Block 4 of Plataforma Deltana, off eastern Venezuela (OGJ, Sept. 4, 2006, Newsletter).

The well, 240 km from the Orinoco Delta, was drilled to 3,406 m TD. "The true potential of Block 4 cannot be confirmed until the whole exploration program has been completed," Statoil said.

Transocean Inc.'s Sovereign Explorer semisubmersible will now proceed to the next well location, Ballena-1X, to drill in 350 m of water. No well has been drilled in deeper water off Venezuela to date, according to Statoil.

The Venezuelan government awarded the Plataforma Deltana Block 4 license to Statoil in 2003. Statoil is operator with a 51% share, and Total SA holds 49%. PDVSA Gas has the option to participate with up to 35% once a commercial discovery has been declared.

Statoil is a partner, together with PDVSA and Total, in the extra-heavy Sincor oil project in the Orinoco Belt.

Aussie JV given nod to develop Woollybutt field

A joint venture led by ENI Australia has been given the green light to spend $180 million (Aus.) to develop the South Lobe section of Woollybutt oil field in the Carnarvon basin off Western Australia.

The new project, in production license WA-25-L, involves connection of two horizontal wells (Woollybutt 4 and 6) to the existing leased floating production, storage, and offloading vessel Four Vanguard via subsea pipeline.

Contracts have been secured for drilling and completion of the two wells, modifications to the FPSO, subsea wellheads, flowlines, manifolds, and control systems as well as installation and transport of the necessary equipment.

The wells will be drilled in midyear, and first production from the South Lobe is expected early in 2008.

The new development will boost oil production from the field by about 10,000 b/d and will increase field life. The FPSO contract runs until 2009, and there are optional extensions until 2013.

So far Woollybutt field has produced about 26.5 million bbl and is currently flowing at 11,000 b/d.

ENI Australia has 65% interest, with Mobil Australia Resources 20% and Tap Oil Ltd. 15%. ✦

Drilling & Production — *Quick Takes*

Kvitebjørn field production reduced in North Sea

Natural gas and oil production from Kvitebjørn field in the Norwegian sector of the North Sea is being reduced by 50% for 5 months, effective Dec. 23, said operator Statoil ASA.

During that time, output will be reduced to 95,000 boe/d from 190,000 boe/d, in the interest of "sound reservoir management and safe drilling operations" for wells remaining to be drilled, based on reservoir conditions and available methods for drilling in reservoirs with high pressure and high temperature. That would amount to a net decrease of 15,000 boe/d in 2007 for Statoil, said company officials.

Meanwhile, Statoil will meet commitments to gas customers by increasing production from other fields.

Kvitebjørn has been on stream since fall of 2004. Located in 190 m of water, it was Statoil's first high-pressure and high-temperature field and was expected to plateau in late 2005. However,

in February 2006, estimates of recoverable reserves from the field were increased by 50%, or by 29 billion cu m of gas and 70 million bbl of condensate.

OMV begins first oil deliveries from Yemen

OMV AG has begun production of 1,000 b/d of oil from its Kharwah-1 well on Block S2 (Al Uqlah) in central Yemen, and it plans to deliver 11,000 b/d of oil by 2008.

OMV wants to expand oil production to 32,000 b/d by 2009-10 under the second phase of its development plan. The field, which has 50 million bbl of proved oil, "is expected to have a lifetime of at least 20 years," OMV added.

Block S2, which spans 1,000 sq km, will initially cost OMV $85 million to develop, but costs are expected to rise to $250-350 million for Phases 1 and 2.

OMV has also won operatorship of Block 29 in the Jeza-Qamar basin under Yemen's third licensing round. It will work with Pakistan Petroleum Ltd. on a joint venture partner basis, each taking a 50% share in this project. Block 29, in eastern Yemen, covers an area of 9,237 sq km. Exclusive negotiations for a production-sharing agreement will commence shortly, OMV said.

OMV is the operator of Block S2 with a 44.0% stake. Its partners are Sinopec International Petroleum Exploration & Production Corp. 37.5%, Yemen General Corp. for Oil & Gas 12.5%, and Yemen Resources Ltd. 6%.

Block S2 is situated close to Block 2 (Al Mabar), for which OMV signed a production-sharing agreement (PSA) on July 13, 2005. The Yemeni Parliament ratified the PSA for Block S2 on May 15, 2006, and President Ali Abdulla Saleh signed it June 7.

Statoil secures rig for Gjøa project

Statoil ASA, development operator of Gjøa oil and gas field off western Norway, has signed a 3-year contract with Transocean Offshore for the Transocean Searcher semisubmersible.

The $427 million contract allows for the drilling of 13 production wells, with options for an additional three, at the North Sea field. Drilling is planned to begin in October 2008.

Lying on Blocks 35/9 and 36/7 in 380 m of water, Gjøa is scheduled to come on stream in 2010 at which time Gaz de France will become operator with a 30% stake.

The field, proved in 1989, has estimated reserves of 40 billion cu m of gas and 83 million bbl of oil and condensate.

Statoil recently signed an agreement for construction of the semisubmersible production platform deck and supply of subsea installations for Gjøa (OGJ Online, Dec. 6, 2006). The next major contract will be for building the platform's jacket, Statoil said.

Total investment for the Gjøa project is estimated at 27 billion kroner.

DNO to produce oil in northern Iraq

Norway's DNO ASA will begin production from its Tawke crude oil project in northern Iraq in the first quarter, the company said Dec. 28.

The company stands to earn more from this production because it recently signed an agreement with the Kurdistan regional government whereby DNO will assume 100% of the funding obligations of its production-sharing agreements in return for an additional 15% increase in its working interest.

DNO can recover its well costs from future Tawke oil production under the cost oil entitlement because the well is located within the Dihok PSA area. In the government negotiations, DNO said it made some adjustments to its Dihok PSA area.

"Some areas at the eastern border have been removed in return for receiving some new acreage to the south," DNO said. "Another area has also been relinquished, and no further relinquishments will be required until June 2011."

To deliver Tawke oil to the main northern pipeline, DNO has installed 8 km of a 42-km pipeline, and central processing facilities with a 50,000 b/d capacity will now be transported to the Tawke area for installation and commissioning.

This year DNO plans to drill 18 development wells, which include oil producers and water injectors. Three rigs will be dedicated to Tawke for most of 2007.

DNO said that its Tawke No. 2 appraisal well was an oil producer following an oil flow test of 3,840 b/d. Tawke-2 is 2 km west of the Tawke No.1 discovery well.

DNO has moved its rig to the Tawke No. 4 location some 0.8 km to the northeast of Tawke No.1 and will develop Tawke-4 as an oil producer in early 2007. ✦

Processing — *Quick Takes*

Aramco to cut ethane in petrochemical feeds

Saudi Aramco expects to reduce the proportion of ethane in petrochemical feedstock to 60% by the end of the decade, down from 100% during the 1980s, said Khalid A. Al-Falih, the company's industrial relations senior vice-president.

Speaking during a Gulf Petrochemical and Chemical Association Forum in Dubai late last month, al-Falih discussed evolving regional feedstock parameters.

Al-Falih said associated gas has an ethane content of 18-20% while nonassociated gas has an ethane content of 4-6%. Saudi Aramco's incremental gas production capacity is not expected to yield significant quantities of associated gas.

Industry has developed effective feedstock with lower ethane content by using propane and butane. Ethane accounted for 100% of regional petrochemical feedstock from the 1980s through 1990, he said. In 1992, Arabian Petrochemical Co. mixed propane with ethane as a cracker feedstock.

Air Products starts up Port Arthur hydrogen plant

Air Products & Chemicals Inc. has brought on stream a second hydrogen production facility at Port Arthur, Tex.

The facility supplies high-purity hydrogen to Valero Energy Corp.'s 250,000 b/cd Port Arthur refinery and other Gulf Coast refiners. It is part of Air Products' Gulf Coast hydrogen pipeline network, which has a capacity of more than 900 MMscfd, following the recent completion of several projects. Jeffry L. Byrne, Air

Products' vice-president and general manager for tonnage gases, said the company plans to add additional capacity to the network as needed.

Air Products also plans in 2008 to bring on stream a second hydrogen facility at Edmonton, Alta. This facility will be the first commercial plant in Canada to provide hydrogen for upgrading Canadian oil sands.

Shell lets effluent plant EPC to Saipem, partners

Qatar Shell Ltd. awarded Saipem SPA and two partners a €255 million contract for the engineering, procurement, and construction of an effluent treatment plant to serve the planned 140,000 b/d Pearl gas-to-liquids (GTL) project in Qatar (OGJ Online, July 27, 2006). Saipem will partner with Abu Dhabi-based Al Jaber and will participate in a 50-50 joint venture with OTV, a subsidiary of France's Veolia Environment.

The plant, to be located in Ras Laffan Industrial City 85 km north of Doha, will treat water coming out of the two-train GTL complex. The effluent plant will be completed in two phases—in summer 2009 and summer 2010, respectively.

The $18 billion Pearl GTL also will be developed in two phases, with the first phase to begin producing 70,000 b/d of GTL products in 2009 and the second phase to be completed less than 2 years later. ✦

Transportation — *Quick Takes*

Break shuts Venezuela's ICO gas line

Venezuela's Interconnection Centro Occidente natural gas pipeline, which experienced a rupture at a joint on Dec. 6, 2006, is under repair and likely to remain shut-in until early February.

The 36-in, 70-km line carries gas from the East Falcon fields to the Paraguana Peninsula refining complex.

The PetroCumarebo mixed company began shipping 10 MMcfd of gas into the ICO pipeline last year from Cumarebo field (OGJ Online, Aug. 8, 2006).

Cumarebo field is operated by the PetroCumarebo mixed company, a joint venture of Petroleos de Venezuela SA (60%) and Vinccler Oil & Gas CA, a subsidiary of PetroFalcon Corp., Carpinteria, Calif. (40%).

Saipem to expand Dampier-Bunbury pipeline

Saipem SPA has received a $328.6 million contract from the DBP Group to expand the Dampier-Bunbury pipeline in Western Australia by first quarter 2008. The contract signals further capital expenditure in electric power generation and value-added processing in southwestern Western Australia (OGJ Online, Feb. 21, 2006).

Saipem will design, install, and precommission 570 km of nominal bore pipeline and associated facilities. Construction will occur alongside half the existing mainline, Saipem said. The proposed Stage 5A expansion will handle an extra 100 TJ/day of natural gas.

Saipem originally built the Dampier-to-Bunbury pipeline in the 1980s.

In September, DBP Group said the timing of Stages 5B and 5C depends on a range of issues, including the price and availability of gas to support new resource processing and power generation developments.

PGN solicits bids for Riau-North Sumatra gas line

Indonesia's state-owned gas distributor PT Perusahaan Gas Negara (PGN) plans to invite bids for construction of a $600 million, 360-km gas pipeline to link Riau and North Sumatra.

The pipeline, which will carry 200-300 MMscf of gas from Duri, in Riau, to Medan, in North Sumatra, is expected to come on stream by yearend 2007.

PGN Pres. Sutikno said the projected pipeline would connect with two other lines currently under construction.

One will extend between Grissik in South Sumatra and Rawa Maju in West Java, while the other will join Pagardewa in South Sumatra and Cilegon in Banten. The two lines, spanning 1,106 km, will be able to transport 950 MMscfd of gas.

Indonesia has come under pressure to accelerate development of the country's gas infrastructure.

In October, the Indonesian Chamber of Commerce and Industry (Kadin) asked the government to draw up a policy to accelerate development to ensure domestic gas supply to meet rising demand.

"Gas distribution infrastructure which has already been planned should be built soon," said Gito Ganindito, Kadin deputy chairman for mining affairs, responding to reports on the sluggish construction of Indonesia's gas infrastructure and its shortages of gas for the domestic market.

China begins receiving oil via Mekong River

China has begun receiving oil shipments from Thailand via the Mekong River, marking the start of an experimental program announced earlier this year (OGJ, Apr. 10, 2006, p. 28).

Two ships, each carrying 150 tonnes of oil, arrived in southwest China's Yunnan Province on the Mekong River, which is being viewed as an alternative to the Strait of Malacca as a regular route for shipping oil to China.

China in March signed an agreement with Laos, Myanmar, and Thailand on shipping oil on the waterway, with an initial shipping quota of 1,200 tonnes/month.

But the three Southeast Asian nations later agreed to raise the quota after China set up an emergency response team to ensure the safety of the shipments.

Experts said as much as 200,000 tonnes of oil would be shipped to Yunnan via the Mekong when the quota was scrapped and the transportation cost was about $25/tonne less than for shipping by land.

Because of the increased quota, Qiao Xinmin, chief of the Yunnan provincial maritime affairs bureau, said China would ship about 70,000 tonnes/year of oil from Thailand alone via the river.

According to Qiao, more than 20 experts from China, Laos, Myanmar, and Thailand are checking ports and oil shipping facilities along the river, studying the feasibility of shipping even larger volumes of oil. ✦

Calendar

✦ Denotes new listing or a change in previously published information.

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2007

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Offshore Asia Conference & Exhibition, Kuala Lumpur, (918) 831-9160, (918) 831-9161 (fax), e-mail: oaconference@pennwell.com, website: www.offshoreas-iaevent.com. 16-18.

GTLtec Conference, Doha, (65) 6345 7322, (65) 6345 5928 (fax), e-mail: cynthia@cmtsp.com.sg, website: www.gtltec.com. 22-23.

Power-Gen Middle East Conference, Manama, (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.pennwell.com. 22-24.

API Exploration and Production Winter Standards Meeting, Scottsdale, Ariz., (202) 682-8000, (202) 682-8222 (fax), website: www.api.org. 22-26.

Deepwater Operations Conference & Exhibition, Galveston, Tex., (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.deepwater-operations.com. 23-25.

SPE Hydraulic Fracturing Technology Conference, College Station, Tex., (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 29-31.

Underwater Intervention Conference, New Orleans, (281) 893-8539, (281) 893-5118 (fax), website: www.underwaterintervention.com. Jan. 30-Feb.1.

FEBRUARY

NAPE Expo, Houston, (817) 847-7700, (817) 847-7704 (fax), e-mail: nape@landman.org, website: www.napeonline.com. 1-2.

IPAA Small Cap Conference, Boca Raton, Fla., (202) 857-4722, (202) 857-4799 (fax), website: www.ipaa.org/meetings. 5-8.

IADC Health, Safety, Environment & Training Conference & Exhibition, Houston, (713) 292-1945, (713) 292-1946 (fax); e-mail: info@iadc.org, website: www.iadc.org. 6-7.

Russia Offshore Oil & Gas Conference, Moscow, +44 (0) 1242 529 090, +44 (0) 1242 060 (fax), e-mail: wra@theenergyexchange.co.uk, website: www.theenergyex-change.co.uk. 7-8.

Multiphase Pumping & Technologies Conference & Exhibition, Abu Dhabi, (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.multi-phasepumping.com. 11-13.

SPE Middle East Oil & Gas Show & Conference (MEOS), Bahrain, +44 20 7840 2139, +44 20 7840 2119 (fax), e-mail: meos@oesallworld.com, website: www.allworldexhibitions.com. 11-14.

International Petrochemicals & Gas Technology Conference & Exhibition, London, +44 (0) 20 7357 8394, e-mail: Conference@EuroPetro.com, website: www.europetro.com. 12-13.

IP Week, London, +44(0)20 7467 7100, +44(0)20 7580 2230 (fax); e-mail: events@energyinst.org.uk, website: www.ipweek.co.uk. 12-15.

Pipeline Pigging & Integrity Management Conference, Houston, (713) 521-5929, (713) 521-9255 (fax), e-mail: info@clarion.org, website: www.clarion.org. 12-15.

CERA Week, Houston, (800) 597-4793, (617) 866-5901, (fax), e-mail: register@cera.com, website: www.cera.com/ceraweek. 12-16.

International Downstream Technology & Catalyst Conference & Exhibition, London, +44 (0) 20 7357 8394, e-mail: Conference@EuroPetro.com, website: www.europetro.com. 14-15.

Pakistan Oil & Gas Conference, Islamabad, (92-21) 6634795, (92-21) 6634795 (fax), website: www.pakoil-gas.com. 18-20.

SPE/IADC Drilling Conference and Exhibition, Amsterdam, (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 20-22.

AustralAsian Oil Gas Conference and Exhibition, Perth, (704) 365-0041, (704) 365-8426 (fax), e-mail: sarahv@imexmgt.com, website: www.imexmgt.com. 21-23.

Pipe Line Contractors Association Annual Meeting, Aventura, Fla., (214) 969-2700, e-mail: plca@plca.org, website: www.plca.org. 21-25.

International Conference and Exhibition on Geo-Resources in the Middle East and North Africa, Cairo, 00202 3446411, 00202 3448573 (fax), e-mail: alisadek@mailer.eun.eg, website: www.grmena.com.eg. 24-28.

Laurance Reid Gas Conditioning Conference, Norman, Okla., (405) 325-3136, (405) 325-7329 (fax), e-mail: bettyk@ou.edu, website: www.lrgcc.org. 25-28.

CERA East Meets West Executive Conference, Istanbul, (800) 597-4793, (617) 866-5992 (fax), e-mail: register@cera.com, website: www.cera.com. 26-28.

SPE Reservoir Simulation Symposium, Houston, (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 26-28.

Subsea Tieback Forum & Exhibition, Galveston, Tex., (918) 831-9160, (918) 831-9161 (fax), e-mail: registration@pennwell.com, website: www.subseatiebackforum.com. Feb. 27-Mar. 1.

International Symposium on Oilfield Chemistry, Houston, (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. Feb. 28-Mar. 2.

MARCH

Natural Gas Conference, Calgary, Alta., (403) 220-2380, (403) 284-4181 (fax), e-mail: jstaple@ceri.ca, website: www.ceri.ca. 5-6.

Gas Arabia International Conference, Abu Dhabi, +44 (0) 1242 529 090, +44 (0) 1242 060 (fax), e-mail: wra@theenergyexchange.co.uk, website: www.theenergyexchange.co.uk. 5-7.

SPE E&P Environmental and Safety Conference, Galveston, Tex., (972) 952-9393, (972) 952-9435 (fax), e-mail: spedal@spe.org, website: www.spe.org. 5-7.

International Pump Users Symposium, Houston, (979) 845-7417, (979) 847-9500 (fax), website: http://turbolab.tamu.edu. 5-8.

Purvin & Gertz International LPG Seminar, Houston, (713) 236-0318 x229, (713) 331 4000 (fax), website: www.purvingertz.com. 5-8.

African Refiners Week, Cape Town, +44 (0)20 7343 0014, +44 (0)20 7343 0015 (fax), website: www.afrra.org. 5-9.

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The webcast will be based on the annual Forecast and Review special report appearing this year in the January 15 issue of Oil & Gas Journal. The Forecast and Review projects oil and gas demand worldwide and in the US for the new year. The US forecast analyzes demand by petroleum product (such as gasoline, diesel, jet fuel, and so forth). As the name implies, the report compares the forecast with estimates for actual numbers for the prior year. In addition to oil and gas markets, the Forecast and Review includes a forecast for US and Canadian drilling activity.

The format for the webcast will include predictions made at this time last year for 2006. Bob Tippee, Editor, will make the presentation. If schedules permit, Marilyn Radler, Senior Editor-Economics, and G. Alan Petzet, Chief Editor-Exploration, will be on hand for questions. Marilyn assembles the numbers and writes copy for the supply-demand portions of the Forecast and Review. Alan does the drilling forecast.

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EOR awaits new CO_2 sources

Guntis Moritis
Production Editor

Field examples continue to show the value of carbon dioxide injection for enhancing oil production.

The Permian basin of West Texas and Eastern New Mexico remains the most active area, but this technology has potential for other regions of the world, as noted at last December's annual CO_2 flooding conference in Midland, Tex.

The conference was the 12th held and with about 350 attending, the largest in attendance to date. Over the years, attendance at the conference has fluctuated, largely reflecting oil price swings.

In the last 4 years, the CO_2 conference has added a carbon management workshop, with the last one held in Houston prior to the Midland venue.

The heightened worldwide interest in managing carbon emissions with geologic storage of CO_2 may provide the industry new incentives for converting this waste product into a valuable asset for recovering additional oil from mature reservoirs.

The Society of Petroleum Engineers-Permian Basin Section and University of Texas of the Permian Basin were two of the conference sponsors.

Flood examples

Although CO_2 EOR is a proven technology, the process requires extensive engineering and usually involves a phased development as well as close monitoring and multiple adjustments during a flood's life.

The Denver Unit in Wasson field in West Texas is a prime example of a CO_2 flood that continues to evolve. Wasson, discovered in 1935, held an estimated 4 billion bbl of oil initially in place and produces primarily from a 300-ft thick San Andres carbonate.

Prior to the formation of a waterflood unit in 1964, primary oil production from the wells in the unit area peaked at about 50,000 b/d in 1946. Waterflooding led to a new peak oil production plateau of about 150,000 b/d from 1972-80 prior to the onset of a production decline.

To arrest the decline, Shell Oil Co., then operator of the unit, in 1984 initiated CO_2 injection in the eastern part of the unit. Unlike waterflooding, CO_2 injection did not create another peak but did lower the decline rate. The initial response to CO_2 injection leveled the production to 35,000-40,000 b/d. Occidental Permian Ltd. now operates the unit, which currently produces about 29,000 bo/d attributed to CO_2 injection.

Maintaining these production levels required the unit to undergo various changes as more was learned about the process, according to a presentation at the Midland conference. Changes included:

- Changing the continuous CO_2 injection in the eastern part to water-alternating-gas (WAG) injection and expanding the CO_2 injection to the western and central part of the unit in 1989.
- Stopping CO_2 injection in the southern part of the unit and in nonperforming patterns in the central area in 1992.
- Revising the approved CO_2 slug sizes in the eastern area to 60% from 40% hydrocarbon pore volume in 1994, to 80% in 1996, and to 100% in 2001. The increases in slug size allow CO_2 to enter more portions of the moderate and low-permeability layers.
- Changing from an inverted nine-spot pattern in the eastern area to a semi-infill line drive in 1996.
- Developing the transition zone in the eastern area in 1996.
- Continuing to optimize the chase water volumes and WAGs based on pattern maturity.

Other areas

Outside the Permian basin some other CO_2 EOR activity includes Denbury Resources Inc. expanding CO_2 EOR to new fields in Mississippi, Anadarko Petroleum Corp. continuing phased development of CO_2 injection in Salt Creek field in Wyoming, and Apache Canada Ltd. evaluating pilot projects that inject acid gas in previously waterflooded pinnacle reefs in Alberta. A project is also slated for Croatia.

The North Sea is another area with potential projects. BP PLC has proposed a CO_2 EOR project in Miller field, off UK, and Shell and Statoil ASA have announced a feasibility study on Draugen field, off Norway. Both these North Sea projects would use CO_2 from newly built onshore power plants.

New CO_2 sources are vital for expanding CO_2 EOR. Even the expansion of projects in the Permian basin is limited by constraints in CO_2 supply. ✦

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Editorial

The role of business

Fad words come and go in business, usually without hurting anything but communication. A specimen now in circulation, however, is more insidious than most.

The culprit is "stakeholder," of which corporations now have many, which is as precise as anyone can be where stakeholders are concerned. The word encompasses all people who might be affected by a corporation's actions: employees, neighbors, customers, contractors, suppliers, breathers of air and drinkers of water downstream of its waste outlets, environmental activists, human rights advocates, and anyone else willing to claim a "stake," loosely defined. Some corporate managers seem to adore the word, which implies social relevance. They send out "Dear stakeholder" letters.

Blurring boundaries

With one exception, emergence of a stakeholder class does no particular harm. It upholds healthy egalitarianism and provides useful affirmation that corporate deeds have consequences, some potentially malign. The exception is how much "stakeholder" sounds like "shareholder" and thus blurs critical boundaries.

Shareholders own corporations; stakeholders own nothing unless they also hold shares. Shareholders assume risks, enjoy profits in good times, sustain losses in bad times, and take responsibility—some direct, some indirect—at all times; stakeholders embody concern about how corporations perform in specific areas, mostly nonfinancial, but assume no responsibility. Shareholders and the managers they employ can make occasional mistakes but cannot be wrong consistently and remain in business; stakeholders can ride the cycles of fashionable opinion and lose nothing when they're wrong. Shareholders and stakeholders play legitimate roles in business. But the roles are distinct and need to be kept that way.

A reminder of the importance of this distinction came in November with the death of eminent economist Milton Friedman. In 1970, when the social role of business became a popular issue, Friedman wrote an essay published in the New York Times Magazine with a message encapsulated in its title: "The Social Responsibility of Business is to Increase its Profits."

Friedman argued that the exercise of "social responsibility" by a business executive can amount to the imposition of taxes and to decision-making by an unelected agent of how to spend the proceeds. This occurs, he reasoned, when the executive's actions reduce returns, raise prices, or lower wages on behalf of social goals that stockholders, customers, or employees could pursue on their own but on which they would spend their own money differently. Friedman, a champion of market freedom, considered such activity by business people ineffective and politically unacceptable. "The doctrine of 'social responsibility,'" he wrote, "involves the acceptance of the socialist view that political mechanisms, not market mechanisms, are the appropriate way to determine the allocation of scarce resources to alternative uses."

Although the word "stakeholder" didn't in 1970 enjoy the popularity that it does now, Friedman's essay addressed the familiar fusion of stakeholding with shareholding for the purpose of advancing political agendas. The oil and gas industry has had a full share of this as activists buy stock and try to influence corporate policies on public issues such as global warming.

"In most of these cases, what is in effect involved is some stockholders trying to get other stockholders (or customers or employees) to contribute against their will to 'social' causes favored by the activists," Friedman wrote. "Insofar as they succeed, they are again imposing taxes and spending the proceeds."

Profits, prosperity

Friedman wrote his essay at a time when business people, to his expressed dismay, were supporting the imposition by a Republican administration of wage and price controls aimed at combating inflation. It was a time when socialism had more support, at least in the US, than it does now. It was a time before events had demonstrated the perils of overregulation and market intrusions by governments. It was a time when profits tended to be disparaged as manifestations of greed.

Countries and populations have prospered since then to the extent governments and corporations followed Friedman's guidance on the role of business. Yet calls persist for businesses to assume social responsibilities best left with people. In the prevention of any such retrogression, everyone has a stake. ✦

US industry expects political excitement to continue in '07

Nick Snow
Washington Correspondent

The US oil and gas industry is entering 2007 with much the same fervor as a year ago, according to industry and trade association executives.

Although 2006 was a year when energy played a prominent role in the nation's politics, industry leaders believe this year's political scene could be every bit as unpredictable and exciting.

And this wouldn't be just because Democrats now control both the House of Representatives and Senate for the first time in 12 years, they said.

"The Democrats have been in charge before. Bipartisan participation still is needed to adopt major proposals, said William F. Whitsitt, president of the Domestic Petroleum Council. "I believe that in the end, a lot of Democrats and Republicans are concerned about major energy issues."

Several Washington, DC-based trade association officials began meeting with federal lawmakers and their staffs soon after November's election. "Our mission hasn't changed because the gavels have moved from the Republicans to the Democrats," said Charles T. Drevna, executive vice-president at the National Petrochemical & Refiners Association.

"The Democrats have been in charge before. Bipartisan participation still is needed to adopt major proposals."
—DPC Pres. William F. Whitsitt

Drevna said the first 100 hr of the 110th Congress, during which incoming House Speaker Nancy Pelosi of California said the new majority would make significant changes, might not be as encompassing as originally thought. But he and other industry association officials also said they lacked specific information about the Democrats' plans when they spoke with OGJ in mid to late-December. "That's only the beginning of the 110th Congress. I expect it to look hard at our industry," Drevna said.

"The Democrats have kept their plans secret," said Brian T. Petty, senior vice-president for government affairs at the International Association of Drilling Contractors. "They could hold investigatory hearings, but it's still not certain what they'll do beyond that."

'Hard-pressed'

Petty also has not seen specifics for the Democrats' first 100 hr, but he expected an effort to repeal geologic and geophysical expense amortization on successful wells and other provisions in the 2005 Energy Policy Act (EPA) favorable to oil and gas. "Even our Blue Dog friends will be hard-pressed not to vote for a gigantic bill that plants the flag for

the Democrats," Petty said.

The Independent Petroleum Association of America is drawing on the political expertise of its staff, some of whom have worked in Washington for decades. "We've already spent time meeting with new members and committee staffs," said IPAA Pres. Barry Russell, who noted that 65 contacts were made from early November to mid-December.

"But it's also very important for the industry to speak with one voice," Russell said. "Our grassroots network lets us work with other associations, such as landowners and drilling contractors, as well as state and regional oil and gas groups."

IPAA Chairman Mike Linn anticipates the group will need to defend independent producers from potentially damaging legislation more than it did when Republicans controlled Congress.

"We're reaching out to Democrats who have helped us in the past, such as incoming Senate Energy and Natural Resources Committee Chairman Jeff Bingaman of New Mexico. He understands independents and their commitments, particularly reinvesting 150% of their profits," said Linn, who also is president and chief executive officer of Linn Energy LLC of Pittsburgh.

Lee O. Fuller, IPAA vice-president of government relations, said congressional Democrats' plans for their first 100 hr may have evolved from repealing the 2005 EPA's provision dealing with geologic and geophysical expenses to removing all Republican-enacted oil and gas incentives.

Other possibilities

"It's somewhat of a shifting target," Fuller said, adding that the 110th Congress also could examine domestic producers' inclusion in a manufacturers' tax cut and trying to recover federal royalties believed lost from the omission of price thresholds from those 1998 and 1999 deepwater leases. "It's an issue that's going to be addressed. We expect some formulation to pass," Fuller said of the latter issue.

Whitsitt said he hoped progress was being made on convincing House and Senate members not to repeal the tax exemption for intangible drilling costs, which he suggested "would be a killer for the industry."

Whitsitt said, "To their credit, very senior Democratic staff members have been very receptive. In some cases, they've gone out of their way to hear what we have to say."

"It's also very important for the industry to speak with one voice."
—IPAA Pres. Barry Russell

"Even our Blue Dog friends will be hard-pressed not to vote for a gigantic bill that plants the flag for the Democrats."
—Brian T. Petty, IADC senior vice-president, government affairs

Other industry associations expect to be less directly affected by 2007 congressional actions. "This next Congress will do some things differently, such as exercise more oversight, said Tom Fry, president of the National Ocean Industries Association. "But our issues traditionally have been more regional than partisan." Association executives also believe federal legislative deliberations over global climate change this year could have longer-term impacts on their members' businesses.

"The ground was shifting before the elections, even though there were some members of Congress in denial," said Donald F. Santa Jr., president of the Interstate Natural Gas Association of America. "But the change in committee chairmanships will accelerate the discussion."

'Fully participate'

Discussions in 2007 could help set the stage for consideration of mandatory carbon controls or other major steps in 2008 and beyond, Santa said. "The main drivers involve constructing a program to deal with oil, gas, and coal. Gas produces less carbon dioxide than the other two, but its companies still need to be part of the discussions," he said.

"The main issue involves mechanics. How do you put together a program that discourages greenhouse gas emissions and encourages alternatives while fully considering economic consequences?" said Martin E. Edwards III, INGAA vice-president for legislative affairs.

Santa raised some specific questions: "At what point do you regulate emissions? To which segments do you assign responsibility for allowances? Who absorbs the cost?"

Trying to identify potential costs of a program driven by environmental considerations can be difficult, however. "We've had some significant increases in oil and gas prices, but they haven't made a long-term economic impact," said Terry D. Boss, INGAA senior vice-president for regulatory affairs.

Yet not doing anything and sticking with established technologies also poses

a risk, Santa said. He noted that one INGAA member company, which has a local distribution division, found that 40% of its load growth is at established sites as consumers buy more computers and other high-technology appliances.

"The challenge becomes producing more energy and finding more ways to deliver it," Santa said.

Special interests

Drevna expects a lively global climate change debate in the Senate, where incoming Environment and Public Works Committee Chairwoman Barbara Boxer (D-Calif.) has decided that two subcommittees will need to take jurisdiction. But the NPRA official also said it will be imperative to keep some special interest groups with powerful lobbies in check.

"The challenge becomes producing more energy, and finding more ways to deliver it."
—INGAA Pres. Donald F. Santa Jr.

"When the president talked about a US addiction to oil, that did more politically to create uncertainty and a push toward unsound policies," Drevna said, adding, "If this country is addicted to oil, ethanol is not the methadone."

At the same time, Drevna said, Congress should become more aware that petrochemical and other industries are finding it hard to compete worldwide because domestic gas prices are higher than those in other countries.

"There are politicians who are dismayed about overseas outsourcing of computer technology jobs. That will pale in comparison if we allow the same thing to happen to the petrochemical industry," Drevna warned.

Producers also are concerned that not enough attention is being paid to finding supplies to satisfy additional demand. "We're on borrowed time," said Whitsitt. "We haven't seen the necessary long-term supply response. Regardless of who's in charge, Congress can either do things that make this situation better or impede the progress we're making."

Whitsitt and some other association officials don't expect more radical proposals to get far this year. But DPC's president warned that they could send the wrong signals to markets and discourage investment.

"We're trying to point out to the new leadership and our friends in Congress that we take the natural gas supply situation very seriously. To some extent, their proposals may affect decisions, even if they aren't adopted," Whitsitt said.

Fund programs

IPAA wants to preserve recently enacted or launched programs that help its members produce more domestic oil and gas. Fuller cited the US Bureau of Land Management's drilling permit processing pilot program, which is reducing backlogs in the Rocky Mountains but needs to keep its funding in the 2005 EPA as well as the $50 million designated for oil and gas research and development.

"The administration will have many matters competing for its attention," Fuller said. "It also will be dealing with a Democratic Congress that will probably be more aggressive in its oversight. That, by itself, will make it less appealing to make a controversial decision."

Hardly any industry association official in Washington expects additional Outer Continental Shelf legislation in Congress during 2007, largely because the bill which passed late in 2006 was very significant.

"Those 8.3 million acres represent about a 20% increase from the areas already under lease," NOIA's Fry said. "That's pretty big, but challenges need to be overcome. It's a long way from shore, but infrastructure is fairly close. We look forward to the first lease sale as soon as possible."

"If this country is addicted to oil, ethanol is not the methadone."
—NPRA Executive Vice-Pres. Charles T. Drevna

But the 2006 bill also established a precedent of sharing federal OCS revenues with coastal states, which must absorb the impact of such activity and provide support services, Fry said. Virginia's interest in possibly participating, and its inclusion in the US Minerals Management Service's 5-year plan, now being prepared, may encourage other states' policymakers to consider acting, he said.

"The first bill in Virginia was vetoed for procedural reasons in 2005,

but it stimulated both of its US senators to become vocal supporters where they'd previously been ambivalent," Fry said. "This showed us the importance of working even in noncoastal states such as Utah or Tennessee in getting legislatures to pass resolutions of support. In other coastal states, we've tried to build coalitions with chemical and other manufacturers to promote similar actions."

'Signal for future'

Petty sees the comprehensive energy strategy bill—which includes possible OCS activity off Virginia—that the state's legislature passed in 2006 and Gov. Timothy M. Kaine signed into law, as "a signal for the future, at least for the eastern seaboard states."

Petty thinks Georgia and South Carolina are likelier to consider similar steps than Florida, which the IADC official considers closer to California in its attitude toward offshore oil and gas activity. But he also said that some Floridians might press for change if Cuba exercises its sovereign rights and starts exploring and developing resources off its coast, particularly if it's with financial assistance from China.

Petty also anticipates that foreign energy confrontations, such as that of Belarus and Russia's OAO Gazprom, will have an increasing US impact if Europe and other consuming

"The first bill in Virginia was vetoed for procedural reasons in 2005, but it stimulated both of its US senators to become vocal supporters where they'd previously been ambivalent."
—NOIA Pres. Tom Fry

areas decide to diversify their resources and compete more aggressively for other supplies.

"The world outside the US will increasingly drive domestic oil and gas issues. There's no way to stop it," Petty said.

Whitsitt conceded that the Senate, with its more deliberate approach in which 60 votes are still needed to stop a filibuster, probably would stop more radical proposals that may pass the House.

"But just because there's that institutional ability, I think it's incumbent to not look simplistically at energy issues," Whitsitt said. "I think we need to be focused on energy policy questions from the beginning, whether it's in the Senate, the House, or the administration. We need to keep talking about things that matter to domestic producers and to the rest of the country." ✦

Iran's nuclear stance may reflect oil export declines

Nick Snow
Washington Correspondent

Iran may need to develop nuclear power plants to meet domestic energy requirements because its crude oil operations are seriously declining, a Johns Hopkins University researcher suggests.

Recent analyses by former National Iranian Oil Co. officials project that the country's oil exports could disappear in 12-19 years, according to Roger Stern, a graduate student in the Geography and Environmental Engineering Department at Johns Hopkins's Whiting School of Engineering in Baltimore.

"It therefore seems possible that Iran's claim to need nuclear power might be genuine, an indicator of distress from anticipated export revenue shortfalls. If so, the [Iranian] regime may be more vulnerable than is presently understood," he said in an article published online in the Dec. 26 Proceedings of the National Academy of Sciences (www.pnas.org).

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—Roger Stern, Johns Hopkins University researcher

Stern said that most of Iran's oil export revenue comes from monopoly rents derived from the difference between the market and competitive prices. In Iran and other producing countries that subsidize domestic demand, pressure on exports can occur when demand grows more quickly than supplies, he said.

"This is what happened to Iran. Since 1980, energy demand growth (6.4%) has exceeded supply growth (5.6%), with exports stagnant since a 1996 peak," Stern said.

The country's recent oil production decline and resulting failure to meet its Organization of Petroleum Exporting Countries quota in all but 22% of the months since the Iran-Iraq War ended may signal that exports already are dropping, he said.

Stern said that Iran's 8% oil depletion rate, which is higher than the 5-6% global average, can be combined with the country's 5% oil demand growth to determine a 10% export decline rate. He said a former petroleum minister has suggested that Iran's oil depletion rate is closer to 10%, which implies a 12% export decline rate (EDR).

"Both 10% and 12% EDR estimates are conservative. These estimates ignore offshore production, where depletion is higher, and assume refinery leakage and depletion to be linear, whereas depletion recently increased," said Stern.

Investment's role

Foreign investment in Iranian oil and gas operations may be falling short of what is needed to arrest declines in production and exports, he continued. Such investment has averaged $2.1 billion/year since 2000, which exceeds the $1.6-1.9 billion/year amount he estimated was necessary to halt export declines. "However, Iran's post-2004 production decline is inconsistent with this expectation," he said.

Stern said that Iran itself makes it harder to extrapolate further what effect lagging investments will have on its oil exports. In 2006, it withheld oil production data, which it previously routinely reported to comply with an annual International Monetary Fund certification, although it issued forecasts that seven new projects due to come on stream in 2006-10 would add as much as 990,000 b/d of production, he said.

Some of the projects face problems, Stern said. Reports in the oil trade press and from Iranian and Japanese sources suggest that the Azadegan project, which is scheduled to add 125,000 b/d of production by 2009, doesn't have a contract. "Therefore, the project cannot produce by 2009 or even 2010 unless a contract is agreed [to] almost immediately, which seems unlikely," Stern said.

Negotiation problems have been compounded by Japan's displeasure with Iran's apparent violations of the nuclear nonproliferation treaty, he continued.

Stern said that another project, the Ahvaz expansion, which is scheduled to add another 255,000 b/d of production in 2009, is equally questionable. NIOC, which is building the project alone, has not led a major project since the 1978 revolution, he said.

"We would expect that if a project of Ahvaz's great size were proceeding without foreign help, it would be a cause for national pride and, therefore, well reported. We find no reports, however," he said.

"Of course, Ahvaz could be proceeding with reportage only in Farsi, which we do not read. This would be atypical, given that English, French, or Italian reporting exists for all other [Iranian] projects. Hence, we believe that neither Ahvaz nor Azadegan will be built on schedule," said Stern.

Iran's ability to attract foreign investment for oil and gas projects may be restricted further by a unique buyback investment vehicle, he continued. In most petroleum exporting countries, foreign exploration and development firms offer capital, technology, and management in exchange for a share of the extracted resource, he explained.

"Iran's constitution considers such arrangements as foreign ownership, which it prohibits. This prohibition has affected disinvestment and deterioration in Iran's petroleum infrastructure, most of which was built before the Iranian Revolution. Compounding the problem is NIOC's inability to lead major project construction," Stern said. ✦

Iranian, Russian project woes hinder Japanese strategy

Troubled projects in Iran and Russia have set back the Japanese government's newly aggressive effort to secure international oil and gas supplies, reports Tomoko Hosoe of FACTS Inc., Honolulu.

Iranian and Russian production is important to a goal announced by the government in May to increase the share of oil developed and imported by Japanese companies to 40% of total imports by 2030 from 15% in recent years.

Hosoe noted in a FACTS report that the strategy included the first numerical targets set for the energy industry in many years and sharply increased the role of government.

Project problems

But the Iranian project central to the strategy, development of Azadegan oil field by Inpex Corp., has stalled.

Inpex, in which the Japanese government holds a 29.35% interest, agreed in October to cut its stake in the Azadegan buyback contract to 10% from 75% and to shift the role of operator to Iran's Naftiran Intertrade Co. The company had signed the contract for appraisal and development with National Iranian Oil Co. in February 2004.

Hosoe said the Azadegan project has suffered through slow mine-clearing from the oil field and consequent refusal by insurance companies to provide coverage for contractors, cost increases that left the project "financially unfeasible," and geopolitical pressure related to Iranian nuclear ambitions.

While it represents a blow to Japanese supply goals, Hosoe said Azadegan's foundering hurts Iranian interests even more because of the reduction in Japanese support and the trouble Iranian companies probably will have advancing the project.

In Russia, the East Siberia-Pacific Ocean oil pipeline is making little progress, Hosoe notes. And recent decisions by the Russian government about the Sakhalin-1 and 2 projects, in both of which Japanese companies hold interests, have conflicted with Japan's supply strategy.

Russia's Natural Resources Ministry and Audit Chamber threw Sakhalin-2 into doubt by revoking environmental licenses and questioning the need for spending increases. Mitsubishi and Mitsui are minority partners in the project with Royal Dutch Shell PLC.

Hosoe cited reports that Russia might divert gas from the Sakhalin-1 project, in which the Japanese group Sodeco holds a 30% interest, to China. And there are concerns that the project might fall subject to the type of environmental resistance that has stalled Sakhalin-2.

Japanese LNG buyers hope for Sakhalin-2 supplies to offset shortfalls in deliveries from Indonesia and to fill shortages that will develop by 2015 unless all existing contracts are renewed as they expire.

Effects on strategy

Although Japanese energy demand will remain unchanged or decline because of an aging and shrinking population, Hosoe said, "The change in the global landscape and the dramatic shifts in the LNG supply availability pose a serious challenge to Japan's energy security."

The "fierce competition from the emerging markets in the region" sets limits on what the government's new strategy can accomplish, the analyst said.

"To go forward and to defend Japan's stake, even more interventionist policies may well be needed—far beyond what the current Japanese system is willing to consider." ✦

CFTC expected to bring action against BP in futures probe

Nick Snow
Washington Correspondent

BP PLC expects the US Commodity Futures Trading Commission staff to recommend that a civil enforcement action be brought against the company over alleged violations of federal commodity exchange regulations.

The allegations are in connection with BP North America's trading of unleaded gasoline futures on Oct. 31, 2002. CFTC's staff notified the company of its plans on Nov. 21, BP said in a Dec. 13 filing with the US Securities and Exchange Commission.

CFTC has been investigating various aspects of BP's crude oil trading and storage activities in the US since 2003, the company said. It added that it has provided, and continues to provide responsive data and other information to the federal regulatory agency.

In a civil action that it filed June 28 in the federal district court for northern Illinois, CFTC charged that BP Products North America cornered the market for February 2004 TET physical propane and manipulated the price.

It also charged the BP products unit with trying to corner the April 2003 TET physical propane market and manipulate the price. BP Products North America denied both charges.

BP said it also is cooperating with CFTC in the gasoline futures trading inquiry. The US attorney for the Northern District of Illinois also is investigating the company's US gasoline trading, it noted.

"Additionally, an independent review of the group's US trading compliance culture and its related systems has been undertaken by KPMG. The review's findings and recommendations, and management's response to them will be made available to the appropriate regulators," BP said in an amendment to its 2006 third-quarter and 9-month financial results report to the SEC.

Supreme Court decision

The disclosure came 2 days after the US Supreme Court ruled against BP in its appeal of the US Minerals Management Service's 1997 demand for coalbed methane royalties that the Department of Interior agency said BP's US exploration and production subsidiary did not pay.

BP America Production Co. contested the order because it came more than 6 years after the alleged underpayment of royalties from gas leases originally held by Amoco Production Co. in New Mexico's San Juan basin. BP assumed the leases when it acquired Amoco Corp. in 1998.

The company argued that the statute of limitations had run out by the time MMS demanded the additional payment. It appealed first to DOI's assistant secretary, who ruled that the statute of limitations did not apply to an MMS administrative order, and then to various federal courts, which upheld the DOI ruling.

The Supreme Court agreed with the lower courts that the 6-year limit applied only to court actions. "In the final analysis, while we appreciate [the] petitioners' arguments, they are insufficient to overcome the plain meaning of the statutory text," it said in the opinion written by Justice Samuel A. Alito Jr.

On Dec. 7, MMS announced that it is billing BP America Inc.'s E&P subsidiary $18.9 million for additional royalties and $13.3 million in interest payments from the leases. Payment for production from June 1991 through May 2006 was due by yearend 2006, MMS Director Johnnie Burton said. ✦

Producers to pay royalties for 1998-99 deepwater leases

Nick Snow
Washington Correspondent

Five Gulf of Mexico producers agreed to pay royalties on their 1998 and 1999 deepwater leases that were originally issued without price thresholds, the US Department of Interior announced on Dec. 14.

BP PLC, ConocoPhillips, Marathon Oil Corp., Shell Oil Co., and Houston independent Walter Oil & Gas Corp. signed agreements under which they will pay royalties for production from Oct. 1 onward, said C. Stephen Allred, DOI assistant secretary for land and minerals management.

"While these agreements we signed today are a step in the right direction, we look forward to continuing to work with Congress on this issue," Allred said. "We appreciate and commend these companies for voluntarily signing these lease amendments. We encourage the remaining companies that have not yet agreed to sign to join us in resolving this issue."

Leases issued under the Deepwater Royalty Relief Act of 1995 included an incentive suspending royalties until a specific amount was produced to encourage producers to explore in areas where costs were high. The incentive did not apply if prices reached a certain level in most years, but was apparently accidentally omitted for leases issued during 1998-99.

Members of Congress demanded that the US Minerals Management Service move aggressively to correct the error when it was discovered early in 2006 and recover revenues that were lost due to the oversight, but some lessees argued that being forced to renegotiate would violate contract law. After consulting with DOI lawyers, MMS Director Johnnie Burton

asked holders of the 1998 and 1999 leases to voluntarily renegotiate terms.

US House members came within two votes of amending the Senate's Outer Continental Shelf leasing reform bill on Dec. 8 and inserting language which would have required holders of the 1998 and 1999 deepwater leases to renegotiate if they expected to bid on future federal OCS tracts. While the vote fell short and the OCS bill passed both the House and Senate, it clearly signaled that deepwater royalty lease renegotiation was a major issue with lawmakers.

Allred said few US deepwater leases produced oil and gas before Oct. 1. "I am pleased at the progress we are making on resolving this issue. While the omitted price thresholds did not occur during this administration, we are continuing to work to resolve this difficult problem in a manner that ensures the American taxpayer receives a fair rate of return," he said. ✦

Gastech: LNG driving changes in gas markets

Angel White
Associate Editor

Driven by the rapid development of LNG, gas markets are being transformed from regional into global markets and have been undergoing other major changes, said Total SA Executive Vice-Pres. Yves-Louis Darricarrere at the 2006 Gastech Conference in Abu Dhabi.

"As long as LNG flows were concentrated east of the Suez Canal and based on inflexible, very long-term contracts, they basically reflected the same relationship of mutual interdependence as when producers and consumers were linked by a gas pipeline. It's just that a different technological solution was used."

He said globalization of gas markets will soon result from the development of consumption in the Atlantic markets combined with the growing liquidity of spot markets such as Henry Hub in the US and the UK's National Balancing Point.

Global gas consumption is expected to continue to grow by 2-3%/year through 2020. Fueled by this demand along with expensive and limited pipe solutions and the gradual depletion of gas fields near main consumer regions—which is pushing supply further and further away from markets—LNG is taking a larger share of the traded gas market. It is growing by 8%/year to represent 40% of traded gas in 2020 and 15% of consumption, Darricarrere said.

"In this context, the Middle East, which sits on one third of the world's natural gas reserves and is located halfway between the two major consumer regions—the United States and Asia—is on the way to becoming the world's leading source of LNG, with a unique position of arbitrating the markets," he said. "The Middle East is where we can observe how the gas industry is changing, not only because of the strategic location of its gas resources, but also [because of the] favorable conditions for the implementation of a variety of new gas technologies."

Gas projects

Darricarrere said megaprojects worldwide, but particularly in Qatar, are becoming "bolder and more daring. LNG projects are not only innovative by their size but by their design and commercial arrangements," he said.

In addition, there is a sharp increase in the number of gas receiving terminals in the main markets, particularly the US and Europe; construction of new long-reach pipelines, such as the 380-km Dolphin pipeline that extends from Qatar to the UAE; and with the development of sour gas and of gas fields in harsh environments, such as that off Sakhalin Island. For all the projects to be launched and meet success, major capital programs will have to be carried out in both producer countries and consumer regions.

According to International Energy Agency estimates, Darricarrere said, capital investments for gas projects over the next 25 years are placed at $3.9 trillion ($156 billion/year), with the largest investment, $2.2 trillion, being in exploration and production followed by $1.3 trillion for pipes, $100 billion for storage, and $300 billion for LNG.

However, he said, there are numerous smaller innovations such as the systematic use of associated gas in the new projects or the multiflow transport of hydrocarbons, which together are very important to bringing more gas resources to the markets in a sustainable and responsible way.

He said it is evident that "[companies will] have to cost-effectively develop gas resources that are located farther and farther from the markets and that are smaller and smaller and more and more difficult to produce."

But just as with many technical challenges, these challenges also will surely be met, Darricarrere said.

Managing growth

Technology and human resources will drive continued innovation in the gas industry, Darricarrere said.

Technology already allows us to reach resources that were previously considered "stranded." Nevertheless, "a sustained effort is required to reach even more difficult developments and transform more stranded gas into commercial fields," he said. "Growth in the gas market, which is very solid, ...cannot be met without deploying more technology in a world where the easiest resources have already been tapped.

"Arctic gas fields, tight gas, very sour gas, small and remote resources will all benefit from new technologies, and, in common with large gas developments,

they all have to address the need to improve the energy efficiency of our plants, particularly in LNG, not to mention GTL [gas-to-liquids]," he added.

Along with the need for technology, the gas industry requires more human resources due to the increasing complexity of gas projects—finding markets, setting commercial terms, managing onshore plants in harmony with host communities and sometimes across borders.

"Sourcing more people locally is critical," for a number of reasons, Darricarrere said. Local know-how is a major advantage in designing projects that benefit all stakeholders. They help in developing markets, in maintaining relations with customers, in supporting local communities in their sustainable development, and in operating and maintaining a plant over 20 years or more. Secondly, maximizing the involvement of the people to whom the projects matter simply makes good business sense.

"Companies that can put forward dedicated technological capabilities and the right people to guide stakeholders through the right decision process then implement the project on time and on budget will not only maximize the benefits for host communities and countries but also help to meet the gas challenges," he concluded. ✦

LNG facility incident prompts security measures

Nick Snow
Washington Correspondent

A mid-August security breach at an LNG facility in Lynn, Mass., should remind other operators of LNG terminals, peak-shaving plants, and other facilities to implement security measures to stop intruders, the US Pipeline and Hazardous Materials Safety Administration said on Dec. 28.

"PHMSA's pipeline safety regulations require operators to implement security regulations that deter intruders. These measures include written procedures, protective enclosures, security communications, lighting, and monitoring," the Department of Transportation agency said in an advisory bulletin.

In the Massachusetts incident, PHMSA said that an LNG facility operator learned during routine maintenance of a gate at the side of a storage tank that security had been breached earlier when intruders broke through the gate. The tank itself was not damaged, the agency added.

"Investigation revealed that the intruders had cut through the outer and inner perimeter fences and through the locked gate to gain access to the storage tank several days before the incident was discovered," PHMSA said.

It noted that the facility's microwave intrusion system documented the break-in on a computer monitoring system that should have alerted operating personnel, but employees did not respond.

"In the days following, personnel conducted several routine visual inspections of the area without noting the cuts in the fences. Although there was also video surveillance of the perimeter, personnel did not review the tape until they investigated the breach," PHMSA said.

Operator's response

The facility is owned and operated by a division of KeySpan Corp. A spokeswoman confirmed that the incident occurred and said that the company responded by internally reviewing its security procedures and hiring an outside security consultant.

It also invited the US Department of Homeland Security to review policies and procedures at the Lynn LNG facility, she told OGJ on Jan. 3. "We made additional adjustments to our security protocols to assure that such an incident doesn't happen again," the spokeswoman said.

The Massachusetts Department of Telecommunications and Energy fined KeySpan $250,000 on Dec. 8 for allegedly violating several safety regulations in the incident. In determining the fine, the department, which is part of the state's consumer affairs and business regulation office, said that it also proposed remedial actions to prevent a similar event in the future.

"The LNG plants in Massachusetts are an important and vital part of the state's gas supply system. They must have in place rigorous security practices and procedures to safeguard their facilities against intruders so that they can continue to function safely with uninterrupted service to their customers. The security personnel and equipment at these plants not only protect the facility, but protect the public as well," said Massachusetts Consumer Affairs and Business Regulation Director Janice S. Tatarka.

In setting the amount of the fine, DTE said it considered the gravity of the security breach, KeySpan's culpability, and remedial actions already undertaken by KeySpan after the incident. Under state regulations, the company has 30 days to respond to the allegations by either signing a consent agreement and paying the fine or requesting a hearing before DTE.

The department also undertook a comprehensive review of all Massachusetts LNG facilities, with help from the state police's Commonwealth Fusion Center Critical Infrastructure Assessment Unit, and submitted a report to Gov. Mitt Romney in September. The review found that LNG facilities in Massachusetts substantially comply with federal and state safety and security regulations, DTE said.

In its Dec. 28 advisory, PHMSA rec-

ommended that LNG plant and facility operators:

- Test systems thoroughly to verify that alarms work and monitoring devices function as intended.
- Ensure that security personnel are properly trained on the security procedures of each facility they monitor.
- Determine whether designated employees can promptly respond to intrusions or other security breaches.
- Update procedures as needed to provide the most effective security and incorporate the most relevant threat information.
- Confirm that remote monitoring station employees properly coordinate activities with parties responsible for security.
- Independently audit LNG plant security or conduct unannounced tests of security systems, procedures and personnel. ✦

COMPANY NEWS

Linn Energy plans three oil, gas acquisitions

Linn Energy LLC has agreed to acquire a private oil and gas company in the Texas Panhandle for $415 million and two Appalachian basin properties for $39 million in three separate transactions.

In other recent company news:

- BG Group PLC has agreed to acquire ConocoPhillips's equity stakes in Armada and Everest fields in the Central North Sea for $143 million.
- UK-based Energy Resource Technology (ERT) has acquired from ExxonMobil Corp. Block 53/1a, which contains Camelot gas field in the southern UK North Sea for an undisclosed sum.
- OAO Lukoil agreed to buy 376 retail outlets in six European countries from ConocoPhillips. The price was not disclosed.
- Indian state refiner Bharat Petroleum Corp. Ltd. (BPCL) agreed to acquire 25% interests in Blocks 48-1B and 48-2C in the UK North Sea's Southern Gas basin.
- Edge Petroleum Corp., Houston, agreed to acquire Anadarko Petroleum Corp.'s stake in Chapman Ranch field oil and gas properties in Nueces County, Tex., for $26 million.
- FieldPoint Petroleum Corp., Cedar Park, Tex., has paid $1.67 million to a privately owned company for a 50% working interest and 43% net revenue interest in Bilbrey field in Lea County, NM.

Linn acquisitions

Linn's Texas transaction involves a field with a production mix of 55% natural gas liquids, 35% natural gas, and 10% oil from more than 820 wells. The acquisition involves proved reserves of 55 MMboe, more that half of which are proved developed.

The Appalachian transactions include more than 55 producing gas wells in West Virginia. Those properties have 24-26 bcf of proved reserves, Linn said.

BG's North Sea deal

BG's acquisition will raise its interest by 11.45% to 58.22% in Armada gas-condensate field and by 1.0134% to 59.32% in Everest oil field.

As part of the agreement, BG also will purchase ConocoPhillips's 16.89% interest in Block 22/14a, southwest of Everest. The deal is expected to close in the first quarter.

BG-operated Armada gas-condensate fields—Fleming, Drake, and Hawkins—span five exploration blocks covering 31 sq km. Initial Armada production began in October 1997. Following two development phases completed in September 2002, the field reached average production rates of 170 MMscfd and 6,400 b/d in 2005.

Everest field, operated by BP PLC, reached average production rates of 115 MMscfd and 4,000 b/d in 2005.

Production from BG-operated Maria field will be tied back to Armada. Estimated reserves for Maria and Maria Horst are about 30 million boe. First production is scheduled for this year.

Armada and Everest gas moves through the CATS pipeline to Teesside, while the produced liquids move through the Forties Pipeline System to the Kinneil processing plant at Grangemouth.

ERT buys into Camelot

Block 53/1a is on the southern margin of the Permian basin, and Camelot field is now considered mature, having produced 150 MMcfd of gas at its peak in 1994.

Alan James, ERT subsea surface manager, told OGJ at the Prospects Fair in London that this was ERT's first asset in the UK and would provide a base for the company to look at nearby prospects and develop them via the Camelot Alpha platform. The platform is a 6-slot, remote unit that can process 120 MMcfd of gas. The Perenco gas plant at Bacton takes gas from Camelot Alpha.

ERT believes that there could be 17.5-30.8 bcf of recoverable gas in the mature satellite area.

"Four kilometers south of the platform lies the undeveloped 53/1a-13 discovery drilled by Mobil in 1996. The vertical well found a 65 ft gas column with very high-quality Rotligendes reservoir but was not tested as at that time it was considered too small to be commercially viable," ERT said. Technological advancements and high gas prices make the development commercially attractive now.

First gas from the discovery will be

PERSONNEL MOVES AND PROMOTIONS

Exploration Co. elects Sigmon as chairman

Exploration Co., San Antonio, has elected **James E. Sigmon** as chairman to succeed **Stephen M. Gose Jr.**, retired after more than 20 years of service.

Sigmon, an engineer and the company's president and chief executive officer, has been president and a director for more than 20 years. Gose, a geologist, had been chairman since July 1984.

Gose continues with Retamco Operating Inc., Billings, Mont., active in several oil and gas projects, mainly in Rocky Mountain basins.

Other moves

Sonoran Energy Inc., Dallas, has appointed **Frank Smith** president and chief financial officer.

Smith's appointment comes 6 months after he joined the company as executive vice-president and chief financial officer. He has more than 30 years of senior banking experience, many of them with oil and gas companies.

Before joining Sonoran, he served as senior vice-president, finance, for Remington Oil & Gas Corp., Dallas.

San Antonio independent Baseline Oil & Gas Corp. has hired **Thomas Kaetzer** as president and chief operating officer.

Kaetzer has 25 years of oil and gas experience, including 14 years with Texaco Inc.

He has experience in both onshore and offshore operations and production management, asset acquisition, and development, including drilling and workover operations in the US, the Gulf of Mexico, the UK North Sea, Colombia, Saudi Arabia, China, and West Africa.

Since 1995, Kaetzer has worked for and served as a consultant or director for several independent E&P companies, including Vastar Resources Inc. and Crimson Exploration Inc.

Deer Lake Oil & Gas Inc., St. John's, Newf., has appointed **James M. Edwards** chairman.

Edwards, of Malakoff, Tex., is responsible for finding experienced oil industry partners to join in the exploration and development of Deer Lake's 400,000 acres of land holdings on Newfoundland's west coast.

Patch International Inc. has appointed **Terry Buchanan** vice-president of exploration, geoscience, and reservoir.

With an extensive knowledge of oil sands projects, Buchanan, will play a key role with respect to the acquisition, exploration, and development of the company's oil sands interests in Alberta.

He has more than 30 years of oil and gas field experience, specializing in reservoir description, hydrocarbon prospecting, completions, and production.

Most recently, he served as the geoscience advisor for Imperial Oil Ltd.

brought on stream during 2007-08 and will contribute to enhancing gas production from Camlot gas field. ERT is working on a development plan to launch the production phase.

"At the end of the project, ERT would use the facilities of the Helix SG Group for decommissioning," it said.

Lukoil's outlet deal

Lukoil's agreement with ConocoPhillips covers 156 outlets in Belgium, 49 in Finland, 44 in the Czech Republic, 30 in Hungary, 83 in Poland, and 14 in the Slovak Republic.

The outlets, carrying the Jet brand fuels, are to be rebranded as Lukoil within 2 years. Subject to regulatory approvals, the transaction is expected to close in the second quarter.

ConocoPhillips plans to increase its interest in Lukoil to 20% through a strategic alliance announced in 2004 (OGJ, Oct. 11, 2004, p. 28).

BPCL's block interests

BPCL is paying $12.2 million to join a consortium led by Encore Oil PLC, London. Recently, BPCL formed an upstream subsidiary, Bharat Petro Resources, which has committed to spend $133 million on four blocks in India and two abroad.

Edge buys Chapman stake

Edge said the transaction means that the company will operate the properties. In 2005, Edge acquired nonoperated interests in seven producing wells from three private companies. The existing stakes involve 44-50% interest in those wells.

Through Anadarko's divestiture, Edge is obtaining an additional interest of 44-50% interest in the seven wells, plus interests in two additional wells. Net production being acquired is 3.6 MMcfd of gas equivalent. Production is 90% gas.

Edge estimates there are at least 10 proved undeveloped sites to be drilled plus additional prospects that the company has yet to verify with a 3D seismic survey and a drilling program.

FieldPoint deal

The reserves being acquired by FieldPoint are expected to add an estimated 108,000 boe in proved developed producing reserves net to the company. The seller's name was not released.

As with its previous acquisitions, FieldPoint plans an active redevelopment program for the property. ConocoPhillips operates the property. ✦

Russia to increase oil, natural gas exports in 2010

Eric Watkins
Senior Correspondent

Russia's Economic Development and Trade Ministry, in forecasting the country's oil and gas production and exports to 2010, said gas exports in 2010 will increase to 223.4 billion cu m and oil exports, to 271 million tonnes.

It said Russia's 2010 natural gas production will increase to 722 billion cu m in 2010, following 655 billion cu m in 2006, 668 billion cu m in 2007, 683 billion cu m in 2008, and 705 billion cu m in 2009.

It forecast gas exports of 202.5 billion cu m in 2006, 200.8 billion cu m in 2007, 208.5 billion cu m in 2008, and 218.4 billion cu m in 2009.

The ministry said oil production will grow to 512 million tonnes in 2010, following 480.4 million tonnes in 2006, 492 million tonnes in 2007, 500 million tonnes in 2008, and 507 million tonnes in 2009.

It expects crude oil exports of 251.5 million tonnes in 2006, 262 million tonnes in 2007, 269 million tonnes in 2008, and 274 million tonnes in 2009.

It also reported that exports of refined petroleum products—103.5 million tonnes in 2006—are forecast to grow to 105 million tonnes in 2010. ✦

WATCHING THE WORLD

Eric Watkins, Senior Correspondent

Price wars

The Russians continue to have problems over oil and gas with their fellow states in the former Soviet Union. Consider Belarus, where the government has imposed a customs duty on Russian crude transported through the country's pipelines.

Belarusian Prime Minister Sergei Sidorsky said the customs duty would amount to $45/tonne of oil effective Jan. 1.

The total customs duty will add up to quite a few dollars, too, since Russia's oil transit through Belarusan pipelines comes to some 70-80 million tonnes/year and reaches several important markets.

The 1,923-km Gomel oil pipeline carries supplies toward Ukraine, Poland, and Germany and accounts for more than 70% of all oil transit through Belarus, while the 1,065-km Novopolotsk oil pipeline handles shipments to the Baltic states.

Tit for tat

Sidorsky, defending his country's action, said a draft of the decree imposing the duty on oil transit, which is legally based on a 2004 law on foreign economic activities, was submitted to the government on Dec. 31, 2006.

"The government instructed the Economy Ministry and the State Customs Committee to inform the Russian Economic Development and Trade Ministry and the Transneft company about this," he said.

Sidorsky also said Russian Prime Minister Mikhail Fradkov and he came to an agreement at a recent meeting: "every possible measure will be taken to relieve the existing tensions."

Tensions? Ah, that's where the drama comes in as the hastily conceived Belarusian tax is actually a counter attack on Russia's recent price rises for gas and crude.

In fact, Belarusian President Alexander Lukashenko lashed out angrily at the Russian leadership over energy price increases, calling its conduct "shameless."

Pay for services

The customs duty and harsh remarks came after Belarus avoided a cut off of its gas supplies on Jan. 1 only by agreeing to pay twice the previous price this year and even more in the future.

The Belarusians also are upset about a new customs duty Russia plans to impose this year on oil exports to its neighbor. The customs duty would deprive the Belarusian government of major profits it has reaped by exporting products made from cheap Russian crude.

As a result, Belarus has reportedly stopped importing Russian oil as a way of persuading Moscow to reconsider the duty of $180/tonne, saying the additional charge makes oil purchases too expensive and could badly damage the economy.

"If they are drowning in petrodollars and other currency income and have decided...to place us in conditions worse even than Germany and other European countries, then let's ask this rich Russia to pay us for our services," said Lukashenko, in nationally televised remarks.

In addition to the customs duties on oil passing through his country, Lukashenko said he had ordered the government "to send Russia a proposal on payment for everything they get here for free—from military facilities and transit." ✦

WEST AFRICA—1

Undiscovered oil potential still large off West Africa

Mohamed Barkindo
Ivan Sandrea
OPEC
Vienna

For more than half a century the West Africa region, in particular the countries bordering the Gulf of Guinea and Congo Delta, has been one of the most exciting and attractive regions in the world for the oil industry.

A review of E&P literature as well as an assessment of the strategy of all major international oil companies reveals that this region has not only remained attractive in recent years but that in the future it will become even more important.

From an E&P perspective, the excellent exploration record and the start of many new fields over the last few years particularly in deep water are proof that the region has remained attractive. However, the facts that oil production will continue to expand in the coming years and that more oil is to be found clearly indicate that the region will become even more important in the future.

The countries that comprise West Africa include Nigeria and several non-OPEC countries. The latter group includes seven important producers, three small producers, and many nonproducers.

The important producers are Angola (defines the southern limit of West Africa), Cameroon, Congo (Brazzaville), Gabon, Equatorial Guinea, Ivory Coast, and Mauritania (defines the northern limit of West Africa). The small producers are Benin, Ghana, and Senegal. The nonproducers include Gambia, Guinea, Guinea Bissau, Liberia, Sao Tome and Principe, Sierra Leone, and Togo.

Considering the well-known challenges that face many of these countries that inevitably affect the oil industry, it is worth reflecting on two key points.

First, the number of exploration wells drilled in West Africa (including Nigeria) over the last 10 years (1996-2005) accounts for 5% of the world total, but in terms of volume the region contributed 21% of the total oil reserves discovered globally and 40% of the reserves discovered in deepwater provinces in the world.

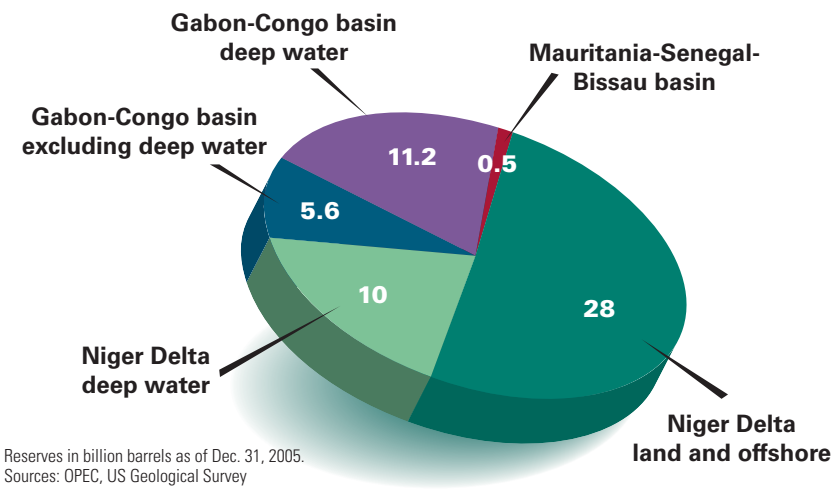
Second, on the supply side, in the last 5 years (2001-05) West Africa excluding Nigeria was the second best performing non-OPEC region after the FSU; the region's oil supply increased to 2.3 million b/d in 2005 from 1.6 million b/d in 2000.

Given that it took 40 years to reach 1.5 million b/d (1960 to 2000), the recent response is clearly strong. Nigeria, the largest producer in West Africa and an OPEC member, also saw its production capacity expand to 2.6 million b/d in 2005 from 2.2 million b/d in 2000, and this came despite unexpected capacity losses in 2003 in some parts of the Delta.

In the medium term, most studies conclude that the region will be able to deliver stronger growth than in the 2001-05 period. OPEC's medium-term world oil supply forecast shows that West Africa's oil production excluding Nigeria is expected to increase to 3.8 million b/d by 2012, driven by over

WEST AFRICA OIL RESERVES BY BASIN

Fig. 1



Reserves in billion barrels as of Dec. 31, 2005.
Sources: OPEC, US Geological Survey

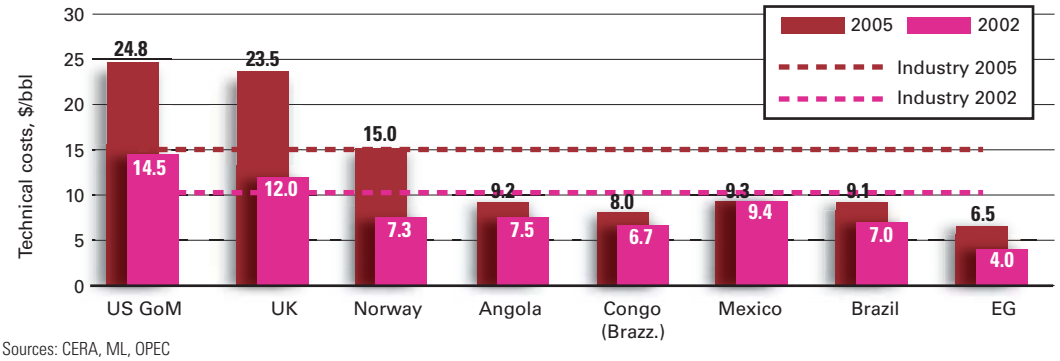
26 new deepwater developments. Nigeria's production capacity will also rise to 4 million to 4.2 million b/d by 2012, driven by more than 15 developments in deep and shallow water.

This article is divided in two parts. Part one provides an overview of recent E&P trends in deep water, undiscovered oil potential, current production by type of environment, cost trends, and active players. Part two will provide a summary of the key projects to come on stream in West Africa and OPEC's medium term oil supply outlook for the main producing countries.

If there is one conclusion to be drawn from this article, it is that despite the well-known challenges that face many West African countries, the region has delivered in the past and will deliver again.

TECHNICAL COSTS IN SELECTED OFFSHORE PRODUCING COUNTRIES

Fig. 2



Sources: CERA, ML, OPEC

WEST AFRICA'S OIL RESERVES

Table 1

	Total discovered			Remaining, split		
	Produced	Remaining	Total	Onshore	Offshore	of which deep water
	Billion bbl					
Angola	6.0	14.4	20.4	0.011	14.40	10.5
Eq. Guinea	1.0	1.6	2.6	0	1.60	1.3
Congo (Brazz.)	2.0	2.0	4.0	0.320	1.65	0.7
Gabon	3.0	1.4	4.4	0.600	0.80	na
Ivory Coast	0.1	0.4	0.5	0	0.40	0.3
Mauritania	0	0.5	0.5	0	0.50	0.5
Subtotal	**12.1**	**20.3**	**32.4**	**0.9**	**19.35**	**13.3**
Rest of West Africa						
Cameroon	1.0	0.3	1.3	0	0.30	0
Guinea Bissau	0	0	0	0	0	0
Sierra Leone	0	0	0	0	0	0
Subtotal	**1.0**	**0.3**	**1.3**	**0**	**0.30**	**0**
Nigeria	**26.0**	**35.2**	**61.2**	**16.4**	**18.80**	**7.3**
Total West Africa	**39.1**	**55.8**	**95.0**	**17.3**	**38.50**	**20.6**

Sources: IHS Inc., OPEC

WEST AFRICA DEEPWATER OIL DISCOVERIES THROUGH 2005

Table 2

	Exploratory wells	No. of discoveries	Discovery volume	Avg. discovery size
			Million bbl	
Nigeria	120	28	7.3	261
Angola	145	53	11.0	208
Eq. Guinea	22	8	1.4	175
Congo (Brazz.)	23	5	0.7	140
Ivory Coast	4	1	0.2	200
Mauritania	18	5	0.5	100
Total	**332**	**100**	**21.0**	**211**

Sources: IHS Inc., OPEC

History and recent trends

West Africa including Nigeria is a large, world-class petroleum province with over 140 billion bbl (2P) of oil and gas reserves discovered since the 1950s.

During the first 40 years, the success of E&P activities was excellent, focusing initially on the onshore and later on the shallow offshore. By the end of 2005, a total of 75 billion bbl of oil (2P) have been discovered in the onshore and shallow offshore, of which 38.6 billion have been produced (Table 1).

A shift to deepwater exploration (>500 m of water) began in the early 1990s, and this has also turned out to be a great success. Since the first well was drilled in 1995, a total of 21 billion bbl of oil reserves have been discovered, of which 500 million bbl have been produced (Table 2).

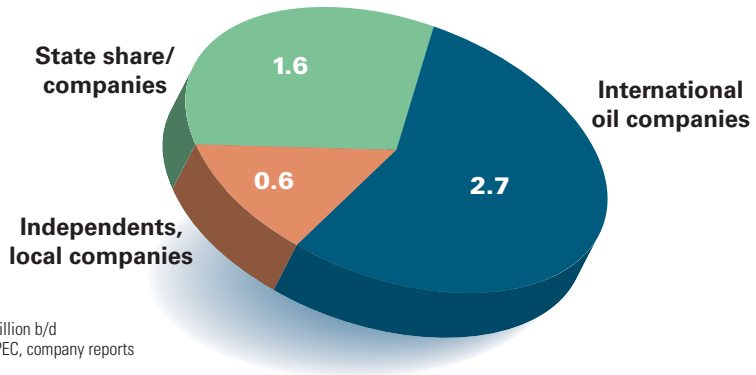
At the end of 2005, total remaining oil reserves (total cumulative discoveries less cumulative production) were estimated at 55 billion bbl, and 25 billion bbl of this were discovered just in the last 10 years (1996-2005). During this period, 567 exploratory wells were drilled, 493 of them offshore, resulting in 225 new oil discoveries (~100 in deep water and 102 in shallow water).

Most of the recent exploration and success took place in three prolific provinces (Fig. 1): the Niger Delta Tertiary system (central West Africa-Gulf of Guinea), the Gabon-Congo Province (southern West Africa), and the Mauritania-Senegal-Bissau Province (northern West Africa).

The Niger Delta is the richest, covers more than 300,000 sq km, and is unique given that it has only one petroleum system, the "Tertiary Niger Delta System," the majority of which lies in Nigeria and extends onshore, offshore, and into deep water.

NET PRODUCTION BY INDUSTRY GROUP IN 2005

Fig. 3



Values in million b/d
Sources: OPEC, company reports

The province, which includes the Rio del Rey basin, is also the main source of hydrocarbons in Cameroon, Equatorial Guinea, and Sao Tome and Principe. In fact, it is the main system in most countries that border the Gulf of Guinea and in Ivory Coast to the west.

At the end of 2005, remaining oil reserves in this province (including Rio del Rey) were estimated at 38 billion bbl (2P), of which the onshore and shallow water portions hold 29 billion bbl. In the deepwater portion, where most of the recent success has taken place, 9 billion bbl have been discovered in over 30 fields.

The Gabon-Congo Province is the second richest. It stretches south of the Gulf of Guinea along the West African coastline from Gabon to Angola out to more than 3,000 m of water. It is composed of several basins, the most important of which is the Congo basin.

At the end of 2005, total remaining oil reserves for this large province were estimated at 16 billion bbl (2P), of which 11.7 billion bbl were discovered in the deepwater part of the Congo basin in Angola in over 50 discoveries. Further success has taken place in deepwater Congo (Brazzaville), although this part has been less explored compared with deepwater Angola. In Angola are two other basins, Kwanza and Namibe, but limited exploratory activity has located only limited hydrocarbons.

The Mauritania-Senegal-Bissau (MSB) Province covers 600,000 sq km along the northern West Africa offshore margin and extends from Guinea to Mauritania. This province is composed of several basins, the most prospective being the Senegal basin.

The basins in the MSB province are thought to contain the necessary elements of successful petroleum systems, but exploration has been successful only in limited areas. One accumulation off Senegal is thought to contain 800 million bbl of heavy oil but remains unproven, while in Mauritania some discoveries totaling 500 million bbl (2P) have been made in deep water.

WEST AFRICA'S UNDISCOVERED OIL VOLUME*

Table 3

	USGS undiscovered oil at 2000	Discovered oil, 2000-05	Undiscovered oil at 2005
Angola	14.00	6.00	8.00
Eq. Guinea	2.50	0.50	2.00
Congo (Brazz.)	5.80	0.70	5.10
Gabon	8.10	0.15	7.95
Ivory Coast	0.60	0.30	0.30
Mauritania	0.05	0.50	0
Subtotal	**31.0**	**8.20**	**23.40**
Rest of West Africa			
Cameroon	1.50	0.10	1.4
Guinea Bissau	0.04	—	0.04
Senegal	0.05	—	0.05
Gambia	0	—	0
Benin	0	—	0
Ghana	0.20	—	0.20
Subtotal	**1.79**	**0.10**	**1.69**
Nigeria	**37.00**	**4.20**	**32.80**
Total	**69.80**	**12.50**	**57.80**

*US Geological Survey estimate.
Sources: USGS, IHS Inc., OPEC

Undiscovered oil potential

It is probably impossible to find a technical publication or study that would not conclude that the explored basins, emerging deepwater basins, and unexplored basins of West Africa, in particular the offshore parts, still have significant volumes of oil yet to be found.

A fair review of the literature indicates that the onshore portions of the provinces are mature but continue to offer exploration opportunities, the shallow water portions have material upside, while the deepwater portions, in particularly the Niger Delta basin, represent the biggest opportunity. The estimates may range significantly for key basins and hydrocarbon plays, but the bottom line is that all indicate a relatively large amount of oil yet to be found.

The only source available that gives detailed estimates for undiscovered oil reserves on a country basis based on a common methodology is the US Geological Survey.

In 2000 the USGS published the World Petroleum Assessment of undiscovered resources covering many basins. One of the conclusions of this global and unique study was that the Gulf of Guinea and Congo Delta areas off West Africa hold some of the greatest volumes of undiscovered oil in the world (Table 3).

The study contains assessments of mean undiscovered volumes in assessed portions of many countries, and based on the reported number for each country the total estimated undiscovered volume of oil in West Africa (including Nigeria) was 70 billion bbl. However, some 12 billion bbl were discovered in 2001-05, leaving

presumably some 58 billion bbl yet to be discovered.

It is worth mentioning that the USGS country estimates do not include reserves growth, which in the case of prolific basins such as the Niger Delta could represent another 10% to 30% of the remaining hydrocarbons (5 to 15 billion bbl).

Oil production

In 2005, West Africa produced 4.9 million b/d of oil, of which Nigeria accounted for 2.6 million b/d, from 200 fields and 2,400 producing oil wells in the region excluding Nigeria and from 241 fields and 2,600 producing oil wells in Nigeria.

By type of environment, 1.13 million b/d of the oil production in West Africa (excluding Nigeria) came from 8 large projects grouping several fields.

Angola was the largest deepwater producer with the most projects on stream (5 projects: Xikomba, Kizomba A and B, Girassol, and Jasmin), followed by Equatorial Guinea (2 projects: Zafiro and Ceiba), and Ivory Coast (1 project: Baobab).

It is interesting to note that the number of deepwater oil discoveries on stream is low relative to the total number of deepwater discoveries made to date. Some 900,000 b/d of the total production (excluding Nigeria) came from 13 developments grouping over 100 shallow water fields and more than 50% of the total onshore production of 300,000 b/d from 3 development areas grouping several fields (Table 4).

In Nigeria, 1.2 million b/d came from 14 onshore projects grouping some 200 fields. The shallow offshore accounted for 1.3 million b/d of total country oil production. Some 30 fields were producing, but 4 projects accounted for 40% of the 1.3 million b/d of production. At the end of 2005, two deepwater projects were on stream (Abo and Bonga), which produced around 130,000 b/d. Bonga was still ramping up to its design capacity of 200,000 b/d.

Overall, most of the production increase came from deepwater fields discovered in the last decade. The region's first deepwater discovery came in 1995 off Equatorial Guinea, and its first oil was produced 2 years after. However, 10 years later (2005) total deepwater oil production from the region reached 1.3 million b/d, to represent 36% of global deepwater production.

ESTIMATED 2005 OIL PRODUCTION BY TYPE OF ENVIRONMENT

Table 4

	Total	Split			Deep-water production in 2000
		Onshore	Offshore	Deep water	
			Million b/d		
Angola	1.23	0.01	0.50	0.77	0
Eq. Guinea	0.36	0	0.06	0.27	0.07
Congo (Brazz.)	0.24	0.08	0.16	0	na
Gabon	0.25	0.14	0.11	0	na
Ivory Coast	0.09	0	0.03	0.06	0
Cameroon	0.08	0.02	0.06	0	na
Subtotal	**2.25**	**0.30**	**0.90**	**1.13**	**0.07**
Nigeria	**2.60**	**1.20**	**1.30**	**0.13**	**0**
Total	**4.90**	**1.50**	**2.20**	**1.30**	**0.10**

Sources: OPEC, IHS Inc.

Cost environment

According to various estimates, West African countries are characterized for being low-cost producers, and this is another reason that makes the region attractive even though technical costs have been rising in the last few years.

The technical cost (sum of finding, development, and production costs per barrel) in Angola, Congo (Brazzaville), and Equatorial Guinea averaged $8.70/bbl in 2005 compared with the global industry average of $14.90/bbl. Technical costs in Nigeria were estimated to be in the range of its West African neighbors.

In the last 10 years, production costs among West Africa's largest producers have remained flat and even declined even though production from deepwater fields has risen rapidly.

The conventional wisdom is that deepwater fields tend to have higher production costs than shallow water fields and that therefore costs should rise, but this does not appear to be the case thanks to the geology, reservoir properties, technology, and good cost management. However, looking at finding and development (F&D) costs, the average cost in Angola, Congo, and Equatorial Guinea show an increase in 2005 vs. 2002 of 50% to 75% primarily due to higher rig and materials costs (Fig. 2).

Active players

International operators produce most of the oil in West Africa.

Many of these have been in the region since the early days of exploration, but new companies have also gained access including national oil companies and independents.

It's worth mentioning that no international oil company has ever exited West Africa completely; in fact most continue to increase their presence in existing or new countries by expanding existing projects and taking new ones.

In terms of oil production share, in 2005 the top international companies (BP, Chevron, ConocoPhillips, Eni, Exxon, Shell, Statoil, and Total) produced 4.3 million b/d or 88% of the total oil, but their entitlement (net oil) was 2.7 million b/d or roughly 55%. International independents and local companies (nongovernment owned) produced the rest, and these amounted to over 70 companies (Fig. 3).

Most of the companies operate under favorable production-sharing contracts that allow even the most challenging fields in deepwater Nigeria and Angola to be developed at a good financial return; only a handful of fields remains under different arrangements (Block 0 in Angola and Yombo field off Congo-Brazzaville are concession agree-

ments), but these, too, have favorable conditions.

In contrast to conventional wisdom, all contracts have remained relatively stable in recent years, but the general terms have been renegotiated in close coordination with the operators to reflect evolving global and local conditions. Importantly, the upward trend in production is a clear reflection that the industry has been working effectively in the region.

Next: Expect West Africa's oil production increases to continue, second only to Russia among non-OPEC suppliers. ✦

The authors

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Kenya

A group led by Woodside Petroleum Ltd., Perth, has spudded an exploration well on the Pomboo prospect on Block L-5 in the Indian Ocean off northern Kenya.

The Lamu basin well is projected to 5,000 m in 2,200 m of water. After drilling Pomboo, the drillship is to move to Block L-7 to drill the Sokwe South prospect.

Laos

Salamander Energy Ltd., London, said it is in late stages of negotiating a production sharing contract for the Vientiane and Savannakhet exploration blocks in nonproducing Laos.

Salamander holds a 9.5% interest in Hess Corp.-operated Phu Horm gas field in northeastern Thailand. In Indonesia, Salamander operates with 70% interest the Bontang PSC, which has the 1982 Tutung gas-condensate discovery and several leads. It holds 5% interest in the BP-operated Offshore Northwest Java PSC and 5% interest in the CNOOC-operated Southeast Sumatra PSC.

Salamander holds interests in several other blocks in Thailand.

Madagascar

Candax Energy Inc., Calgary, is awaiting presidential ratification of a production-sharing contract on Block 1101 in Madagascar.

Interests in the 15,000 sq km block are Candax Energy operator with 60% and EAX, Dubai, 40%.

The work program is geological and geochemical studies, shooting 2D seismic, and drilling 1 well for total spending of $1.5 million in the 2-year first phase.

Peru

Gran Tierra Energy Inc., Calgary, plans to explore blocks 128 and 122 in the Iquitos Arch Trend of the Maranon basin in Peru.

The company is operator with 100% working interest. The two blocks total 3.2 million acres.

Gulf of Mexico

Medco Energi US LLC, Lafayette, acquired a fifth block in the western Gulf of Mexico and said all five blocks are to be drilled in 2007.

Medco purchased 100% interest in Brazos Block 437 in 60 ft of water from Centaurus Gulf of Mexico LLC. It is a 5-year federal lease.

Medco now holds various interests in noncontiguous Brazos blocks 437, 435, 492, and 514, all in 60-80 ft of water off Matagorda, Tex. The company holds 43.75% interest in Mustang Island Block 758.

Ridgelake Energy Inc. of Louisiana and Lion Energy Ltd., Perth, were to spud an exploratory well on South Marsh Island Block 138.

The well targets multiple Pleistocene age Lentic sands at 9,800-11,800 ft. Projected TD is 11,900 ft.

Colorado

New Frontier Energy Inc., Denver, purchased the operator's 36.7% working interest in Slater Dome field in the Sand Wash basin for $8 million and plans to drill several wells in the field in 2007.

The purchase covers 8.2 bcf of gas and increases New Frontier's interest in 11 gas wells and its proportionate share of 32,000 acres.

The field, which extends into south-central Wyoming, produces from six wells in Cretaceous Mesaverde coals. Three wells are shut in awaiting further development work to enhance dewatering, one awaits completion, and one is shut in for hookup.

Washington

Cascadia Energy Corp., a subsidiary of Torrent Energy Corp., Portland, filed intents to drill three wells in the nonproducing Chehalis basin.

The locations are near Winlock, 30 miles south-southwest of Olympia. The spots are in 36-13n-3w, 15- and 36-12n-3w, and 36-12n-3w, Lewis County. Approvals and start of drilling are expected in the first quarter of 2007.

The companies gave no depths but plan to pursue coalbed methane and conventional gas in the basin.

This area is 35 miles north-northeast of Mist gas field in Columbia County, Ore.

North Sea data yield insight on fatigue life of drill pipe

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Failure of drill pipe due to fatigue is very costly problem in the oil and gas industry. Inspection costs represent a very small amount in well planning, and yet regular inspection intervals can significantly reduce fatigue problems.

Models used today can predict only about 20% of drill pipe life. Environmental conditions can change these predictions by significant amounts; predicted values seldom match with experimental values. This article provides an analysis of North Sea data regarding the effect of drilling parameters on the fatigue life of drill pipe.

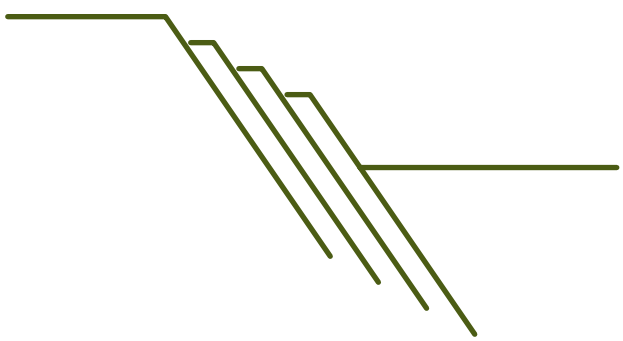
Fatigue

Fatigue refers to changes in properties that can occur in metal due to repeated application of stresses or strains, although usually this term applies to those changes that lead to cracking or failure.[1]

The problem of fatigue increases during drilling of long and extended-reach wells. Despite several studies conducted of this subject, results seldom match with experience because the numerous drilling parameters vary considerably. Among those parameters, environment plays a vital role because it varies from well to well. The effect of severe environmental factors can cause sulfide stress cracking, hydrogen embrittlement, and corrosion of drillstring.

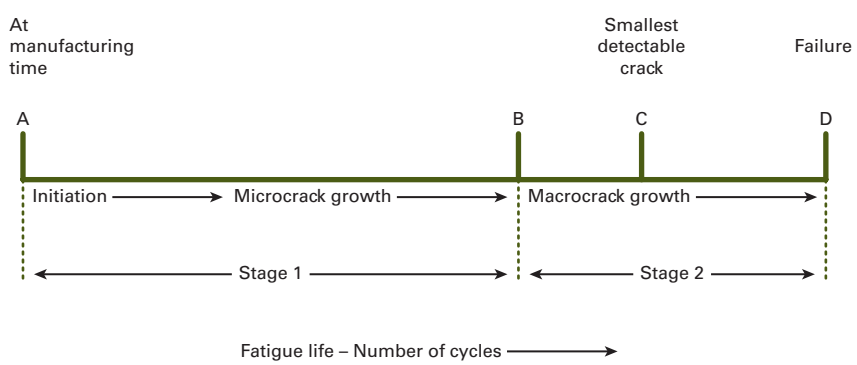
SLIP PROCESS

Fig. 1



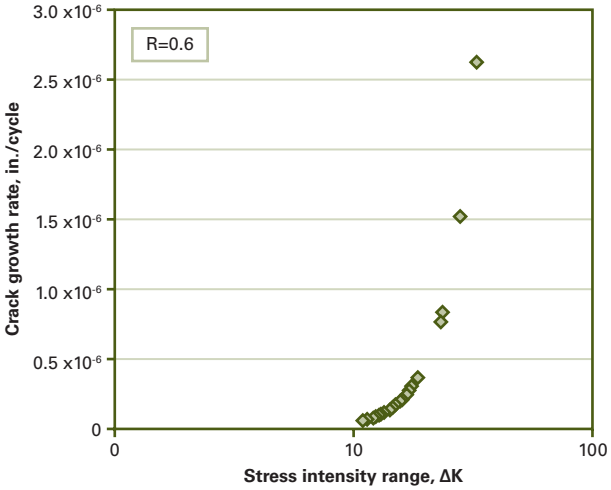
STAGES OF FATIGUE

Fig. 2



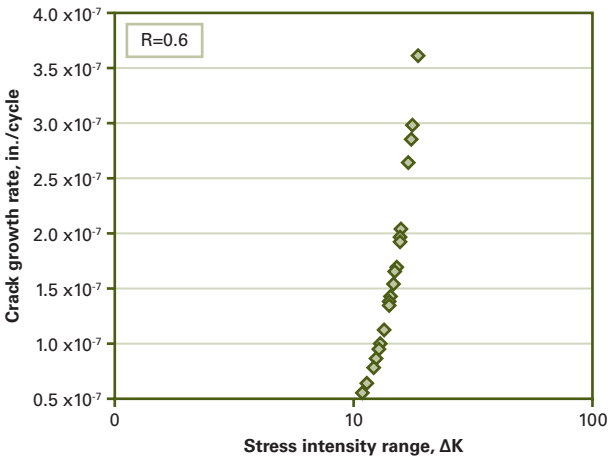
GROWTH RATE OF FATIGUE CRACKS

Fig. 3



FATIGUE CRACK GROWTH RATE*

Fig. 4



*Magnified view of smaller range of stress intensity

The variation of drilling parameters is not constant. These variations result in unexpected behavior of drill pipe. Although the effects of these variations are known, still unknown is the degree to which these variations affect drill strings. These variations usually lead to unexpected behaviors that often result in the failure of drillstrings.

Possible solutions to mitigate fatigue include design optimization of drillstring, better well planning, and improved inspection intervals. This article presents a statistical approach to design inspection intervals to avoid washouts. The effect of various drilling parameters on fatigue life of drill pipe is also investigated based on North Sea data.

Fatigue mechanism

Iron has 24 different slip or deformation systems. This is twice the number found in most of the common metals. The slip mechanism is like shearing a deck of cards, in that one plane slips over another (Fig. 1).[2]

The slip process does not occur by whole one plane moving a distance of one atom over the plane below it, for this would require breaking all bonds over the whole slip plane at one time. Such a process would require about 1,000 times more shear stress than is required to cause slip in real crystals.[2] The explanation for real behavior lies in the fact that crystals have imperfections, called dislocations. Crystals generally contain about 10^9 dislocations/cu cm.

If crystals were perfect, slip could only occur by shearing, and pure iron would have a yield of about 2 million psi. But, dislocations are metallurgical boundaries responsible for fatigue behavior. Work hardening of material is done so that these dislocations cannot move as easily as before. This type of material imperfection means that the smallest possible crack always exists at crystal scale. These imperfections grow at the atomic scale.

Whether the crack will propagate from inside or outside the pipe depends on the type of loading. If a specimen is work hardened, then there are more chances that a crack will grow from outside to the inside of the pipe because the outer fibers are in compression. If external stresses are applied, the imperfection will grow to an extent that the material will eventually fail. Therefore, the fatigue mechanism should be divided into two stages.

- *Stage 1 growth*. Due to cyclic loading, minute imperfections grow at different scales from crystal level to visibility.

EQUATIONS

$$\frac{da}{dN} = C\Delta K^m \quad (1)$$

$$\frac{da}{dN} = \frac{C\Delta K^m}{(1-R)K_{ic} - \Delta K} \quad (2)$$

$$\Delta K = K_{max} - K_{min}$$

$$K_{max} = \sigma_{max}\sqrt{\frac{\pi a}{Q}}\,Y$$

$$K_{min} = \sigma_{min}\sqrt{\frac{\pi a}{Q}}\,Y$$

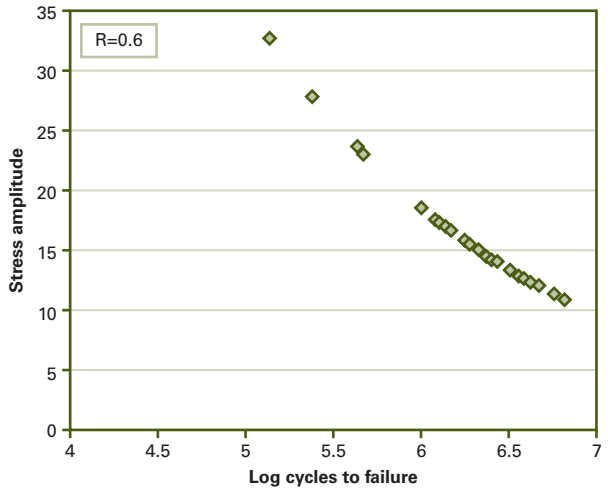
$$R = \frac{K_{max}}{K_{min}}$$

Nomenclature

ppg = Parts/gram
cc = Cubic cm
a = Crack length, in.
N = Number of cycles
$\frac{da}{dN}$ = Crack propagation rate, in./cycle
ΔK = Stress intensity range, Ksi$\sqrt{in}$
C = Fatigue coefficient
m = Fatigue exponent
K_{max} = Maximum stress intensity factor, Ksi$\sqrt{in}$
K_{min} = Minimum stress intensity factor, Ksi$\sqrt{in}$
K_{ic} = Critical stress intensity factor, Ksi$\sqrt{in}$
R = Stress ratio
V = Component geometry correction factor
Q = Crack shape correction factor
ROP = Rate of penetration, ft/hr
WOB = Weight on bit, Kip
σ_{max} = Maximum applied stress, kpsi
σ_{min} = Minimum applied stress, kpsi

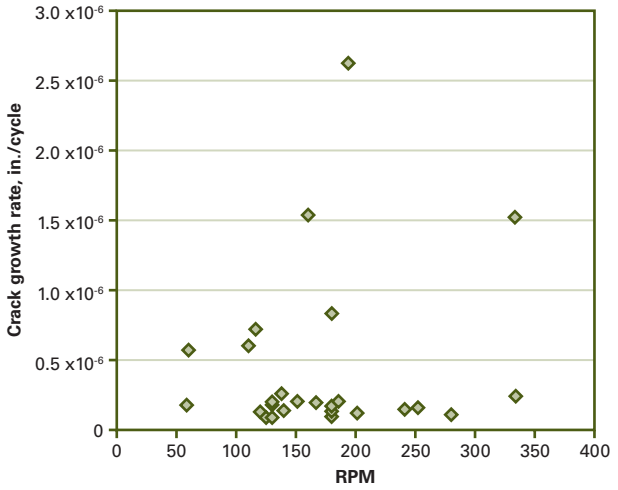
S-N CURVE

Fig. 5



EFFECT OF BIT REVOLUTIONS

Fig. 6



Physically speaking, these imperfections also act as stress concentrators but at undetectable levels. This is why, while estimating fatigue life of drill pipe, we cannot practically estimate about 80% of the actual life of the drill pipe (Fig. 2).[3]

• *Stage 2 failure.* Sudden fracture of the cross section occurs when a crack reaches its critical size. This size will vary with geometry, loading conditions, and material toughness. Point C in Fig. 2 represents smallest crack size detectable by inspection.

Fatigue models

Various researchers have postulated that the growth of a crack under cyclic loading should be governed by Equation 1.[1]

The stress intensity range, ΔK, depends on crack shape, component geometry, stress applied, and minimum crack size. The empirical constants, C and m, are functions of material properties and microstructure, fatigue frequency, mean stress or load ratio, environment, loading mode, and stress state.

The Forman crack growth rate model is employed in this statistical approach to setting up the inspection intervals. This model is a modification of the Paris model. The Forman model also incorporates crack opening and closure during the application of cyclic stress cycles.[4] The fatigue model is written as Equation 2.

Statistical analysis

It is impossible to predict the actual amount of stress generated in drill pipe, especially while drilling long, extended-reach horizontal wells. This is due to the conditions under which drilling takes place. Therefore, it is impossible to correctly predict the number of cycles before drill pipe failure.

It is common practice to report number of rotating hours of drill pipe in a well before it fails. This is also based on estimation. Certain oil companies are trying to install computerized chips on drill pipe that will record different drill string parameters such as cycles to failure, location of pipe, date last inspected, etc.[5]

The maximum operating stress for drill pipe is taken as 80% of the lower yield strength; minimum stress level varies from zero to the endurance limit. If a component is being operated at the endurance limit, it can have an infinite number of cycles to failure. This statement is the basis for Goodman curve.[1]

The endurance limit is usually 0.35% to 0.4% of yield strength. The minimum crack size should be the size that is not detectable by inspection methods used in the oil and gas industry. In this article, a semielliptical surface crack is assumed. The constants, C and m, were taken from the North Sea.[6] Values for K_{ic} can be found from literature. The load ratio R is 0.6.

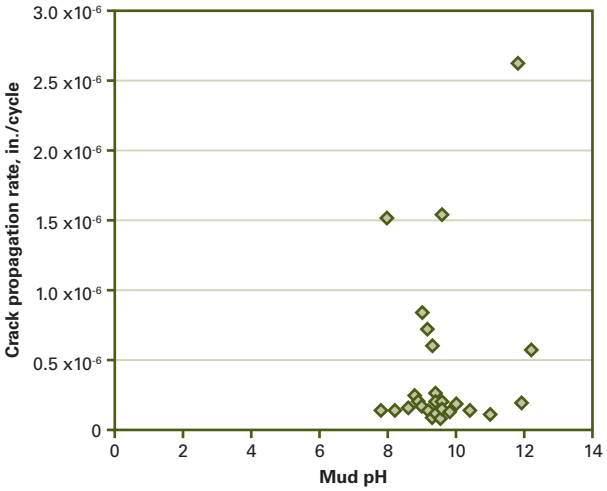
Fig. 3 shows a plot of stress intensity range and crack propagation rate. The relationship suggests that whenever a crack is formed in the drill pipe, it will grow at an exponential scale with a slope, m. The position of this line will be determined by the constant C.

At higher stresses, it will grow at a faster rate, meaning that drillstring subjected to the higher stresses has greater probability of breaking off than washing out. A closer look at the lower stress intensity range shows that this crack will grow nearly vertically (Fig. 4). The negative aspect of this finding is that life of drill pipe will be shorter. The positive aspect is that after a crack is formed, it should be easier for inspection companies to detect the crack.

Based on the plot in Fig. 4, if drill pipe is stressed to its maximum limit and the bit is rotating at 150 rpm with a ROP of 70 fph, then it can drill 42,665 ft during the whole of its life. Therefore, inspection should be kept at economically feasible number of feet drilled. This work suggests that inspection should be done for every 35-40,000 ft drilled. This inspection

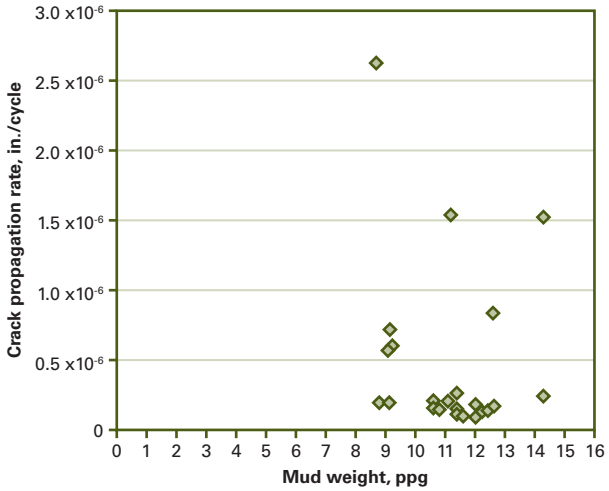
Effect of mud pH on crack propagation

Fig. 7



Effect of mud weight on crack propagation

Fig. 8



interval should reduce washouts by more than 50%.

It should be noted that this inspection interval is limited to offshore environments typical of the North Sea.

Fig. 5 shows an S-N curve for corrosive environment. The plot of this curve is determined by drilling conditions. This means that drill pipe will always remain at some stress level. The data suggest that drill pipe has a low endurance limit if it is operated in corrosive environments.

This reduced endurance limit can cause sudden failure of the pipe. Calculations can be done at the maximum stress intensity range and show that under a stress intensity factor of 32 Ksi $\sqrt{in}$, failure will occur after 13,293 ft. That is why under varying environmental conditions drill pipe can break at any point.

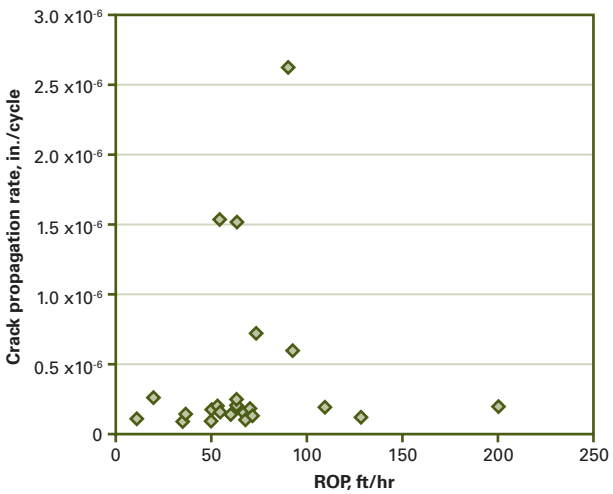
Crack growth

Different drilling parameters will affect the crack growth rate.

- *RPM*. Fig. 6 shows the effect of RPM on crack growth rate but not in a very descriptive manner. Apparently, RPM has no effect on crack propagation. Most points that have high crack growth rate have either high WOB or an excessive number of doglegs.
- *pH of mud*. Fig. 7 shows the effect of pH on crack propagation rate. It is evident from this plot that the pH of mud does not seem to have any effect as long as mud pH is in the range of 8-12. This result also confirms the finding of Azar that concludes that pH has no effect if drilling mud has basic nonacidic properties.[7]
- *Mud weight*. Fig. 8 shows that the mud weight does not seem to affect crack propagation rate. By plotting such data, one can narrow the search to fewer suspect drilling parameters. Properly investigating these parameters will result in a better understanding of the fatigue life of drill pipe.
- *Rate of penetration (ROP)*. Fig. 9 shows the effect of ROP on crack propagation rate, but the data present no discernible trend.
- *Weight on bit (WOB)*. Fig. 10 shows the effect of WOB on the crack-propagation rate. This plot is interesting as it shows that having a high WOB can significantly increase crack growth rate. Note that longer number of rotary hours and even greater depths have been achieved by less WOB.

Effect of ROP on crack propagation

Fig. 9

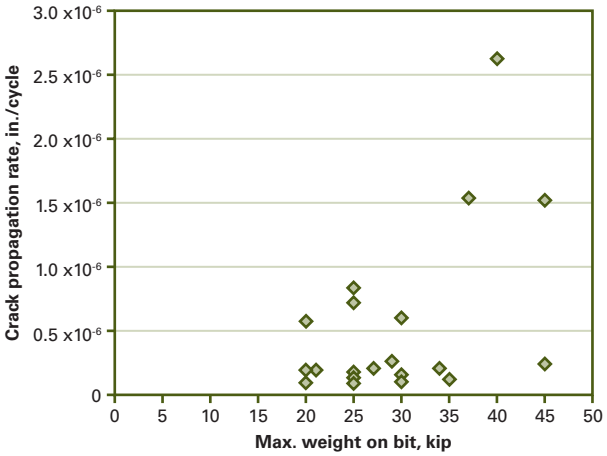


The physical understanding of higher WOB means that drillstring is subjected to more stress cycles. Microcracks in the string will fluctuate at a faster rate than before. This results in faster crack propagation. This is why washouts are often observed while back reaming—because high axial weight is being applied on the bit.

Hence, weight on bit is an important parameter during design of fatigue life of the components. The higher crack growth rate shows that time period from washout to break off will be shorter and eventually break off will

EFFECT OF WOB* ON CRACK PROPAGATION

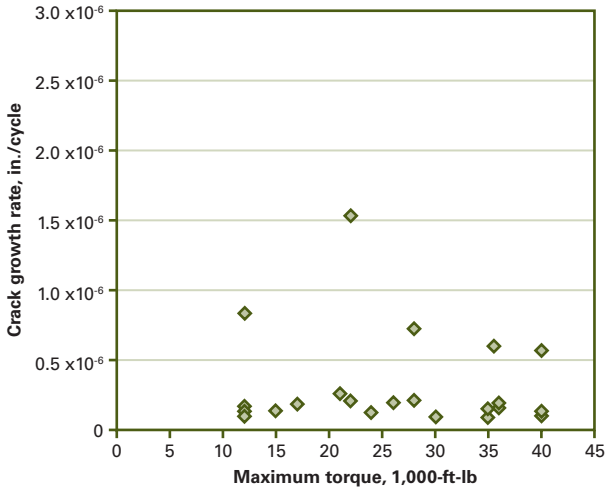
Fig. 10



*Based on surface indicator gauge

EFFECT OF TORQUE ON CRACK PROPAGATION

Fig. 11



occur before there will be a washout warning.

• *Rotary torque.* Fig. 11 shows that there is no effect of rotary torque on crack-propagation rate. This means that keeping WOB constant but applying more torque can result in achieving greater depths without increasing crack-propagation rate.

Next steps

There is no information about 80% of the life of a drill pipe. More research is needed to understand crack propagation from microlevel to visibility scale.

This analysis suggests a new inspection interval, based on Forman crack-growth model, that claims to reduce washouts by 50%.

It seems that various drilling parameters have almost no effect on crack-propagation rate. The WOB should not be increased, as more WOB will cause cracks to propagate faster. Greater depths can be achieved by applying more torque and constant WOB.

All studies have been done on S135 19.50 lb/ft, premium class pipe.

The data only represent North Sea failures.

Acknowledgments

Appreciation is due Maersk Oil and Gas (drilling department) for providing data and the suggestions and assistance of Andy Sloan, senior drilling engineer, Maersk Oil and Gas. ✦

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Ion exchange helps CBM producers handle water

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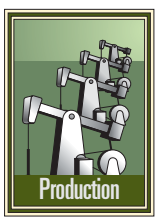

In western US, ion-exchange technology is helping coalbed methane operators handle the large amounts of water produced with the gas.

Benefits of the technology include:

- Less environmental impact.
- Reduced regulatory-compliance paperwork.
- Lower future liability.
- Increased overall operations efficiency.
- Lower overall costs.

Waste water minimization

In recent years, the industry has undertaken commercial production of coalbed methane in the US and other countries. Large amounts of methane-rich gas are found in coal beds but production of much of this methane also requires producing large amounts of water.

This produced water may contain high levels of sodium (Na) that typically range from 500 to 1,200 ppm, total dissolved solids (TDS) ranging from 1,800 to 3,000 ppm, and carbonates (CO_3). More stringent US federal and state water regulations now prohibit discharge of this water into the environment or its use for irrigation due to its high salt content.

Chemical treatment of this produced water can be cost-prohibitive. The industry, therefore, has sought other safe, affordable treatment alternatives to meet regulatory standards.

Since 2003, the Higgins Loop continuous-ion-exchange technology has provided an economical and efficient process for purifying produced water without gen-

A closed-in housing protects the Higgins Loop from the weather (Fig. 1).

erating hazardous wastes or large byproduct streams.

Water purification

A typical 7,000 bw/d Higgins Loop coalbed methane operation has a 20-ft × 60-ft footprint (Fig. 1). The process incorporates a continuous countercurrent ion exchange contactor for liquid phase separation of ionic components with solid exchange (I-X) resins.

The loop contactor is a vertical cylindrical loop about 36-ft high containing a packed bed of I-X resin that is separated into four operating zones by butterfly or loop valves. These operating zones (adsorption, regeneration, backwashing, and pulsing) function as four separate vessels.

Produced water containing high Na levels enters the adsorption zone within the loop where it contacts strong acid cation resin that loads Na ions in exchange for hydrogen (H) ions. Treated water leaves the loop with less than 10 mg/l. Na.

A CO_2 evolution from the low-pH treated water removes the carbonate contained in the water, which is also harmful to the environment.

Na-loaded resin regeneration is concurrent with adsorption and takes place in the lower section of the loop (Fig. 2). The regeneration process uses either hydrochloric or sulfuric acid to produce a small, concentrated spent brine stream. Water rinses the regenerated resin before its reentry into the adsorption zone where acid removal from the resin pores takes place.

As resin in the upper layer of the adsorption zone becomes loaded with Na, momentary interruption in flows to the loop allow advancement of the resin bed (pulsing) through the loop in the opposite direction of liquid flow.

Na-loaded resin regeneration takes place in the bottom of the Higgins Loop (Fig. 2).

Liquid flow restarts after completion of the resin pulsing.

Treated water is slightly acidic due to its increased H-ion strength and is neutralized with limestone, which also increases its calcium concentration so that the water's sodium adsorption ratio is less than 1.0. Spent brine containing removed Na ions has a density high enough for use as a kill fluid.

The Higgins Loop technology makes water laden with Na and CO_3 safe for reintroduction to the environment. The byproduct water, which once was an environmental problem, now can be used by ranchers for irrigation, watering cattle, and for drinking water. The process generates no wastewater.

System maintenance primarily involves the pump, valve, and instruments, as well as the spent regenerant treatment and other routine equipment maintenance.

Maintenance costs as a percentage of equipment costs are lower than average for water treatment equipment.

Applications

In Montana and Wyoming, water from coal beds typically contains such high levels of sodium that its use for irrigation or release into nearby streams is not allowed.

To solve the problem of excessive discharge water, several companies, including Pinnacle Gas Resources Inc. of Sheridan, Wyo., installed a Higgins Loop to treat the water.

In southern Montana, about 150 miles southeast of Billings, Mont., the technology allows Pinnacle to replenish the flows of the Tongue River just downstream of the Tongue River Reservoir. The reservoir, river, and its tributaries are home to some of the state's best fishing, with species including smallmouth bass, yellow perch, channel catfish, northern pike, and walleye.

The loop produces 240 gpm of water that meets or exceeds the ambient quality of the Tongue River and the standards established by the Montana Department of Environmental Quality. Pinnacle discharges this water directly into the river.

Just across the border in Wyoming, a pending Pinnacle project will use the Higgins Loop for treating 1,000-1,500 gpm, depending on the seasonal discharge limitations. This equates to about 2½ bbl of produced water/Mcf of natural gas extracted.

The safe, high-quality discharge from this operation potentially will benefit downstream irrigation of alfalfa and forage acreage.

The treating cost of the produced water with the Higgins Loop is the low-

est among currently used technologies, and the primary costs are regenerant acid and spent-brine disposal. Spent-brine volumes generated equate to 1-2% of produced water treated, and the process consumes no fresh water beyond that in the spent brine.

Other technologies evaluated for this application include reverse osmosis and zeolite treatment, both of which generate at least five times more waste and have treatment costs of more than $0.40/bbl higher.

The Higgins Loop technology is a more effective ion exchange technology than fixed bed and other ion-exchange systems. It efficiently uses the resin capacity, needs less regenerant and fresh water, generates consistent product quality, and minimizes wastewater volumes. The technology offers expanded ranges for the use of ion-exchange resins and adsorbents in commercial separations. ✦

The author

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Study tests accuracy of methods that estimate hydrate formation

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Because inhibitors are important in reducing formation of hydrates in gas streams, we performed a study to investigate and evaluate the accuracy of available tools that predict hydrate formation conditions in the presence of inhibitors.

We evaluated two commercial process-simulation programs and three shortcut methods. The study covered wide ranges of pressures and inhibitor concentrations.

Required model parameters for one of the shortcut methods are reported for the first time.

In general, engineers should check the process simulator results against experimental data before using the simulator for an actual process. All three shortcut methods studied were accurate down to 20° F.; below that temperature, the Moshfeghian-Maddox method is most accurate but requires more calculations.

Based on a presentation to the 22nd European Symposium on Applied Thermodynamics, June 28-July 1, 2006, Elsinore, Denmark.

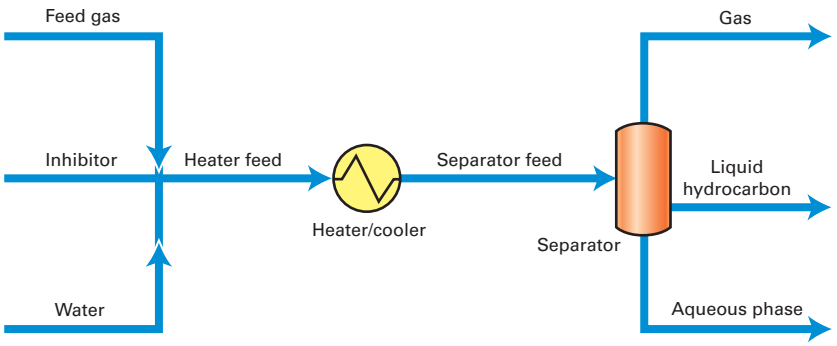
Hydrate inhibitors

Inhibitor injection is one of the practical means for preventing hydrates from forming in process equipment and natural-gas transportation pipelines. Accurate knowledge of hydrate formation conditions in the presence of inhibitors is therefore very useful for safety and economic reasons.

Many materials when added to water will depress the hydrate and freezing temperatures. For many practical reasons, alcohol or a glycol—usually methanol, diethylene glycol (DEG), or monoethylene glycol (MEG)—is

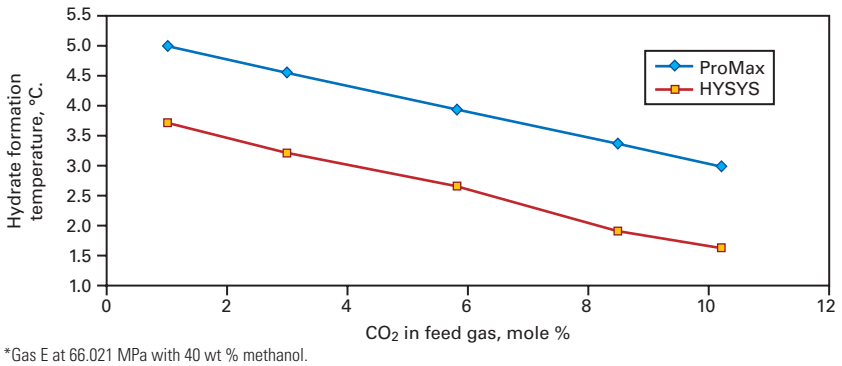
PROCESS FLOW DIAGRAM

Fig. 1



EFFECT OF CO_2*

Fig. 2



*Gas E at 66.021 MPa with 40 wt % methanol.

used as an inhibitor. All can be recovered and recirculated in a process, but recovering methanol may not be economic in many cases.

The total injection rate is the amount of inhibitor needed in the liquid water plus inhibitor that enters the vapor and hydrocarbon liquid phases. Any inhibitor in the vapor or liquid hydrocarbon phase has little effect on hydrate formation conditions.

Determining the amount and concentration of inhibitors and their distribution in different phases is important for practical purposes. Determining the required amount and concentration of these inhibitors is possible with several thermodynamic models for hand and rigorous calculations that have been developed and incorporated into software programs.

This study evaluated the accuracy of two commercial process simulators—ProMax[1] and HYSYS.[2] Three shortcut methods can be used to calculate the required concentration of inhibitor and the injection rate for dewpoint correction, NGL recovery, or pipeline transportation of natural gas. The calculation procedure is shown in Chapter 6 of "Gas Conditioning and Processing," Vol. 1.[3] The three methods we evaluated are those developed by Hammerschmidt,[4] Nielsen-Bucklin,[5] and Moshfeghian-Maddox (OGJ, Aug. 30, 1993, p. 78).

The study examined multicomponent natural gas mixtures over a wide pressure range, up to 100 MPa, and identified the strengths and limitations of these methods.

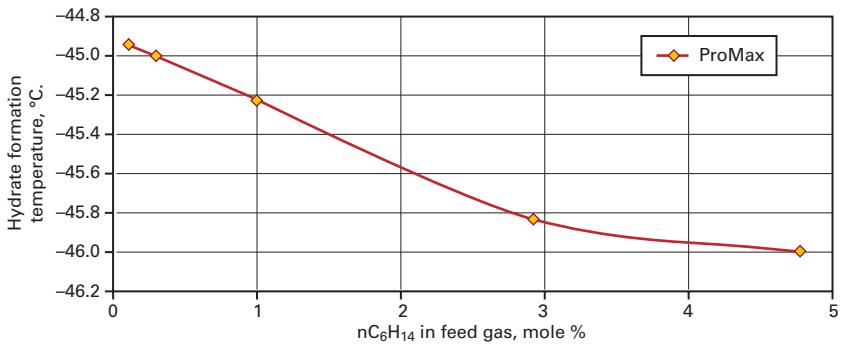
Computer simulators

Various literature sources report hydrate formation pressure and temperature conditions.[6-9] Reported experimental data include pressure, temperature, dry gas composition, and concentration of inhibitor in water solution mixed with the hydrate former. Overall compositions are not provided.

In some reports, overall composition can be approximately inferred by the phase equilibrium data presented, but McIntyre[10] disputes that these data do not extend to the higher inhibitor con-

Effect of n-hexane composition*

Fig. 3



*Gas D at 19.703 MPa with 85 wt % methanol.

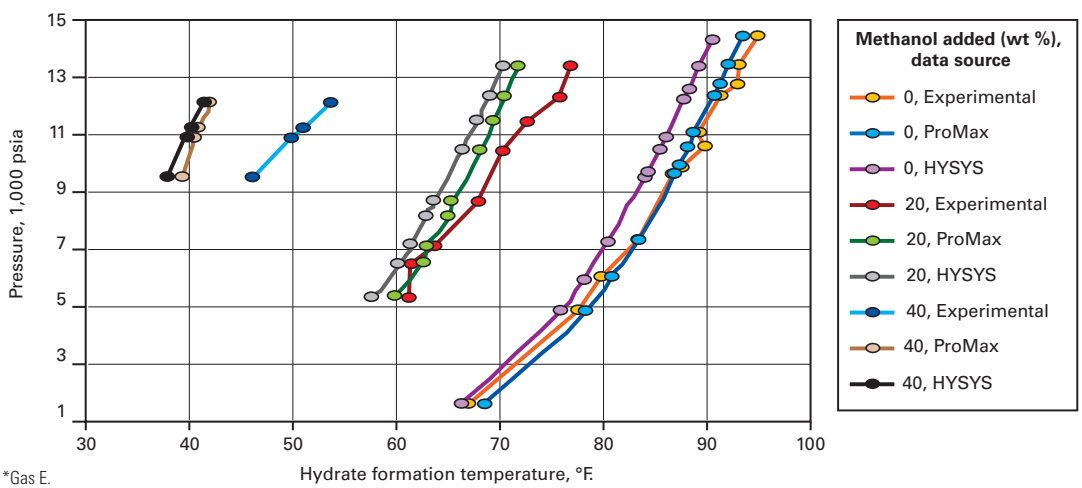
Gas compositions

Table 1

Stream	A	B	C	D	E	F
Component, mole %						
N_2	7.00	5.96	—	—	—	—
CO_2	—	14.19	—	—	3.00	—
CH_4	84.13	71.60	93.51	89.99	84.50	74.130
C_2H_6	4.67	4.73	4.58	6.31	8.70	7.210
C_3H_8	2.34	1.94	1.31	2.40	3.80	4.500
iC_4H_{10}	—	—	0.10	0.30	—	0.900
nC_4H_{10}	0.93	0.79	0.20	0.50	—	1.810
iC_5H_{12}	—	—	0.10	0.10	—	0.870
nC_5H_{12}	0.93	0.79	0.10	0.10	—	0.890
nC_6H_{14}	—	—	0.10	0.30	—	9.690
Inhibitor	MeOH	MeOH	MeOH	MeOH	MeOH	MEG
Concentration range, wt %	10-20	10-20	65-85	65-85	20-40	25-50
Pressure, psia	131-2,729	151-2,778	95-2,955	110-2,926	5,366-13,474	105-2,879
Data points	13	18	15	14	13	10
Reference	7	7	8	8	9	10

Process simulator estimates*

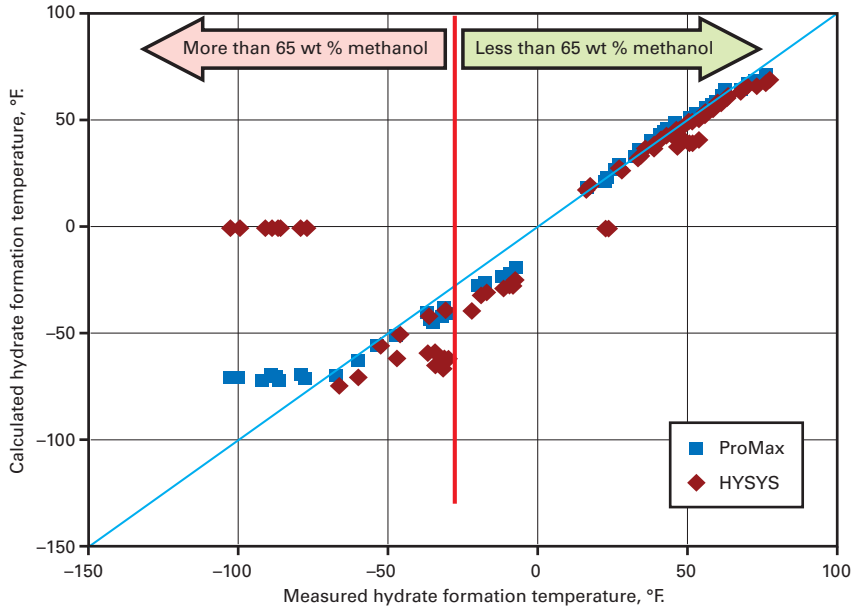
Fig. 4



*Gas E.

PROCESS SIMULATOR ACCURACY FOR METHANOL*

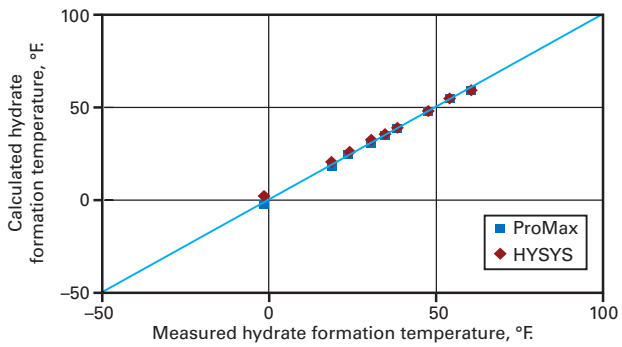
Fig. 5



*Gases A-E with 10-85 wt % methanol.

PROCESS SIMULATOR ACCURACY FOR MEG*

Fig. 6



*Gas F with 25 wt % and 50 wt % MEG.

EQUATIONS

$$X_R = \frac{(MW)(T_0 - T)}{A + (MW)(T_0 - T)} \quad (1)$$

$$x_R = 1 - \exp\left(\frac{T_0 - T}{A}\right) \quad (2)$$

$$x_R = 1 - \frac{1}{\gamma_{H_2O}} \exp\left(\frac{\Delta H}{nR}\left[\frac{1}{T} - \frac{1}{T_0}\right]\right) \quad (3)$$

$$\frac{\Delta H}{nR} = \frac{-2{,}063}{\alpha + \beta \cdot 10^{-3} + \delta \cdot \ln P} \quad (4)$$

$$\ln\gamma_{H_2O} = (x_R)^2 [B = 2(A - B)(1 - x_R)] \quad (5)$$

$$A = \alpha_1 + \frac{\alpha_2 T}{1{,}000} \quad (6)$$

$$B = \beta_1 + \frac{\beta_2 T}{1{,}000} \quad (7)$$

Nomenclature

A	=	Moshfeghian-Maddox constant
A_H	=	Hammerschmidt constant, 1,297 in SI units or 2,335 in English units
A_{NB}	=	Nielsen-Bucklin constant, –72 in SI units or –129.6 in English units
B	=	Moshfeghian-Maddox constant
MW	=	Molecular weight of inhibitor
P	=	Pressure, psia
x_R	=	Mole fraction of inhibitor in aqueous phase
XR	=	Weight fraction of inhibitor in aqueous phase
T	=	Minimum flowing temperature, °C. or °F. for Equations 1 and 2, °R. for Equation 3
T_0	=	Hydrate forming temperature, °C. or °F. for Equations 1 and 2, °R. for Equation 3
α	=	Constant
α_1	=	Constant
α_2	=	Constant
β	=	Constant
β_1	=	Constant
β_2	=	Constant
δ	=	Constant
γ_{H_2O}	=	Water activity coefficient

centrations presented, the region where they are most needed.

Fig. 1 shows the process flow diagram used in this study to simulate the experimental measurements. Feed gas, inhibitor, and water are mixed at the mixer. All three streams are at the same pressure and temperature.

Table 1 shows different feed-gas compositions. The inhibitor stream is either pure methanol or MEG, and the water stream is pure water. The water-stream flow rate was set to a small flow rate for the resulting aqueous phase. We adjusted the inhibitor-stream flow rate to produce the specified weight percent of inhibitor in the aqueous phase.

Mixing effects will change the temperature; we therefore added a heater-cooler with no pressure drop to readjust the mixed separator feed stream temperature to the experimental hydrate formation temperature value.

This process flow diagram ensures that the condition of hydrate-formation temperature in the three-phase separator is close to those measured experimentally. We therefore used it in both commercial process simulators.

Overall effects

To investigate the impact of overall composition (which was unknown) on hydrate formation temperature, we adjusted the water rate, CO_2 concentration, and heavy ends.

Water rate

For 100 mole/hr of Gas E in the presence of 40 wt % methanol, we varied the water rate from 1-10 mole/hr and predicted hydrate-formation temperatures using the two simulators. For each water flow rate, we adjusted the inhibitor stream rate to produce the specified inhibitor concentration of 40 wt % methanol.

Hydrate-formation temperature is independent of the water rate in both simulators. In subsequent runs, we set the water-stream rate to 10 mole/hr for 100 mole/hr of gas.

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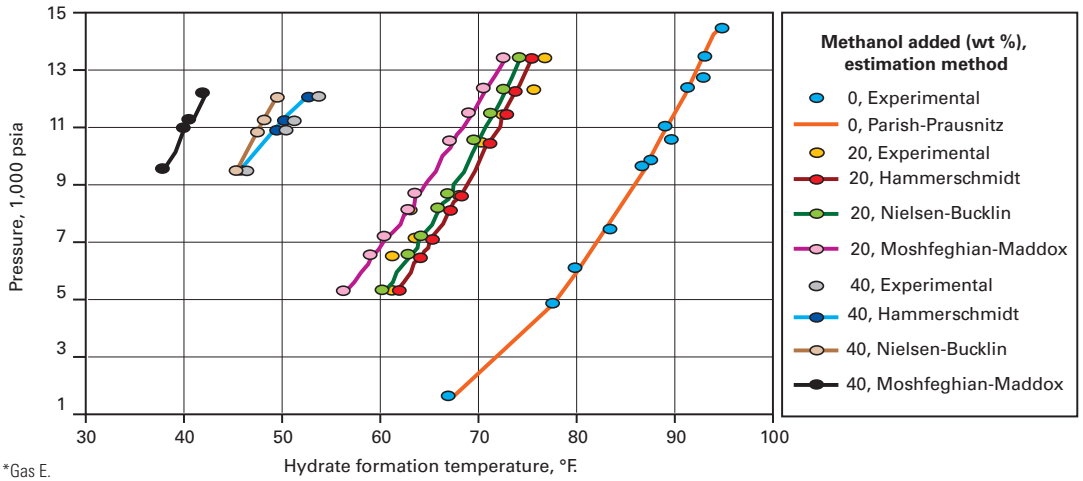
ESTIMATION METHODS*

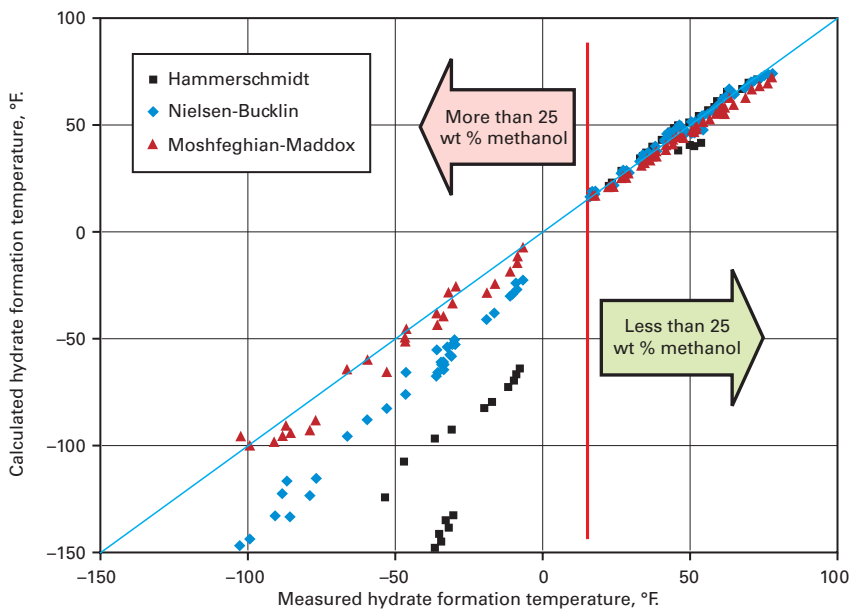
Fig. 7



*Gas E.

METHOD ACCURACY FOR METHANOL*

Fig. 8



*Gases A-E with 10-85 wt % methanol.

CO_2 composition

The reported composition of CO_2 in Gas E was 3 mole %; we therefore varied the CO_2 concentration in our study from 0.1 to more than 10 mole %. For each mole % of CO_2, the gas mixture was normalized, but other conditions remained the same as the reported experimental values.

Fig. 2 shows that, even though CO_2 concentration varied more than 100-fold, the variation of predicted hydrate-formation temperatures in the presence of 40 wt % methanol is less than 2° C.

Heavy ends

We conducted a similar study for Gas D in the presence of 85 wt % methanol in which the nC_6H_{14} composition in the feed gas was varied from 0.1-4.8 mole %. This change in nC_6H_{14} corresponds to a change in the methane composition from 90.17 to 85.95 mole %. The reported composition of nC_6H_{14} was 0.3 mole % and that of methane was 89.99 mole %.

Changing the nC_6H_{14} composition by a factor of 50, and consequently changing the overall composition, the hydrate formation temperature changed only 1.2° C. with ProMax. HYSYS could not converge for this test run.

Fig. 3 shows these results.

Even though overall composition is important, Figs. 2 and 3 show that variation of overall composition has only a slight effect on the predicted hydrate temperature and the error is within ±2° C. This magnitude of error is normally within the experimental error and is not in agreement with McIntyre's remark that "predictions of hydrate formation conditions in process simulators is difficult to verify in cases where the mutual solubility of the hydrate former and inhibitor is relatively high."[10]

The authors also warn that, "without knowledge of the overall composition, a significantly wide range of predicted conditions is possible. More significantly, depending on the nature of the system, therefore they suggest that caution must be exercised when using these experimental data for design or other use since the reported conditions are for an unknown overall composition."

Evaluation results

Table 1 shows the composition, inhibitor range, pressure range, number of data points, and the reference of the experimental data for the gas mixtures studied. Fig. 4 shows the ability of ProMax and HYSYS to predict the hydrate-

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formation temperature for Gas E. Figs. 5 and 6 show the accuracy of these software products for the mixtures in Table 1.

Figs. 5 and 6 indicate that for methanol inhibition, the lower limits of hydrate formation temperatures are –75° F. (–60° C.) for ProMax (maximum of 70 wt % methanol) and –25° F. (–32° C.) for HYSYS (maximum of 50 wt % methanol). HYSYS could not converge for cases of 85 wt % methanol. For MEG, both simulators give accurate results down to 0° F. (–18° C.) corresponding to 50 wt % MEG.

Shortcut methods

Three shortcut methods were evaluated in this study (see equation box)—those developed by Hammerschmidt, Nielsen-Bucklin, and Moshfeghian-Maddox.

Hammerschmidt[4] was the first to present a correlation for calculation of the required mass fraction of inhibitor in the aqueous phase. Equation 1 shows the widely used correlation of Hammerschmidt.

Nielsen and Bucklin proposed a more accurate correlation,[5] shown in Equation 2.

To predict inhibition effects accurately for pressures as high as 14,500 psia (100 MPa) and higher concentrations of methanol and MEG, Moshfeghian and Maddox suggested a correlation, shown in Equation 3.

They proposed correlations for the enthalpy of formation-hydrate number (Equation 4) and used a temperature-dependent Margules model for water activity coefficient (Equation 5).

Equations 6 and 7 define the temperature-dependent parameters.

Unfortunately, parameters for this model were not previously published. In this study, Table 2 shows the required parameters for Equations 4-7; these are released for the first time.

The required hydrate-formation temperatures in the absence of inhibitor (pure water) were predicted by the Parish and Prausnitz[11] model for all three inhibition shortcut methods. This ensured the same basis and accurate results.

Fig. 7 shows that the Parish-Prausnitz method predicts the hydrate-formation temperature for Gas E in the absence of inhibitor (0 methanol) accurately. This method was used to add its prediction temperature to the depression temperature predicted by the three shortcut methods for the sake of easy comparison with the experimental data.

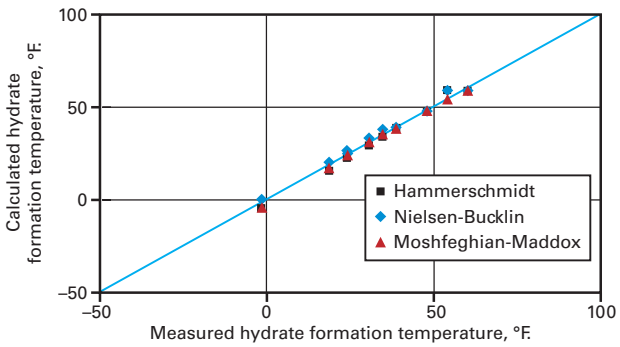
Fig. 7 also indicates that all three methods give good results for 20 wt % methanol; however, for 40 wt % methanol, the Hammerschmidt results deviate from the experimental data considerably.

Fig. 8 shows that all three methods give accurate results for temperatures as low as 20° F. (–6.7° C.) equivalent to maximum of 25 wt % methanol. At lower temperatures (or higher methanol concentrations) the Hammerschmidt method deviates from the experimental data considerably. For lower temperatures, the Moshfeghian-Maddox gives better results than the Nielsen-Bucklin method.

Fig. 9 shows that all three methods give accurate results for Gas F up to a concentration of 50 wt % MEG (as low as 0° F.) for which experimental data were available.

METHOD ACCURACY FOR MEG*

Fig. 9



*Gas F with 25 wt % and 50 wt % MEG.

Findings

Based on our study, we concluded that:

- The accuracy of a process simulator should be checked before its application for an actual process.
- For methanol, the lower limits of hydrate formation temperatures are –75° F. (–60° C.) for ProMax (corresponding to a maximum of 70 wt % methanol) and –25° F. (–32° C.) for HYSYS (corresponding to a maximum of 50 wt % methanol).
- For MEG, both ProMax and HYSYS give accurate results down to 0° F., which corresponds to 50 wt % MEG.
- All three shortcut methods give accurate results for temperatures as low as 20° F. (–6.7° C.), which corresponds to a maximum of 25 wt % methanol. At lower temperatures (or higher methanol concentrations) the Hammerschmidt method deviates from the experimental data considerably. For lower temperatures, the Moshfeghian-Maddox method gives better results than the Nielsen-Bucklin method.
- All three shortcut methods give accurate results for Gas F up to a concentration of 50 wt % MEG (as low as 0° F.), for which experimental data were available. ✦

MOSHFEGHIAN-MADDOX MODEL PARAMETERS

Table 2

Inhibitor	α_1	α_2	β_1	β_2	α	β	δ
MEG	–2.32455	–2.17985	0.66598	–27.42068	2.24035	0.03563	–0.07746
MeOH	–5.84663	15.04912	–2.82261	10.91332	0.76499	–0.03124	0.10006

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ENVIRONMENTAL MITIGATION—2

ROV, diver-collected data show postconstruction epifaunal health

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Gulfstream Natural Gas System LLC gathered ROV and diver-collected data to determine the extent and severity of project construction effects on hard-live bottom areas within the trench corridor and associated spoil mounds and anchor strike-cable sweep locations. The data showed increased epifauna in these areas relative to reference locations.

Part 1 of this article (OGJ, Jan. 1, 2007, p. 58) detailed the methodology of Gulfstream's monitoring activities. Part 2, presented here, discusses the results of its monitoring program. Subsequent parts will examine the use of the pipeline habitat replacement structures by fish and epifauna.

Transect analysis

Gulfstream randomly selected 45 frames from each transect video collected by ROV and 45 photographs from each diver-collected transect. Analysis of each for percent biotal cover by taxon followed the random point analysis described by Bohnsack. This analysis first scatters 100 random dots onto each transect image. Tabulating the percentage of dots touching organisms of each individual taxon then yields the percent biotal cover for a given taxon. Averaging data from individual images along each transect produces a mean for the entire transect.

Reference habitat transect data represented unaffected conditions for statistical comparison to trenched pipeline corridor and anchor strike transects.

Gulfstream calculated mean percent cover, epifaunal-epifloral count, species richness, and species diversity for each transect. Percent cover and epifaunal-

Reference habitat, percent biotic cover

Table 1

	Reference habitat transects					
	Preconstruction			2005		
	Depth zone					
Cover type	1	2	3	1	2	3
Algae	4.37	1.82	1.44	1.18	0.06	0.15
Sponges	1.45	0.48	1.82	0.07	0.35	0.28
Cnidaria	2.32	0.23	0.11	0.25	0.60	0.20
Echinoderms	0.05	0.03	0.13	0	0.05	0.03
Ascidians	0.03	0	0.02	0	0	0
Mollusks	0.01	0	0	0.01	0	0.01
Bryozoans	0.03	0	0	0	0	0
Total biotic	**10.53**	**4.07**	**5.25**	**0.44**	**1.09**	**0.67**
	Mean = 6.61			**Mean = 0.73**		

Percent-cover ANOVA test results, reference habitat transects

Table 2

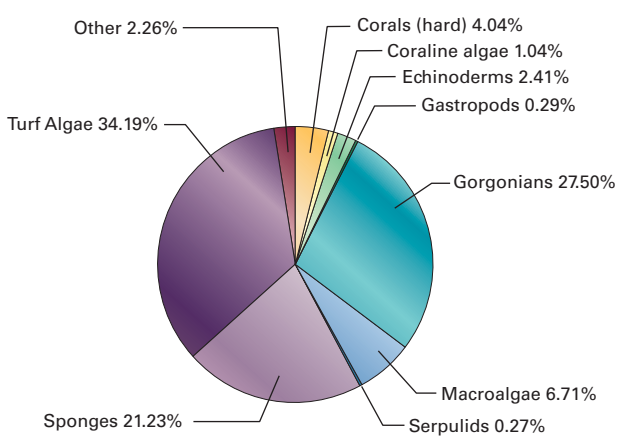
Metric	F or H value[1]	P value[1,2]	Multiple comparison results[2]	Statistical test
Corals (hard)	5.9	0.052	Zone 1 Zone 2 Zone 3	Kruskal-Wallis
Coralline algae	0.1	0.995	Zone 1 Zone 3 Zone 2	Kruskal-Wallis
Echinoderms	6.2	[3]*0.046	Zone 2 Zone 3 Zone 1[3]	Kruskal-Wallis
Gorgonians	1.5	0.469	Zone 2 Zone 3 Zone 1	Kruskal-Wallis
Macroalgae	0.059	0.970	Zone 3 Zone 1 Zone 2	Kruskal-Wallis
Sponge	0.9	0.628	Zone 2 Zone 3 Zone 1	Kruskal-Wallis
Turf algae	8.4	*0.015	Zone 1 Zone 3 Zone2[1]	Kruskal-Wallis
Total biotic cover	**0.195**	**0.824**	**Zone 1 Zone 2 Zone 3**	**One-way ANOVA**

[1]All percent cover data were arcsin square root-transformed in an attempt to meet parametric test assumptions. Parametric test assumptions could not be satisfied and a nonparametric Kruskal-Wallis test was performed instead. A Dunn's test was performed for all posthoc multiple comparisons. [2]Significant P values are denoted with an asterisk. Underlined comparisons are not significant. Results are listed in order of decreasing mean abundance. [3]Although the ANOVA result was significant, multiple comparison results did not indicate any significant pair-related differences at the P = 0.05 level.

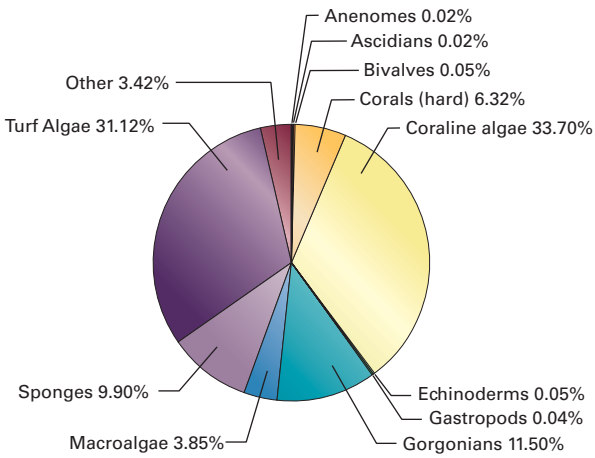
TAXA, PERCENT COMPOSITION

Fig. 1

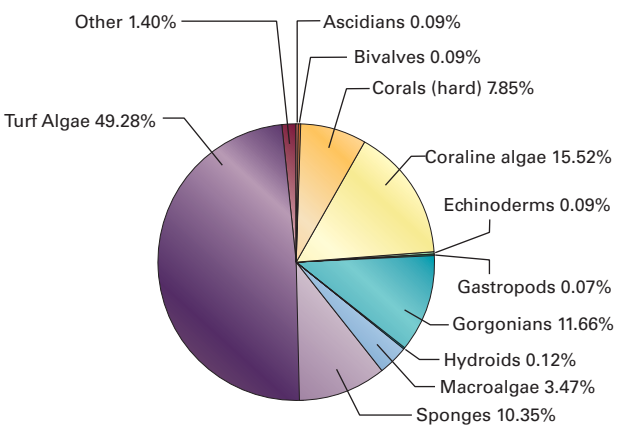
Reference habitat Fig. 1a



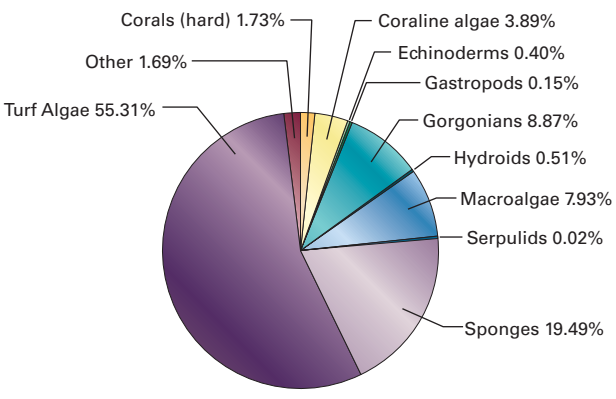
Trench corridor Fig. 1b



Spoil mound Fig. 1c



Anchor strike Fig. 1d



epifloral count consisted of enumerating noncolonial sessile epifauna to the lowest possible taxonomic resolution.

Definitively assigning many organisms to a specific genus or species from the transect images proved difficult. These instances used a unique identifier for classification (e.g., orange sponge). An "unknown" category classified shadows or out-of-focus portions of individual frames. If a transect contained greater than 5% cover classified as unknown, it was excluded from analysis.

REFERENCE TAXONOMIC DIFFERENCES; COMMUNITY MAKEUP, SIMPER RESULTS

Table 3

	Treatment differences, percent contribution* – Depth zone		
Species	1 vs. 2	1 vs. 3	2 vs. 3
Turf Algae	15.9	16.4	5.6
Eunice	10.9	—	14.0
Seagrass	7.8	9.0	6.4
Macroalgae	7.6	9.5	7.3
Cinachyra	7.2	7.0	—
Halimeda	6.0	—	7.9
Solenaastrea hyades	6.0	6.5	—
Gorgonian	5.2	10.9	12.3
Erect sponge	—	11.1	14.0
Asteroidean	—	5.9	9.0

*Percent contribution is only provided for a species if it contributed >5.0% of differences.

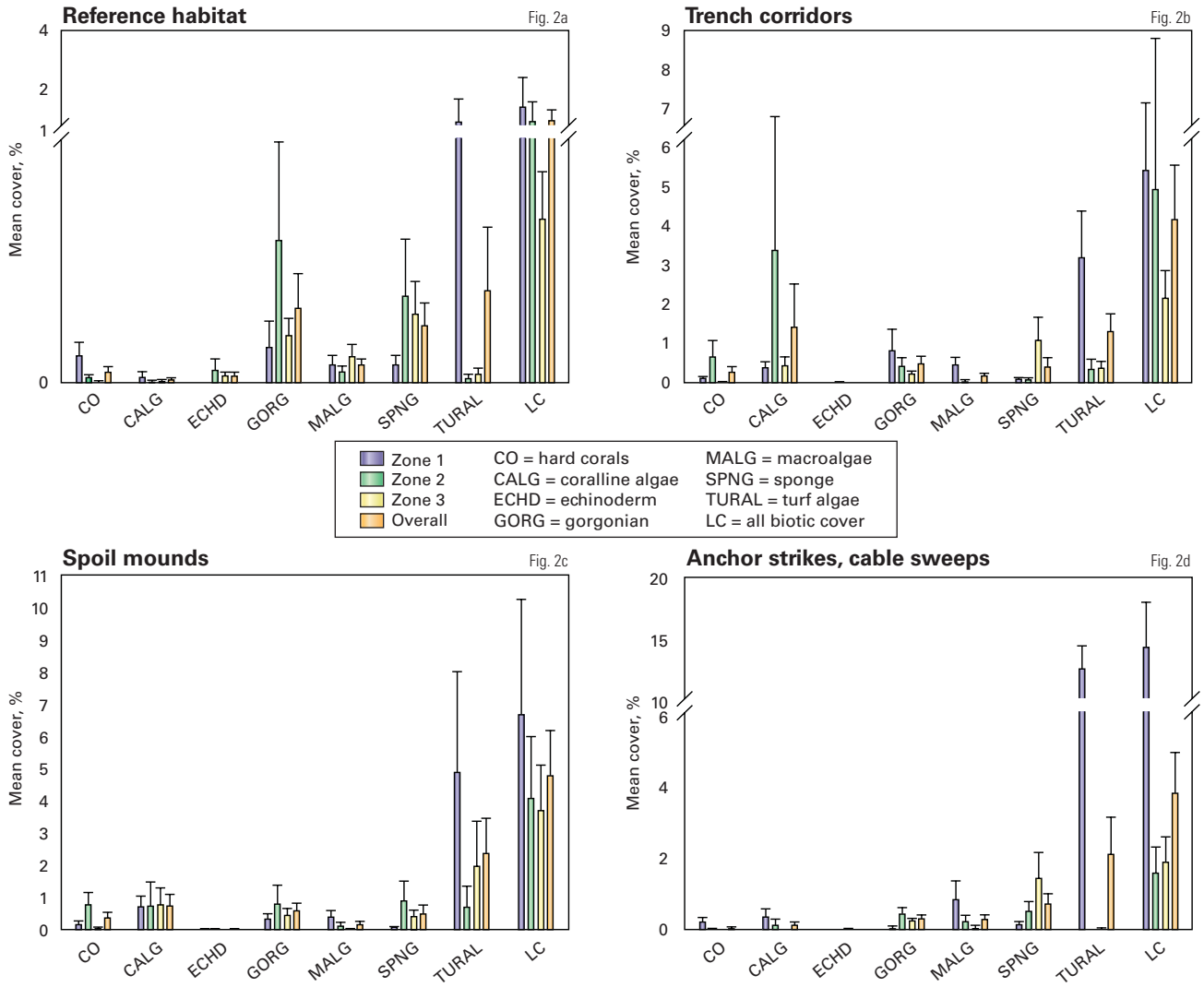
Statistical analysis

Calculation of diversity indices for each transect followed completion of summary data for each transect. Diversity indices calculated included number of species (s), Margalef's species richness (d), Pielou's evenness index (J), Shannon-Wiener (H'), and Simpson (1-λ').

Margalef's and Pielou's bias tends toward rare species, while the Simpson index is considered biased toward dominant species. Shannon-

TAXANOMIC CATEGORIES, PERCENT COVER

Fig. 2



Wiener is sensitive to rare species and regarded as the most balanced index of the four used in this analysis. Grouping some individual species into higher taxonomic levels during analysis produced conservative index results by reducing the number of taxonomic classes contributing to diversity.

A series of statistical tests compared data from the reference habitat transects to the impact areas and among depth zones. Two-way ANOVA tests address differences in abundance, percent cover, species richness, and diversity indices values by treatment and depth. Standard transformations, however, could not satisfy the assumptions of normality and heterogeneity of variances required by a two-way ANOVA.

Instead, performing either a one-way ANOVA or Kruskal-Wallis ANOVA on Ranks tests examined differences separately. If the one-way ANOVA test resulted in a significant p-value, a Student-Newman-Keuls (SNK) multiple comparisons test was performed ($\alpha = 0.05$). Instances when only two treatments were compared used either a parametric T-test or nonparametric Mann-Whitney U-test.

Analysis of Similarities (ANOSIM), a PRIMER v5 multivariate analysis technique assessed any differences in the community assemblage between areas and depth zones. If ANOSIM results indicated a significant difference among groups, a Similarity Percentages (SIMPER) analysis (another PRIMER v5 multivariate analysis technique) determined which groups were most influential in creating the differences.

The SIMPER technique examines both the average similarity within groups and the average dissimilarity between groups. The dominance of turf algae required the data to be double root transformed to increase the importance of rare species prior to ANOSIM and

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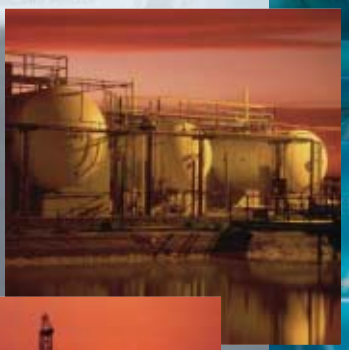

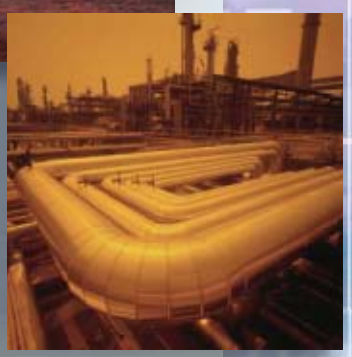

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E1271 $995.00 US

International Refining Catalyst Compilation — Refining catalysts with information on vendor, characteristics, application, catalyst form, active agents, etc.
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OGJ guide to Export Crudes-Crude Oil Assays — Over 190 of the most important crude oils in world trade.
CRDASSAY $995.00 US Current

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Enhanced Oil Recovery Survey — Covers active, planned and terminated projects worldwide. Updated biennially in March.
E1048 $300.00 US Current E1148C $1,000.00 US Historical, 1986 to current

Worldwide Gas Processing Survey — All gas processing plants worldwide with detailed information on capacities and location. Updated annually in July.
E1209 $395.00 US Current E1219C $1,195.00 US Historical, 1985 to current

International Ethylene Survey — Information on country, company, location, capacity, etc. Updated in March.
E1309 $350.00 US Current E1309C $1,050.00 US Historical, 1994 to current

LNG Worldwide — Facilities, Construction Projects, Statistics LNGINFO $395.00 US

Worldwide Construction Projects — List of planned construction products updated in May and November each year.

	Current	Historical 1996–Current
Refinery	E1340 $395.00 US	E1340C $1,495.00 US
Pipeline	E1342 $395.00 US	E1342C $1,495.00 US
Petrochemical	E1341 $395.00 US	E1341C $1,495.00 US
Gas Processing	E1344 $195.00 US	E1344C $ 795.00 US

U.S. Pipeline Study — There are 14 categories of operating and financial data on the liquids pipeline worksheet and 13 on the natural gas pipeline worksheet.
E1040 $545.00 US

Worldwide Survey of Line Pipe Mills — Detailed data on line pipe mills throughout the world, process, capacity, dimensions, etc.
PIPEMILL $695.00 US

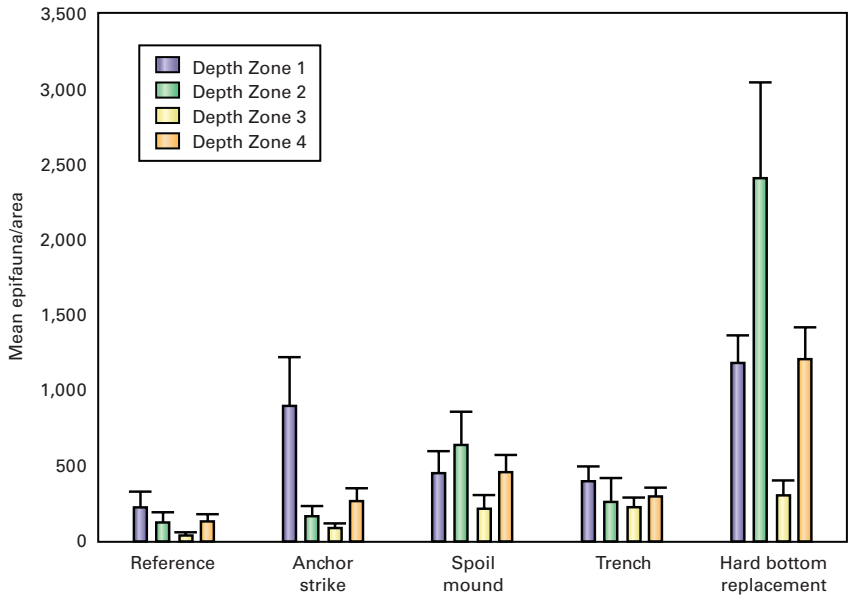
OGJ 200/100 International Company Survey — Lists valuable financial and operating data for the largest 200 publicly traded oil and gas companies.
E1345 $395.00 US Current E1145C $1,695.00 US Historical 1989 to current

OGJ 200 Quarterly — Current to the most recent quarter. OGJ200Q $295.00 US

Production Projects Worldwide — List of planned production mega-projects Location, Project Name, Year, Production Volume, Operator and Type
PRODPROJ $395.00 US

MEAN NONCOLONIAL EPIFAUNAL COUNTS

Fig. 3



SIMPER analysis. Bray-Curtis similarity matrices were used as recommended by Clarke and Warwick.

Results

Epifaunal-epifloral percent cover was relatively low in the reference habitat, averaging less than 2%. Turf algae, gorgonians, and sponges dominated. Other relatively abundant taxa included hard corals, coralline algae, echinoderms, and macroalgae (Figs. 1a and 2a).

Analysis of all transect types included echinoderms, which are not sessile epifauna but are linked to hard-live bottom substrate for both feeding and shelter, due to their abundance and strong ties to habitat structure. Gulfstream identified Cladocora-Oculina (Coral) and Pterogorgia (Gorgonian) in affected transects but not in reference habitat transects.

Tables 1-3 summarize results of the analyses of the live bottom community at the unaffected reference habitat. Table 1 also compares the reference habitat results with data collected along similar transects before construction and reported during the permitting phase of the project. Preconstruction transects contained a higher epifauna percent coverage in each Depth Zone in comparison to the 2005 reference habitat transects. A 2005 red tide likely caused the lower epifaunal-epifloral percent cover in the 2005 reference habitat transects. The red tide affected Depth Zone 1 and a portion of Depth Zone 2 before transect data were collected.

The federal mitigation plan considered depth as a potential influence on live bottom recruitment due to biological community characteristics observed during preconstruction surveys. Results of the 2005 monitoring effort indicate that a significant difference in percent cover based upon Depth Zone was not found and there was no difference with depth in the cover of the dominant taxonomic categories within reference habitat transects (Table 2).

Taxonomic diversity based upon standard indices also did not differ between Depth Zones. ANOSIM results, however, indicated a significant difference in community structure. SIMPER results indicate the community differences related predominantly to the presence of turf algae, sponges, and gorgonians (Table 3).

Trenched corridor

Gulfstream established ten 25-m random transects within both the trench corridor and trench spoil mounds perpendicular to the pipeline in Depth Zones 1, 2, and 3. Analysis of trench corridor transects included percent biotal cover, species richness, and species diversity when compared to reference habitat results.

The trench corridor had a significantly higher proportion of biotic cover than the reference habitat, with biotic cover in the trench corridor of nearly 6% (Table 4). Turf algae, gorgonians, and sponges dominated the trench corridor, with a large percentage of coralline algae observed (Figs. 1b and 2b), similar to the reference habitat.

The high degree of variability limited differences between trench corridor and reference habitat transects in percent cover for individual taxonomic categories (Table 4). Taxonomic diversity was similarly limited between the trench corridor and reference habitat. ANOSIM results indicated a significant difference in community structure between the trench corridor and reference habitat transects.

Gulfstream also analyzed hard-live bottom recovery by depth. The amount of biotic cover decreased with depth along the trench corridor, but the trend was not statistically significant.

Trench spoil mound transects were also analyzed for percent biotal cover, species richness, and species diversity, and compared to reference habitat results. The spoil mounds showed a similarly significantly higher proportion of biotic cover than the reference habitat; more than 7% (Table 5). The trench corridor had a smaller mean biotic cover than the spoil mounds, but the difference was not significant.

Turf algae, gorgonians, and sponges (Figs. 1c and 2c) dominated the spoil mound transects. Turf algae represented about 50% of the fauna present. Analysis did not find a significant difference in the percent cover of individual taxonomic categories (Table 5).

Taxonomic diversity on the spoil

mounds did not differ significantly from either the trench corridor or reference habitat. ANOSIM results also failed to show a significant difference in community structure between the spoil mounds and reference habitat or trench corridor. Analysis of hard-live bottom recovery showed less biotic cover with depth in spoil mound transects, but the trend was not statistically significant.

Anchor-cable transects

Analysis of anchor strike and cable sweep transect images looked for percent biotal cover, species richness, and species diversity, before statistically comparing them to the reference habitat (Figs. 1d and 2d).

The proportion of biotic cover showed no significant difference between the anchor strike-cable sweep and reference habitat transects (Table 5). Visible anchor strikes, however, held a higher proportion of biotic cover (Mann-Whitney, T = 346.0, P = 0.001*) within the strikes themselves (mean of 9.5 ±2.3%) than in the reference habitat (mean of 1.1 ±0.4%).

Gulfstream expected that anchor strikes and cable sweeps would increase the amount of bare rock by scraping away the surface sediment veneer. The percent cover of bare rock the company identified in the anchor strike-cable sweep transects, however, was only slightly greater (and not significantly different) than that found in reference habitat transects.

Comparing bare rock cover by depth, Zone 1 exhibited a significantly higher amount of exposed rock than Zone 2. Performing a separate analysis examining only areas that showed visible signs of anchor impact identified a significantly greater percent cover of bare rock (Mann-Whitney, T = 354.0, P = 0.001*, mean of 11.3 ±2.7%) than the reference habitat (mean of 4.0 ±2.9%).

Biological assessment

Undisturbed hard-live bottom reference habitat areas contained very little biotic cover (<2%) with a predominantly sand veneer substrate. Dominant sessile epifauna included turf algae, gorgonians, and sponges. The red tide that preceded 2005 monitoring led to expectations of diminished biotic cover in Depth Zones 1 and 2.

The community structure differs between Depth Zones within reference habitat areas; diversity based upon standard index values does not, however. Turf algae dominate in the shallower depths, while sponge and gorgonian cover increases with depth. The communities established on exposed rock proved susceptible to either burial or scouring on a regular basis via sand movement.

Hard-live bottom communities on the west Florida shelf, therefore, are not static-state growth communities but instead are dynamic communities frequently disturbed by natural events such as red tide and storms.

The federal mitigation plan stated a measure of 80% similarity for the environment to be considered recovered. It did not state, however, if this required 80% similarity in percent cover or in species composition.

Gulfstream activities appear to have met both criteria, as biotic cover was enhanced in the trench corridor, spoil mound, and visible anchor strike areas compared to natural undisturbed hard-live bottom. An increased amount of bare substrate for epifaunal-epifloral recruitment likely caused the increase in cover.

The enhanced recruitment and greater diversity of fauna found in the areas of the pipeline, however, did not significantly alter the community structure from that found on undisturbed bottom. Rock exposed during trenching and anchoring activities allows for attachment sites in an otherwise predominately sand veneer matrix.

These results are based solely on percent-cover information. Noncolonial epifauna were also counted along each transect. Analysis found similar trends in abundance when examining these counts (Fig. 3). ✦

ANOVA TEST RESULTS, PERCENT EPIFAUNA COVER

Table 4

Metric	H value[1]	P value[1 2]	Multiple comparison results[2]
Corals (hard)	5.7	0.560	Spoil mound Trench corridor Reference habitats
Coralline algae	10.7	*0.005	Trench corridor Spoil mound Reference habitats[3]
Echinoderms	7.0	*0.030	Reference habitats Spoil mound Trench corridor[3]
Gorgonians	2.6	0.276	Spoil mound Trench corridor Reference habitats
Macroalgae	0.2	0.890	Spoil mound Trench corridor Reference habitats
Sponges	1.1	0.585	Spoil mound Trench corridor Reference habitats
Turf algae	4.9	0.082	Spoil mound Trench corridor Reference habitats
Total biotic cover	**11.2**	***0.004**	**Spoil mound Trench corridor Reference habitats**

[1]All percent cover data were arcsin square root-transformed in an attempt to meet parametric test assumptions. Parametric test assumptions could not be satisfied and a nonparametric Kruskal-Wallis test was performed instead. A Dunn's test was performed for all posthoc multiple comparisons. [2]Significant P values are denoted with an asterisk. Treatments are listed in order of decreasing mean abundance. Treatments sharing an underline are not significantly different. [3]Although the ANOVA result was significant, multiple comparison results did not indicate any significant pair-related differences at the P = 0.05 level.

T-TEST RESULTS, PERCENT EPIFAUNA COVER

Table 5

Metric	T value[1]	P value[1]	Multiple comparison results[2]
Corals (hard)	923.5	0.906	Anchor strike Reference habitat
Coralline algae	991.0	0.262	Anchor strike Reference habitat
Echinoderm	915.0	0.994	Anchor strike Reference habitat
Gorgonians	988.5	0.280	Anchor strike Reference habitat
Macroalgae	895.5	0.778	Anchor strike Reference habitat
Sponge	1,028.0	0.096	Anchor strike Reference habitat
Turf algae	926.5	0.870	Anchor strike Reference habitat
Total biotic cover	**1,016.5**	**0.135**	**Anchor strike Reference habitat**

[1]All percent cover data were arcsin square root-transformed in an attempt to meet parametric test assumptions. Parametric test assumptions could not be satisfied and a nonparametric Mann-Whitney Test was performed instead. [2]Treatments sharing an underline are not significantly different. Treatments are listed in order of decreasing mean abundance.

New resin family for drilling uses

Xponent, a new resin family, helps enable downhole instrument manufacturers to design and fabricate a variety of measurement-while-drilling and logging-while-drilling (MWD-LWD) instrument housings, packers, and diverters.

The company optimizes component manufacturing efficiency by offering Xponent bismaleimide in various composite forms such as prepreg, towpreg, and custom compression molded components and molding compound.

Xponent resins provide an alternative to machined and cast metals for MWD-LWD applications. Sacrificial downhole instrumentation in composite housings also enables rapid drill-through compared with metals. The Xponent family supports a range of performance. Depending on structure and design, downhole pressures ranging to as high as 20,000 psi and temperatures to as much as 260° C. may be tolerated. For offshore operations, Xponent resins are resistant to corrosive effects of saline at high pressure and temperature, the firm points out.

Source: **YLA Inc. Div., Perstorp Engineering Materials Group**, 2970 Bay Vista Court, Benicia, CA 94510.

New vortex flowmeter

The new Rosemount MultiVariable 8800 vortex flowmeter promises to lower total installed cost of temperature compensated measurement points by 25% and reduce process variability in saturated steam uses.

By incorporating multivariable technology, this firm can deliver the benefits of its vortex technology and a temperature compensated mass flow output directly from the meter, reducing process variability.

This flowmeter has isolated, independent vortex and temperature sensors, allowing both sensors to be verified or replaced independently without breaking the process seals. This eliminates process shutdown for verification of the temperature sensor.

Cost is reduced by eliminating the need for an external thermowell, temperature sensor and transmitter, and a flow computer or control system compensation program. In addition to temperature compensated saturated steam uses, the device can also be used to output the variables independently, allowing users to obtain additional temperature monitoring points.

Source: **Emerson Process Management**, 12301 Research Blvd., Bldg. 3, Austin, TX 78759.

Corrosion resistant tubulars

DUOLINE 20 corrosion resistant oil field tubulars for seawater injection and disposal of salt water or other environmentally degrading corrosive fluids are discussed in new, free literature.

The filament-wound glass-reinforced epoxy liner is an alternative to internal plastic coating.

Source: **Duoline Technologies LP**, 9019 N. County Rd. West, Odessa, TX 79764.

Intec Engineering

Houston, has announced that E.G. Skip Ward has joined the firm as a technical advisor. Ward will continue to serve as associate director of the Offshore Technology Research Center on a part-time basis. He joined the OTRC in 1998 following his retirement from Shell, where he had 30 years of experience. He holds MS and PhD degrees in mechanical engineering from the University of Houston.

One of Ward's initial tasks with Intec is to develop and manage a research project to improve the understanding of vortex-induced high-mode vibration causing fatigue damage to deepwater steel catenary risers.

Intec Engineering, established in 1984, has 450 employees in offices on five continents.

Fulbright & Jaworski LLP

Houston, has announced the opening of a Denver office to serve energy companies active in the Rockies. Partner Jeff Dykes will head the Denver office. Joining the firm in Denver is Ken Wonstolen, who long served as senior vice-president and general counsel for the Colorado Oil & Gas Association. Partner Poe Leggette and senior associate Bret Sumner will also reside in the Denver location.

In an additional announcement, Fulbright & Jaworski has announced that Scott Schwind has joined the firm as an energy partner in Houston. Schwind's international energy and infrastructure projects work and fluency in four languages will further enhance the firm's ongoing global work. Schwind earned his BA with honors from Hampden-Sydney College, and his JD from the University of Texas.

Fulbright & Jaworski LLP is a full service international law firm operating in 16 locations around the world.

Ionik Consulting

Houston, has appointed Dirk van Oostendorp as regional manager-the Americas. Van Oostendorp has more than 26 years of global industry experience, including senior management positions with other services companies. He holds undergraduate and graduate degrees in physics and physical chemistry.

Ionik Consulting, a business unit of J P Kenny Inc. and part of John Wood Group PLC, is an independent engineering and management group specializing in all aspects of materials, metallurgy, welding, integrity, and corrosion.

J P Kenny Inc. is a leading independent pipeline and subsea engineering organization, operating from 10 locations worldwide.

John Wood Group PLC is an international energy services company operating in 44 countries within three business groups: engineering and production facilities, well support, and gas turbine services.

King & Spalding

Atlanta, has announced plans to establish an office in Dubai to more closely handle client matters in the Arabian Gulf region, where the firm's largest concentration of clients outside the US are located. Partner Philip Weems, who leads King & Spalding's energy practice, will relocate from the firm's Houston office to head the Dubai operations. Jawad Ali, a partner in the firm's Islamic finance and investment practice, will relocate to Dubai from the London office.

King & Spalding is an international law firm with offices in Atlanta, Houston, London, New York, and Washington DC.

Knowledge Systems Inc.

Houston, has announced plans to open facilities in London, UK, and Perth, Australia, adding technical resources and geopressure analysts in both locations.

Russell Smith, most recently international business development manager in the Houston office, will relocate to Perth as managing director for the Asia/Pacific center.

Morris Covington joins the company as managing director for the Europe, Africa and Middle East market, based in the new London facility. Covington had previously held senior management positions with Landmark Graphics, Object Reservoir Inc., and Scientific Software Intercomp.

Knowledge Systems Inc. is a leading provider of software and services to improve well planning and enhance drilling efficiency for the worldwide oil and gas industry.

Modec Inc.

Tokyo, has announced the acquisition by Modec USA Inc. of FMC Technologies Floating Systems Inc. The acquisition gives Modec added strength in the FPSO industry by incorporating the Sofec patented turret and mooring technologies from FMC into Modec's FPSO and FSO construction business.

Modec Inc. is a turnkey service supplier of FPSO vessels, FSO vessels, TLPs, and CPSs for the offshore oil and gas industry.

Natural Gas Services Group Inc. (NGS)

Midland, Tex., has announced the promotion of Robert B. Ingle to sales and marketing manager, and A.J. Posey to operations coordinator.

Ingle, who holds a degree from Texas Tech University, joined NGS in 1999. He most recently concentrated on development of the Barnett Shale market, and will be responsible for market development in existing and new geographic areas.

Posey has advanced through various fabrication and field service positions since joining the company in 1999. His responsibilities will include direction of NGS' field service organization.

Natural Gas Services Group Inc. is a leading provider of small to medium horsepower wellhead compression equipment to the natural gas industry, with primary focus on the non-conventional gas industry.

Severn Glocon

Houston, has appointed Bill Meeks as sales manager for the Americas. Meeks has broad experience in the control valve and actuation industries, having previously held positions with Fisher Controls, Valtek, and Tyco/Keystone.

Severn Glocon is a leading UK-based manufacturer of control valves for the oil, gas, LNG, petrochemical, and power generation industries.

SolArc Inc.

Houston, has announced its acquisition of Trinity Apex Solutions Inc., a Dallas-based developer of software systems for natural gas producers and marketers. The combination of Trinity Apex's full commercial management solution of natural gas from the wellhead to burner tip, and SolArc's trading, physical product handling and risk management capabilities software, will enable the company to provide customers with solutions for the entire natural gas value chain.

SolArc Inc. is a leading provider of enterprise supply and trade management solutions for global energy companies.

Statistics

API IMPORTS OF CRUDE AND PRODUCTS

	Districts 1-4		District 5		Total US		
	12-22 2006	[1]12-15 2006	12-22 2006	[1]12-15 2006	12-22 2006	[1]12-15 2006	12-23 2005
	1,000 b/d						
Total motor gasoline	650	375	17	8	667	383	360
Mo. gas. blending comp.	549	527	8	8	557	535	762
Distillate[2]	371	356	18	15	389	371	402
Residual	360	212	105	44	465	256	601
Jet fuel-kerosine	58	104	118	106	176	210	171
LPG	295	332	—	—	295	332	301
Unfinished oils	513	528	24	76	537	604	462
Other	480	337	60	16	540	353	400
Total products	**3,276**	**2,771**	**350**	**273**	**3,626**	**3,044**	**3,459**
Canadian crude	1,967	1,616	282	165	2,249	1,781	1,567
Other foreign	8,266	6,346	550	715	8,816	7,061	8,853
Total crude	**10,233**	**7,962**	**832**	**880**	**11,065**	**8,842**	**10,420**
Total imports	**13,509**	**10,733**	**1,182**	**1,153**	**14,691**	**11,886**	**13,879**

[1]Revised. [2]Includes No. 4 fuel oil.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

Additional analysis of market trends is available through **OGJ Online**, *Oil & Gas Journal's* electronic information source, at http://www.ogjonline.com.

OIL&GAS JOURNAL online research center

OGJ CRACK SPREAD

	*12-22-06	*12-23-05	Change	Change, %
	$/bbl			
SPOT PRICES				
Product value	72.46	69.39	3.06	4.4
Brent crude	62.39	56.47	5.92	10.5
Crack spread	10.07	12.92	–2.85	–22.1
FUTURES MARKET PRICES				
One month				
Product value	70.87	67.57	3.29	4.9
Light sweet crude	62.83	58.04	4.79	8.3
Crack spread	8.04	9.53	–1.50	–15.7
Six month				
Product value	77.67	71.66	6.01	8.4
Light sweet crude	66.11	60.17	5.94	9.9
Crack spread	11.55	11.49	0.06	0.5

*Average for week ending
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

API CRUDE AND PRODUCT STOCKS

	Crude oil	Motor gasoline		Jet fuel	Fuel oils		Unfinished oils
		Total	Blending comp.[1]	Kerosine	Distillate	Residual	
	1,000 bbl						
PAD I	14,679	50,987	23,684	9,481	65,377	18,763	8,132
PAD II	69,339	51,476	16,216	7,262	24,729	1,686	12,277
PAD III	169,473	65,208	27,045	13,395	33,506	18,225	41,645
PAD IV	14,753	5,995	1,949	491	2,664	476	3,484
PAD V	[1]51,097	27,563	21,216	7,384	11,521	5,846	20,927
Dec. 22, 2006	**[1]319,341**	**201,229**	**90,110**	**38,013**	**137,797**	**44,996**	**86,465**
Dec. 15, 2006[3]	**321,473**	**199,821**	**89,324**	**38,359**	**135,212**	**44,354**	**87,647**
Dec. 23, 2005	**323,482**	**202,504**	**68,218**	**41,336**	**129,487**	**37,900**	**90,511**

[1]Included in total motor gasoline. [2]Includes 4.530 million bbl of Alaskan crude in transit by water. [3]Revised.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

API REFINERY REPORT—DEC. 22, 2006

	REFINERY OPERATIONS					REFINERY OUTPUT			
	Total refinery input	Crude runs	Input to crude stills	Operable capacity	Percent operated	Total motor gasoline	Jet fuel, kerosine	Fuel oils: Distillate	Fuel oils: Residual
District	1,000 b/d								
East Coast	3,180	1,416	1,417	1,618	87.6	1,762	87	534	132
App. Dist. 1	106	95	95	95	100.0	9	0	26	1
Dist. 1 total	**3,286**	**1,511**	**1,512**	**1,713**	**88.3**	**1,771**	**87**	**560**	**133**
Ind., Ill., Ky.	2,135	2,051	2,054	2,355	87.2	1,258	130	551	57
Minn., Wis., Dak.	446	420	432	442	97.7	315	31	125	10
Okla., Kan., Mo.	888	722	734	786	93.4	517	38	274	5
Dist. 2 total	**3,469**	**3,193**	**3,220**	**3,583**	**89.9**	**2,090**	**199**	**950**	**72**
Inland Texas	973	589	621	647	96.0	476	45	175	7
Texas Gulf Coast	3,919	3,336	3,362	4,031	83.4	1,284	347	775	118
La. Gulf Coast	3,413	3,246	3,249	3,264	99.5	1,428	410	769	170
N. La. and Ark.	221	186	195	215	90.7	79	8	45	3
New Mexico	146	90	92	113	81.4	98	1	33	0
Dist. 3 total	**8,672**	**7,447**	**7,519**	**8,270**	**90.9**	**3,365**	**811**	**1,797**	**298**
Dist. 4 total	**699**	**536**	**543**	**596**	**91.1**	**335**	**26**	**174**	**15**
Dist. 5 total	**2,933**	**2,696**	**2,837**	**3,173**	**89.4**	**1,794**	**460**	**608**	**150**
Dec. 22, 2006	**19,059**	**15,383**	**15,361**	**17,335**	**90.2**	**9,355**	**1,583**	**4,089**	**668**
Dec. 15, 2006*	**19,037**	**15,414**	**15,640**	**17,335**	**90.2**	**9,118**	**1,438**	**4,127**	**625**
Dec. 23, 2005	**16,908**	**14,875**	**15,543**	**17,115**	**90.8**	**8,816**	**1,460**	**4,069**	**696**

*Revised.
Source: American Petroleum Institute.
Data available in OGJ Online Research Center.

OGJ GASOLINE PRICES

	Price ex tax 12-27-06	Pump price* 12-27-06	Pump price 12-28-05
	¢/gal		
(Approx. prices for self-service unleaded gasoline)			
Atlanta	187.2	226.9	215.9
Baltimore	185.2	227.1	215.7
Boston	188.6	230.5	208.7
Buffalo	189.4	249.5	211.9
Miami	195.5	245.8	218.7
Newark	190.4	223.3	217.8
New York	182.4	242.5	221.8
Norfolk	183.0	220.6	220.8
Philadelphia	196.1	246.8	223.7
Pittsburgh	184.4	235.1	220.7
Wash., DC	196.6	235.0	223.7
PAD I avg.	189.0	234.8	218.2
Chicago	214.8	265.7	237.1
Cleveland	180.8	227.2	211.6
Des Moines	181.1	221.5	210.5
Detroit	177.3	226.5	212.6
Indianapolis	183.5	228.5	215.4
Kansas City	175.5	211.5	213.5
Louisville	187.6	224.5	210.6
Memphis	179.4	219.2	218.6
Milwaukee	182.6	233.9	220.7
Minn.-St. Paul	181.8	222.2	219.5
Oklahoma City	175.1	210.5	209.5
Omaha	178.2	224.6	215.6
St. Louis	182.5	218.5	219.6
Tulsa	174.8	210.2	208.5
Wichita	174.5	217.9	210.4
PAD II avg.	182.0	224.2	215.6
Albuquerque	183.8	220.2	212.7
Birmingham	184.8	223.5	211.7
Dallas-Fort Worth	185.1	223.5	210.8
Houston	180.1	210.5	208.8
Little Rock	181.6	221.8	211.7
New Orleans	183.1	221.5	254.6
San Antonio	180.7	219.1	215.7
PAD III avg.	182.7	221.1	218.0
Cheyenne	180.8	213.2	210.8
Denver	172.5	212.9	220.8
Salt Lake City	183.7	226.6	215.8
PAD IV avg.	179.0	217.5	215.8
Los Angeles	199.1	257.6	226.0
Phoenix	196.1	233.5	224.9
Portland	218.9	262.2	222.8
San Diego	206.1	264.6	230.9
San Francisco	220.7	279.2	233.9
Seattle	222.8	275.2	224.9
PAD V avg.	210.6	262.1	227.3
Week's avg.	**187.8**	**231.4**	**218.3**
Dec. avg.	**184.9**	**228.5**	**216.5**
Nov. avg.	**180.1**	**223.7**	**229.9**
2006 to date	**212.3**	**255.9**	—
2005 to date	**181.6**	**223.7**	—

*Includes state and federal motor fuel taxes and state sales tax. Local governments may impose additional taxes.
Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

REFINED PRODUCT PRICES

	12-22-06 ¢/gal		12-22-06 ¢/gal
Spot market product prices			
Motor gasoline (Conventional-regular)		Heating oil No. 2	
New York Harbor	167.70	New York Harbor	168.25
Gulf Coast	159.52	Gulf Coast	166.65
Los Angeles	175.02	Gas oil	
Amsterdam-Rotterdam-Antwerp (ARA)	154.67	ARA	169.77
Singapore	166.43	Singapore	166.77
Motor gasoline (Reformulated-regular)		Residual fuel oil	
New York Harbor	167.70	New York Harbor	94.12
Gulf Coast	159.65	Gulf Coast	100.60
Los Angeles	183.02	Los Angeles	106.48
		ARA	90.27
		Singapore	103.82

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

BAKER HUGHES RIG COUNT

	12-29-06	12-30-05
Alabama	4	6
Alaska	8	10
Arkansas	36	15
California	34	32
Land	31	27
Offshore	3	5
Colorado	94	84
Florida	0	2
Illinois	0	0
Indiana	0	0
Kansas	12	7
Kentucky	7	6
Louisiana	189	165
N. Land	60	48
S. Inland waters	20	18
S. Land	42	33
Offshore	67	66
Maryland	0	0
Michigan	2	2
Mississippi	21	5
Montana	21	22
Nebraska	0	0
New Mexico	91	95
New York	10	3
North Dakota	34	22
Ohio	10	9
Oklahoma	174	154
Pennsylvania	17	14
South Dakota	1	1
Texas	784	672
Offshore	12	7
Inland waters	2	1
Dist. 1	19	21
Dist. 2	27	31
Dist. 3	64	56
Dist. 4	93	71
Dist. 5	146	119
Dist. 6	125	107
Dist. 7B	35	24
Dist. 7C	49	39
Dist. 8	98	76
Dist. 8A	25	26
Dist. 9	36	28
Dist. 10	53	66
Utah	44	28
West Virginia	24	25
Wyoming	85	89
Others—HI-1; ID-1; NV-1; TN-4; WA-1	8	3
Total US	**1,710**	**1,471**
Total Canada	**429**	**364**
Grand total	**2,139**	**1,835**
Oil rigs	278	235
Gas rigs	1,425	1,234
Total offshore	84	80
Total cum. avg. YTD	**1,649**	**1,383**

Rotary rigs from spudding in to total depth.
Definitions, see OGJ Sept. 18, 2006, p. 42.

Source: Baker Hughes Inc.
Data available in OGJ Online Research Center.

SMITH RIG COUNT

Proposed depth, ft	Rig count	12-29-06 Percent footage*	Rig count	12-30-05 Percent footage*
0-2,500	45	—	25	4.0
2,501-5,000	114	52.6	89	47.1
5,001-7,500	217	20.2	187	19.7
7,501-10,000	436	2.7	322	4.3
10,001-12,500	409	2.2	351	1.9
12,501-15,000	261	0.3	293	—
15,001-17,500	120	0.8	99	—
17,501-20,000	79	—	59	—
20,001-over	38	—	21	—
Total	**1,719**	**7.3**	**1,446**	**6.9**
INLAND	33		36	
LAND	1,629		1,360	
OFFSHORE	57		50	

*Rigs employed under footage contracts.
Definitions, see OGJ, Sept. 18, 2006, p. 42.

Source: Smith International Inc.
Data available in OGJ Online Research Center.

OGJ PRODUCTION REPORT

	[1]12-29-06	[2]12-30-05
	1,000 b/d	
(Crude oil and lease condensate)		
Alabama	19	21
Alaska	805	836
California	702	680
Colorado	59	59
Florida	8	7
Illinois	31	28
Kansas	95	92
Louisiana	1,408	1,113
Michigan	15	13
Mississippi	53	49
Montana	94	97
New Mexico	165	162
North Dakota	103	104
Oklahoma	173	165
Texas	1,394	1,288
Utah	44	48
Wyoming	142	139
All others	66	73
Total	**5,376**	**4,984**

[1]OGJ estimate. [2]Revised.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

US CRUDE PRICES

$/bbl*	12-29-06
Alaska-North Slope 27°	49.52
South Louisiana Sweet	56.75
California-Kern River 13°	49.35
Lost Hills 30°	57.05
Southwest Wyoming Sweet	58.05
East Texas Sweet	58.28
West Texas Sour 34°	49.00
West Texas Intermediate	57.75
Oklahoma Sweet	57.75
Texas Upper Gulf Coast	54.50
Michigan Sour	50.75
Kansas Common	56.75
North Dakota Sweet	47.50

*Current major refiner's posted prices except North Slope lags 2 months. 40° gravity crude unless differing gravity is shown.

Source: Oil & Gas Journal.
Data available in OGJ Online Research Center.

WORLD CRUDE PRICES

$/bbl[1]	12-22-06
United Kingdom-Brent 38°	62.44
Russia-Urals 32°	58.12
Saudi Light 34°	57.22
Dubai Fateh 32°	58.73
Algeria Saharan 44°	63.45
Nigeria-Bonny Light 37°	64.38
Indonesia-Minas 34°	63.07
Venezuela-Tia Juana Light 31°	57.14
Mexico-Isthmus 33°	57.03
OPEC basket	60.15
Total OPEC[2]	58.46
Total non-OPEC[2]	56.35
Total world[2]	57.22
US imports[3]	55.09

[1]Estimated contract prices. [2]Average price (FOB) weighted by estimated export volume. [3]Average price (FOB) weighted by estimated import volume.

Source: DOE Weekly Petroleum Status Report.
Data available in OGJ Online Research Center.

US NATURAL GAS STORAGE[1]

	12-22-06	12-15-06	Change
	Bcf		
Producing region	947	941	6
Consuming region east	1,773	1,801	–28
Consuming region west	401	425	–24
Total US	**3,121**	**3,167**	**–46**
	Sept. 06	**Sept. 05**	**Change, %**
Total US[2]	**3,323**	**2,932**	**13.3**

[1]Working gas. [2]At end of period.
Source: Energy Information Administration
Data available in OGJ Online Research Center.

Statistics

WORLDWIDE CRUDE OIL AND GAS PRODUCTION

	Oct. 2006	Sept. 2006	10 month average production 2006	10 month average production 2005	Chg. vs prev. year Volume	Chg. vs prev. year %	Oct. 2006	Sept. 2006	Cum. 2006
	Crude, 1,000 b/d						Gas, bcf		
Argentina	630	640	637	648	–11	–1.7	135.0	134.0	1,332.4
Bolivia	45	45	45	41	4	10.0	40.0	38.0	391.0
Brazil	1,762	1,733	1,711	1,623	88	5.4	29.1	29.3	292.1
Canada	2,593	2,590	2,487	2,314	173	7.5	517.1	480.9	5,043.1
Colombia	526	526	530	526	4	0.8	17.0	15.7	159.5
Ecuador	518	530	538	516	23	4.4	0.3	0.3	3.1
Mexico	3,173	3,258	3,293	3,331	–38	–1.1	172.3	167.6	1,615.8
Peru	107	118	115	112	2	2.1	6.5	6.8	51.2
Trinidad	145	143	147	148	—	–0.2	107.0	103.1	1,050.1
United States	5,243	5,188	5,125	5,233	–108	–2.1	1,655.0	1,616.0	16,081.0
Venezuela[1]	2,510	2,550	2,576	2,716	–140	–5.2	82.0	80.0	819.0
Other Latin America	79	79	79	80	–1	–1.3	7.5	7.2	73.3
Western Hemisphere	**17,331**	**17,400**	**17,285**	**17,288**	**–3**	**—**	**2,769.0**	**2,678.9**	**26,911.7**
Austria	17	17	17	17	—	2.4	5.0	4.7	51.5
Denmark	353	260	333	380	–48	–12.5	25.1	19.9	284.3
France	22	22	21	22	—	–0.7	3.5	3.3	35.0
Germany	67	67	70	70	—	–0.2	53.7	45.9	540.8
Italy	106	107	110	115	–5	–4.6	31.0	30.0	321.6
Netherlands	15	16	24	33	–9	–26.2	300.0	290.0	2,555.0
Norway	2,380	2,338	2,492	2,705	–213	–7.9	237.8	219.5	2,501.0
Turkey	41	42	42	42	—	–0.9	2.5	2.4	26.0
United Kingdom	1,537	1,398	1,516	1,686	–170	–10.1	237.2	213.3	2,442.7
Other Western Europe	4	4	5	5	—	–6.0	0.2	0.2	18.4
Western Europe	**4,542**	**4,272**	**4,629**	**5,075**	**–445**	**–8.8**	**895.9**	**829.3**	**8,776.3**
Azerbaijan	670	660	617	422	195	46.2	21.0	20.0	227.0
Croatia	16	17	17	18	–1	–4.5	4.8	4.7	47.4
Hungary	16	16	17	20	–4	–17.8	9.3	8.7	89.2
Kazakhstan	1,120	1,120	1,049	987	62	6.3	74.0	72.0	712.0
Romania	97	97	99	100	–1	–1.3	18.0	17.0	172.0
Russia	9,500	9,500	9,468	9,167	301	3.3	1,850.0	1,790.0	18,705.0
Other FSU	500	500	510	420	90	21.4	400.0	385.0	4,365.0
Other Eastern Europe	45	45	45	49	–4	–8.2	43.9	46.2	428.3
Eastern Europe and FSU	**11,964**	**11,954**	**11,821**	**11,183**	**638**	**5.7**	**2,421.0**	**2,343.6**	**24,745.9**
Algeria[1]	1,350	1,350	1,349	1,348	1	0.1	285.0	277.0	2,727.0
Angola	1,350	1,376	1,393	1,200	192	16.0	2.4	2.0	23.2
Cameroon	86	86	88	82	6	7.9	—	—	—
Congo (former Zaire)	20	20	20	20	—	—	—	—	—
Congo (Brazzaville)	240	240	240	240	—	—	—	—	—
Egypt	650	650	671	696	–25	–3.6	42.0	38.0	404.0
Equatorial Guinea	320	320	320	320	—	—	0.1	0.1	0.6
Gabon	230	230	236	233	3	1.3	0.3	0.3	3.0
Libya[1]	1,750	1,750	1,704	1,638	66	4.0	22.0	22.0	216.5
Nigeria[1]	2,240	2,190	2,224	2,395	–171	–7.1	75.0	72.0	702.0
Sudan	300	290	291	290	1	0.3	—	—	—
Tunisia	65	67	65	72	–6	–8.9	6.8	6.8	67.4
Other Africa	264	266	270	241	29	12.0	10.2	10.0	100.6
Africa	**8,866**	**8,834**	**8,871**	**8,775**	**96**	**1.1**	**443.7**	**428.1**	**4,244.3**
Bahrain	170	170	172	174	–2	–1.1	27.0	26.0	261.2
Iran[1]	3,800	3,850	3,883	3,895	–12	–0.3	265.0	260.0	2,698.0
Iraq[1]	1,940	2,050	1,919	1,848	71	3.8	5.3	5.2	51.8
Kuwait[1,2]	2,510	2,500	2,505	2,414	91	3.8	31.0	30.0	305.5
Oman	720	730	743	757	–14	–1.8	58.5	57.0	581.5
Qatar[1]	810	830	824	792	32	4.0	117.0	115.0	1,149.0
Saudi Arabia[1,2]	8,930	9,010	9,185	9,285	–100	–1.1	170.0	165.0	1,774.0
Syria	410	410	427	462	–35	–7.6	15.4	14.9	153.7
United Arab Emirates[1]	2,670	2,640	2,637	2,437	200	8.2	135.0	130.0	1,308.0
Yemen	350	350	347	348	–1	–0.3	—	—	—
Other Middle East	—	—	—	—	—	9.1	7.9	8.8	73.9
Middle East	**22,310**	**22,540**	**22,641**	**22,411**	**230**	**1.0**	**832.1**	**811.9**	**8,356.6**
Australia	519	493	417	442	–25	–5.7	119.0	114.8	1,142.3
Brunei	214	214	204	185	19	10.1	33.1	36.5	353.8
China	3,660	3,659	3,692	3,630	62	1.7	172.3	163.7	1,716.0
India	692	703	678	666	12	1.8	88.0	77.0	786.9
Indonesia[1]	860	870	899	945	–46	–4.9	185.0	180.0	1,890.0
Japan	14	14	15	16	—	–1.9	8.8	8.5	93.5
Malaysia	770	760	746	774	–28	–3.6	145.0	140.0	1,399.0
New Zealand	10	13	15	15	–1	–4.0	12.0	12.5	114.2
Pakistan	60	61	64	64	—	–0.5	113.0	109.5	1,158.2
Papua New Guinea	55	55	57	46	11	23.5	0.5	0.5	5.0
Thailand	190	209	211	182	29	16.2	72.7	70.9	713.8
Vietnam	340	355	347	340	7	1.9	15.0	15.0	150.0
Other Asia-Pacific	33	38	33	35	–2	–6.8	65.5	64.3	648.4
Asia-Pacific	**7,417**	**7,443**	**7,376**	**7,339**	**37**	**0.5**	**1,029.8**	**993.2**	**10,171.0**
TOTAL WORLD	**72,429**	**72,444**	**72,623**	**72,070**	**553**	**0.8**	**8,391.5**	**8,084.9**	**83,205.9**
OPEC	29,370	29,590	29,704	29,712	–8	—	1,372.3	1,336.2	13,640.8
North Sea	4,284	4,011	4,357	4,782	–426	–8.9	589.9	539.5	5,991.9

[1]OPEC member. [2]Kuwait and Saudi Arabia production each include half of Neutral Zone. Totals may not add due to rounding. Source: Oil & Gas Journal. Data available in OGJ Online Research Center.

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Hot news: Oil profits to be down this year

Here's news you won't read on the front pages of newspapers this year.

Unless prices spurt again, profits of major oil and gas companies in 2007 will fall below last year's record levels.

But stories about the declines will be short and relegated to newspaper business pages, unadorned by quotes from outraged gasoline consumers.

Except for oil company shareholders

The Editor's Perspective

by Bob Tippee, Editor

and managers, nobody cares about oil company profits unless gasoline prices are abnormally high.

But the coincidence of elevated gasoline prices and high oil company profits always provokes a national tantrum in the US. It certainly did so last year, when prices jumped for reasons anyone could see (rebellion in Nigeria, war in Iraq, refineries flooded by hurricanes).

The American public apparently expects oil companies to refrain from earning profits when oil and gas prices jump.

This is not easy. Not profiting when commodity prices leap is more difficult than, for example, producing oil in 5,000 ft of water and making vehicle fuel able to meet ever-toughening air-quality standards.

In the oil and gas business, when prices rise revenues rise if production rates don't drop. It's arithmetic. And if costs don't rise profits rise. Arithmetic again.

It is in fact impossible not to record abnormally high profits when prices leap. It's just as impossible for abnormally high profits to endure.

High profits attract competition, which increases supply, which lowers prices. At the same time, high prices discourage consumption, which lowers demand and also lowers prices. High profits also invite cost increases, which erode profits even if prices stay high.

All that explains why oil-company profits this year probably won't match last year's aberrations. Prices and consumption growth already have eased. Costs are skyrocketing. The diminished profits should delight Americans who were irked so thoroughly last year. But they won't see stories about them on newspaper front pages.

Americans want to believe that rising gasoline prices reflect a conspiracy against them. They refuse to believe that markets, including physical upsets like Nigerian sabotage and Gulf Coast hurricanes, have anything to do with fuel prices.

Newspapers want to please them. So no one learns anything.

(Online Dec. 31, 2006; author's e-mail: bobt@ogjonline.com)

Market Journal

by Sam Fletcher, Senior Writer

Inventory, weather influence markets

The February contract for benchmark US sweet, light crudes increased 26¢ to $63.72/bbl Dec. 20 as the US Energy Information Administration reported a larger-than-expected 6.3 million bbl drop in commercial US crude stocks to 329.1 million bbl in the week ended Dec. 15.

Warm weather then caused the February contract to fall for four consecutive trading sessions through the Christmas holiday, closing at $60.34/bbl Dec. 27, the lowest level for a lead contract in more than a month on the New York Mercantile Exchange.

The price increased to $60.53/bbl Dec. 28 on the report of another large drop in crude stocks, down 8.1 million bbl in the week ended Dec. 22, marking larger-than-anticipated crude draws in 10 out of the last 11 reports. "Since Nov. 17, US crude supplies have declined by 20.2 million bbl, the biggest 5-week drop since the hurricane season in 2005," said analysts in Houston office of Raymond James & Associates Inc.

Weather drives markets

Nevertheless, forecasts of warm weather and fear of a slowing US economy continued to dominate the market. "This month is expected to end up being the warmest December on record while initial forecasts for January are calling for continued mild weather," said Robert S. Morris, Banc of America Securities LLC, New York. Because of a strong El Nino weather pattern, the National Oceanic & Atmospheric Administration called for higher-than-normal temperatures in most of the US for the rest of the winter. "Market sentiment has been driven primarily by mild East Coast weather recently. However, we suggest that the impact is being overdone, given that heating oil is normally just 6% of US demand at this time of year, and last year proved to be less affected by weather than is normally assumed," said Paul Horsnell at Barclays Capital Inc., London.

"The average price of front-month [crude contract on NYMEX] in 2006 is headed for about $66.25/bbl, a 17% rise on 2005 and not much of a major deceleration from the increases of 20%, 32%, and 37% experienced in 2003, 2004, and 2005, respectively," Horsnell said. "However, oil prices are ending the year relatively weakly, with the value of the Organization of Petroleum Exporting Countries' basket currently lower in dollar terms than it was at the start of the fourth quarter. Further, in euro terms the value of the basket is currently only a little above its low for the quarter."

Geopolitical issues ignored

Traders shrugged off several geopolitical issues that could impact the market. The United Nations Security Council voted Dec. 22 to order all countries to stop supplying Iran with materials and technology that could contribute to its nuclear and missile programs. Iran remained defiant, although Iranian Oil Minister Kazem Vaziri Hamaneh said Iran's oil industry and crude exports would not be disrupted.

"This move, although expected, should be viewed as an escalation in the confrontation between the Islamic Republic and Western nations," said Raymond James analysts. The UN resolution "was watered down significantly at the behest of Russia and China; both have significant economic ties to Iran."

Raymond James said: "From an oil market perspective, this resolution does not have any direct impact on Tehran's ability to pump crude oil into the international markets; the sanctions are targeted purely at the country's ability to acquire materials necessary to develop nuclear technology. However, this stern decision by the international community highlights the geopolitical risks that continue to haunt the ever-tightening energy markets. Going forward, threats by Iran to pull out of the Non-Proliferation Treaty and expel UN nuclear inspectors may further aggravate the current situation and inflate the risk premium in oil prices."

Violence escalated in Nigeria's Niger Delta with armed attacks by militants on oil production facilities. "The largest African crude producer has lost anywhere between 200,000-600,000 b/d in hydrocarbon production in the past year," Raymond James reported. "As a precautionary measure, one oil firm has already started to evacuate dependents of foreign employees from the turbulent region. Nigeria continues to be a stark example of the very real geopolitical risk to oil supply, and one that may not be fully recognized by the commodity markets." With the recent reelection of President Hugo Chavez, Venezuela's oil production should remain below its OPEC quota. The loss of more than 30% of Venezuela's former crude production level since 2001 "is one of the worst declines of any major oil producing country," said Raymond James analysts. "The entire political map of Latin America continues to shift towards left-wing governments with generally antitrade and anti-investment policies."

(Online Dec. 29, 2006; author's e-mail: samf@ogjonline.com)

PennWell Petroleum Group's

Virtual Job Fair

Let Your Mouse Do The Knocking.

Whether you're currently employed or not, don't miss PennWell Petroleum Group's Virtual Job Fair.

We've lined up leading energy industry companies and they'll be opening their doors to applicants on **Wednesday, January 24, 2007,** for live, interactive job screenings.

Without leaving your home or office, you'll be able to check out the benefits associated with a "change of address."

"Doors will open" at 8:00 am CST and stay open till 9:00 pm CST. And, resumes can be submitted for up to 60 days after the fair.

Free registration opens all the doors. A promising career may be just a knock away.

Register Now!
http://events.unisfair.com/rt/penn

Here are some of the outstanding companies that hope you come knocking:

OXY

BAKER HUGHES

HALLIBURTON

PennWell® PETROLEUM VIRTUAL JOB FAIR

MEASURE & COMPARE

Baker Hughes delivers Best-in-Class results

Pre-Planning, Logistics & Teamwork Delivered 193,110 Bbls Of Drilling Fluid To Batch Set

Location: GC743, Gulf of Mexico

Client: Major Deepwater Operator

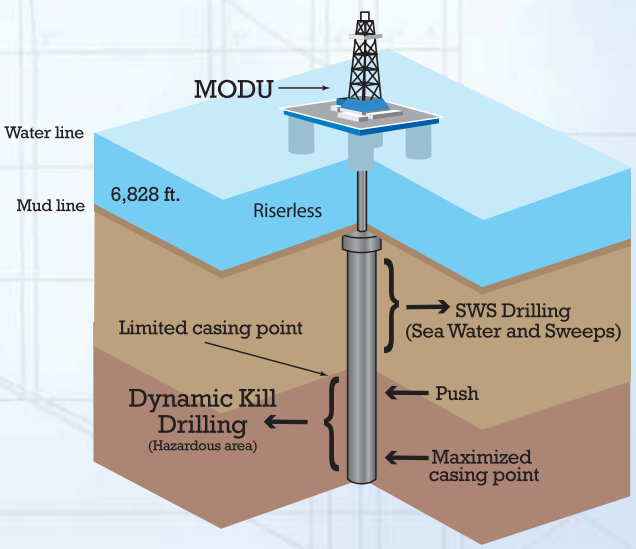
Objectives:

- ✓ Characterize the reservoir to plan the field development
- ✓ Characterize the reservoir fluid to help design lifting and production facilities

Challenges:

- ✓ Water depth: 6,828 ft (2,081 m)
- ✓ Batch drill and set two casing strings for 15 development wells
  - ✓ 4 Drill Phase I with seawater and gel sweeps to set 26-in. protection casing
  - ✓ 4 Drill Phase II using the riserless DKD process to set 20-in. casing
- ✓ Minimize mud volume in the DKD section
- ✓ Maximize hole cleaning and ROP (80-100 fph)

Shallow Hazard Mitigation



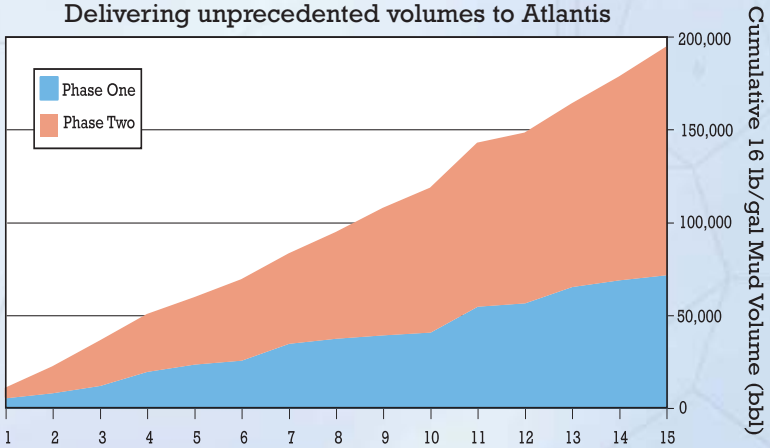
Solution:

- ✓ Baker Hughes Drilling Fluids division dedicated personnel and facilities from its Fourchon, Louisiana supply base
- ✓ Three supply boats and several "spot hires" transported fluid to the rig
- ✓ Largest boat's capacity was: 15,000 bbl

Results:

- ✓ DKD process began in Phase I due to unexpected shallow hazards in the 30-in. hole section
- ✓ 26-in. and 20-in. casing landed and cemented as planned on all 15 wells.
- ✓ Baker Hughes Drilling Fluids built, stored, shipped and offloaded:
  - ✓ 193,110 bbl of fluid (64,885 tons) including 772,440 sacks of barite
  - ✓ 94.5 tons of mud additives
- ✓ Baker Hughes Drilling Fluids performed without problems throughout the execution of this unprecedented program

Delivering unprecedented volumes to Atlantis



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