Summary of Plenary Papers Presented at the World Conference on Emerging Technologies in the Fats and Oils Industries

The following summary presents a brief synopsis of papers presented during the world conference held Nov. 4-10, 1985, in Cannes, France. The conference proceedings will be published by the American Oil Chemists' Society; a copy of the proceedings will be mailed to all conference technical registrants at no additional charge. Persons who did not attend the conference may order proceedings at a cost of $75 for AOCS members, $95 for nonmembers, from the AOCS, 508 S. Sixth St., Champaign, IL 61820 USA.

Keynote session

The keynote session focused on major developments and trends in fats and oils, providing a frame of reference, or perspective, that registrants could use to appraise the more than 70 specialized talks that were to follow.

International trade has changed dramatically in recent decades, with startling changes in production patterns, increased government regulation in trading and consolidation in the industry, R. Randag said. Europe's oilseed production has increased from about half a million tons 20 years ago to about five million tons, including 3.5 million tons of rapeseed. Production has been fostered by EEC agricultural support payments, Randag said, which "we cannot afford any more. We must stop treating agriculture as sacred. We must start to look much further and try to reinstate some form of balance—economic and commercial. We must find ways to enable poorer nations and peoples to buy what they need and what we have to sell. Then we can start talking about international trade again."

Nutritional and consumer concerns include everything from nutritional effects of fats and oils to environmental effects of by-products and waste products, T. H. Applewhite commented. "Caution should be exercised in developing and applying new technologies to the processing of fats and oils so as not to introduce inadvertently significant amounts of isomeric dienes and trienes into the food chain," Applewhite said. He also warned against overreaction to initial reports of beneficial health effects in nutritional research. "Too many times we grasp at the straws of initial findings only to find ourselves embroiled in controversy with no opportunity to retreat or recant," he said. In environmental areas, "the consumer will hold us ultimately responsible for our overall impact on the environment. . . . We should be creative in our attempts to prevent public dissatisfaction with methods of handling by-products," he said.

Biotechnology will affect the raw materials and processing methods for the fats and oils industry, A. R. Macrae said. Plant tissue culture already has been used to produce elite varieties of oil palm and is nearing commercialization with coconut. Somaclonal variation techniques will speed improvement of annual oilseed crops, he said. Protoplast fusion may overcome interspecies barriers to tranfer of desired characteristics—oil composition, disease resistance, cold tolerance—from wild species to cultivated species. Single-cell oils from microorganisms may prove economical only for specialized, high-value products, he said. On the processing side, microbial lipases are being used as catalysts for hydrolysis to produce soaps and, in interesterification, to produce confectionery fats. Further applications await developments in enzyme and immobilized cell technology for commercially viable oxidative and reductive modifications of fats and oils and their esters.

International trade

A four-step process for further reducing problems in international trade resulting from inconsistencies between national standards was proposed by A. Karleskind. He suggested various organizations involved in setting standards should (a) invite authorized representatives of other interested bodies to attend meetings of each international group; (b) organize a system of collaborative studies acceptable to various international bodies before adopting any standards; (c) encourage systematic use of existing international standards and cooperation in establishing methods needed but not yet adopted, and (d) systematically adopt recognized international standards as national standards whenever possible.

In discussing Methods Development and Certification of Chemists, William E. Link first described the American Oil Chemists' Society programs, then discussed international developments. The AOCS chemists' program certifies a chemist's analytical proficiency if he or she successfully completes specified series in the AOCS Smalley Check Sample Program. The recently adopted laboratory certification program involves laboratories doing soybean meal analyses and requires participation in a blind sample analysis series. Link then outlined the history and status of the IUPAC fats and oils unit. He described how a method on determination of water in fats and oils with the Karl Fischer reagent was developed and subsequently adopted by ISO, AOAC and AOCS, providing uniformity in analytical methodology.

In his commentary on trade association rules, E. J. Campbell focused primarily on trade associations' roles in preparing standardized trading contracts that

facilitate equitable trading practices. Such contracts specify quality, analytical methodology and a system for resolution of disputes. If there is any major problem, he said, it may be that too many different groups are writing such contracts. Some relatively new obstacles are government-imposed regulations on trade, including discriminatory tarrifs and duties, Campbell said. "Trading rules and trade associations and their members," he said, "maintain integrity of products and integrity in our transactions."

World reports

Production and trade of fats and oils in the Pacific, the western hemisphere and Europe were reviewed.

The Pacific region produces about one-third of the world's fats and oils supply, T. P. Pantzaris said, or about 20.3 million metric tons of the world's 62.1 million MT 1984 oil production. China led in fats and oils production with 6.08 million MT in 1984, followed by Malaysia, 4.23 million MT; India, 3.95 million MT; Japan, 1.93 million MT; Indonesia, 1.60 million MT, and The Philippines, 889,000 MT. As China's production is mainly for domestic use, Malaysia is the dominant exporter of fats and oils in the Pacific region, with 1984 exports of 3.66 million MT, followed by Singapore (largely transshipments), 883,000 MT; The Philippines, 586,000 MT; Japan, 371,000 MT, and Indonesia, 328,000 MT.

The western hemisphere produces about 53% of world oilseed production, and about 20% of world vegetable and marine oils, R. McDonnell reported. Soybean is the dominant oilseed crop, with about 85% of world soybean production occurring in North and South America. While average annual increase in oil consumption has been under 3% in North America, Western Europe, the USSR and Eastern Europe, annual increases in consumption have averaged 6.6 to 9.4% in China, Africa, the Mideast, Latin America and Asia/Oceania, McDonnell said.

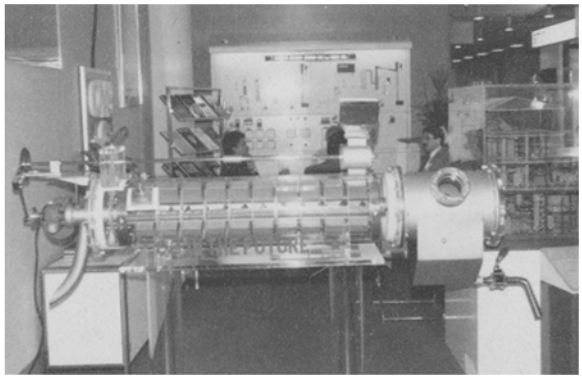
Europe's agricultural support policies evolved from the food shortages of World War II and the years immediately following, C.J.M. Meershoek said. The result today is a major economic burden of support payments to producers and increasing surplus stocks in some commodities. The U.S. soybean embargo of 1973 made Europeans realize how dependent they were on oilseed imports for fats and oils. That realization helped trigger the production increase from about half a million tons in the mid-1960s to the five million metric tons of 1985, Meershoek said. European production of rapeseed and sunflower can be expected to increase further, Meershoek said, particularly when low-glucosinolate rapeseed varieties are adapted for Europe. Total 1984 crush in the EEC was 14.7 million MT, with imports of more than 11 million MT. Meal production was about 10.5 million MT, with imports of 14.3 million MT, for a total supply of about 24 million MT, of which about 2 million tons were exported and the rest was consumed in the EEC. The EEC produced about 3.8 million MT of oil and imported another 1.3 million MT. Including animal fat and marine oils, Europe uses about six million MT of fats and oils a year, Meershoek said.

Process improvements

Alcon processing of soybeans permits physical refining of oils, Georg Penk said. The Alcon process subjects flakes to a conditioning, tempering and drying process immediately before solvent extraction. The resulting crude oil has a phosphatide content of 0.03 to 0.05%, permitting physical refining, Penk said. Physical refining using 1.0–1.2% bleaching earths produces finished oils of 1 ppm phosphorus content, Penk said, perhaps lower if more active bleaching earths are used. Shelf life of such oils is better than for alkali-refined oils, he reported. Further modifications are being tested for further improvement; a toaster modification has reduced hexane loss. Energy consumption is about equivalent to normal refining, Penk said.

Herb Schafer reported on adaption of VPEX processing for Canadian canola. The VPEX process consists of seed cleaning, conditioning, prepressing, extraction and desolventizing—fewer steps than in conventional or direct solvent extraction, Schafer said. The process yields an oil with lower FFA, lower phosphorus, lower sulfur and improved color, he reported. When VPEX was installed in an existing plant, modification of cake processing was required to reduce moisture and to reduce fines and foots. Production capacity increased to 180 MT/day from 150 MT/day.

New rendering processes vary from country to country, but generally they make extensive use of heat recovery, process tallow and meal fully or partly under lower temperatures than older systems, and often use preheaters or low pressure prepresses, Jon Alsaker reported. Preheaters help break down fat cells and prepresses help separate solids and liquids. Rendering at lower temperature reduces energy costs. Finished tallow color generally is lighter, Alsaker said. A



Bernadini's exhibit booth featured its new "Satellite" extractor, which the company termed as "the future" for the industry.

modern waste-heat-dewatering plant may cost 50% more than a plant with traditional processes, but energy efficiency and improved product quality mean the added cost can be recovered within two to five years, he said.

In a report on quality of physically refined oils, Leo Strecker reported the quality is at least comparable to that produced by alkali refining. For practical purposes, only good or moderately oxidized crude oils can be physically refined. Oils examined included corn, sunflower, canola, soybean, peanut, rice bran, safflower, coconut, palm kernel and palm.

New mixing techniques are a "hot topic" in hydrogenation, Robert Hastert reported. Such techniques are designed to increase agitation to improve catalyst activity and thereby create better efficiency. The Buss loop reactors involve injection-mixing nozzles to increase catalyst-hydrogen contact while Union Carbide's Linde Division has reported work involving use of a helical screw and baffles in a vertical tank. The USDA has reported work on ultrasonic agitation that is interesting, but far from being commercial. UOP has obtained a patent on a fixed bed system, and Cambrian reportedly also is investigating fixed bed systems, Hastert said. Heat recovery is the major energy saver being promoted currently, while sulfur-promoted catalysts are being studied as another means to improve efficiency. Many hydrogenators are beginning to realize the importance of feedstock purity in the process, he said.

In a report on filtration, L. Benjamins described use of horizontal and vertical tank filters. A new approach to oil miscella filtration is to use a vertical tank with a conical bottom and a butterfly valve at the bottom to a lower tank that can be put under vacuum. In the realm of sunflower dewaxing, studies have shown one heating and cooling cycle can be eliminated by dewaxing before bleaching rather than after. Cartridges have been developed to remove rust and pipescale from deodorizing steam before it enters the deodorizer unit.

K. Alexandersen described new developments in equipment for production of margarine-type products, designed to optimize crytallization and emulsion processes. New approaches to puff pastry margarine production and low-calorie spreads were described.

Packaging innovation will continue at a hectic pace as new materials and new preservation techniques are developed, Lewis Erwin said. Multilayer materials produced by coextrusion or coating are evolving, with one of the newest examples being a ketchup bottle with six layers of plastic. Squeezable bottles are now being made for preserves, ketchup and viscous dressings. Higher cost than traditional monolayer containers means these materials are used only where weight, squeezeability, microwave heating compatibility and oxygen protection make them cost-effective. Retortable pouches have been more successful in Japan and Europe than in the United States. Aseptic packaging is used primarily with high acid foods, Erwin said, with use fostered by high energy costs since 1973 and the 1981 approval of hydrogen peroxide as a sterilizing agent. Erwin also described developments in packaging for frozen foods, soft drinks and other foodstuffs.

Total plant safety

Effective safety management requires commitment from top management and a safety program that demonstrates that commitment, Francois Loury said. Such a system begins with proper plant design, training of operators so that they not only know what to do but why specific procedures are required, and a permit system that must be enforced to make sure management knows when dangerous work is to be done. Thorough investigation of all accidents, incidents and "near-misses" should be part of the system. Safety should be quantified as much as possible and records of a plant compared with similar company operations elsewhere, with competitors' safety records and with records from the entire chemical industry, to determine if safety management is effective. Setting a goal of reducing emergency down time to less than 2% of available running time and of reducing solvent loss to less than 0.2%, or whatever is appropriate to the seed and equipment in the plant, were cited as two examples of quantifying safety management. The overall U.S. chemical industry has a safety record about seven times better than the U.S. soybean processing industry, he noted.

Luiz Brito (far left) of Brazil and D.K. Bhattacharyya of India (far right) were among the poster session speakers.

A reception Monday evening hosted by the City of Cannes provided the opportunity to renew friendships and make new contacts.

Safety risks in storing oilseeds and meal primarily involve the amount of dust and hexane, respectively, Bertrand Noel said. Dust in storage areas becomes dangerous between 50 grams per cubic meter and 3 kilograms per cubic meter. Ignition of explosions or fires could come from human error (smoking or welding), electric sparks, mechanical heating or friction, product heating from high moisture, fermentation and oxidation, or from intentional ignition. Noel provided detailed suggestions on ways to reduce risks, noting that in Europe the problem of residual hexane in rapeseed is of major concern. Sounding lines help monitor storage conditions so management knows when to take preventive measures. Dust reduction using filters, mists and aeration helps prevent accumulations that could lead to explosions. Controlling potential ignition sources was described in detail by Noel. Eliminating dryer fires requires close attention to seed quality, dryer maintenance and use, and temperature sensors.

Safety considerations in the oilseed preparation process begin with choice of building location, layout and design, Jose Lajara said. Automated controls, if affordable, should be included to monitor belt drives, tank and hopper levels, explosive air mixtures and similar conditions. Other suggestions were made for process equipment, dust collecting and aspirating, and areas where hexane vapors may occur. Sampling, cleaning and unplugging are key concerns in cracking roll operations; cookers and conditioners require special care at startup and shutdown, he said. Routine maintenance on flaking rolls should be strictly controlled.

Safety in solvent extraction usually concerns hexane, the most common commercial solvent, George Anderson noted. Long-term exposure to hexane vapors in the air should not exceed 500 ppm averaged over an eight-hour day, according to U.S. federal guidelines, he said. No effects have been reported in short-term exposures of up to 2000 ppm for 10 minutes. In tests with animals, exposure to 32,000 ppm for two hours or 64,000 ppm for three minutes has led to respiratory arrest and death. Hexane burns in the range of 1.2 to 6.9% hexane by volume (3.4 to 18% by weight), he said. Flash point is -26 C (-15 F); ignition temperature is roughly 247 C (477 F). Anderson listed standards set in NFPA (National Fire Protection Association) Booklet #36 regarding layout of commercial extraction systems, wastewater handling, venting of extraction rooms, isolation and venting of equipment, vapor seals, purging equipment and extinguishing systems. Training and attitude of employees toward safety are of major importance, Anderson stressed.

In a paper on process operation and training in solvent plants, J-M. Buteux listed six critical points that should be closely monitored. These include meal out of the plant, water from the water stripper, oil from the oil stripper, air from the vent system, ambient air and hexane leakage (liquid or gas). As did other safety speakers, Buteux emphasized the need for proper training of employees, established written procedures for maintenance activities, and the desirability of automatic control at critical points.

Alternative energy sources

Sol Nadel's paper on "Cogeneration in the Sunflower Industry" described the burning of sunflower hull from National Sun Industries' Enderlin, North Dakota, plant to produce electricity. The sunflower seed yields about 22% hulls, which have a heat value of 7,500 to 8,500 BTU per pound. High potassium salt content creates a sticky fly ash, requiring a special boiler design, Nadel's paper said. About 300 to 330 tons per day of hulls are produced. Agrest torsional chamber boilers are used, with two steam boilers connected to one steam header. Superheated 400 psi and 700 F steam flows into two turbogenerators of 4,500 KW capacity each. Steam also is directed to the processing system. The generators produce about 8.5 MW electrical power, of which about 1 MW is used by the energy center and another 2.5 to 3 MW by the processing plant. Excess electrical power is sold to the area electrical grid.

Wind energy systems for generating electricity were described by H. J. M. Beurskens. Absolute wind speed is needed to compute potential for generating power, he said. A 10% differential in average wind speed between two sites will mean a 30% differential in energy potential. Wind turbines may be grouped in wind farms to generate electricity in parallel with a high voltage grid, or wind turbines may be constructed individually. Small- and medium-size wind turbines (diameters to 20 m) are commercially available; larger turbines are in prototype or at the start of commercialization. Economics vary according to site, but work is continuing to improve wind turbine efficiency.

P. H. H. Leijendeckers outlined how heat pumps could be used in soybean processing. On-site combined heat and power generation should produce surplus electricity of about nine million KWH a year. This power can be used to drive a heat pump, which would permit residual heat from the soy processing to be reintroduced at usable temperatures, about 110 C. If heat and power generation is used,

The Tecator exhibit booth.

natural gas consumption of 15.8 million cubic meters annually can be reduced to about 13.9 million cubic meters annually. If the surplus electricity generated is used to drive a heat pump, natural gas consumption can be further reduced to about 11.2 million cubic meters annually, he said. Payback for the heat pump would be about 3.7 years, he estimated.

Energy economics in unit processes

Steam, hexane and electricity, in that order, are the major places for potential savings in solvent extraction operations, D. E. Marchand reported, using a 600-MT/day capacity plant as a model. Using hulls to generate steam costs about 10% as much as producing steam from natural gas and about 6% as much as from heating oil, he said. Proper maintenance can reduce costs, he said, noting that a thermometer that reads 5 C below true temperature can cost 610 tons of steam per year. Hexane losses can come in oilcake, crude oil, decanting water, atmospheric discharge or leaks. Oilcake residual hexane at 1,000 ppm rather than 500 ppm can mean loss of 55,500 kg of hexane a year, he noted. Reducing moisture content of seeds from 7.5% to 4.5% before extraction can reduce residual hexane content in meal 12% to 33%. In prepress operations, removing more oil before solvent extraction similarly can reduce residual hexane content in meal.

Deodorizer systems more than five years old are prime candidates for energy savings by use of a new vacuum system, P. C. Linneman reported in a paper on energy conservation in edible oil processing. An older unit requiring 6,000 lb/hr of 125 psig steam to generate and hold a 6-mm mercury absolute pressure could be upgraded today to use about 4,000 lb/hr for the same load, a savings of about 14 million pounds of steam annually, he said. Linneman also described various types of heat exchangers and their applications.

In hydrogenation, the four key areas to reducing purchased utility costs are energy required for product heating to start the process, energy from the exothermic reaction, hydrogen consumption, and dispersion of hydrogen gas in the oil, according to a report by Marc Kokken. Countercurrent heat exchangers can be used to heat incoming bleached oil with heat from hydrogenated oil, using a vertical cylindrical tank under vacuum, he said, at a savings of 4,750 tons of steam a year in a 150-MT/day capacity plant. Exothermic reaction heat for a plant processing 150 tons a day can be equivalent to 3,000 tons of steam a year. Use of a hydrogen gas recovery system can reduce hydrogen consumption to 5% over the stoichometric demand, compared to the average of 10%. Kokken also described how automating can reduce energy costs.

Improvements during the past decades have made hydrogen produced by electrolysis competitive with pipeline hydrogen, liquid hydrogen or hydrogen produced through steam reforming, C. C. M. Baker reported. Production cost, at 15 mill power, is about $2 per thousand cubic feet of hydrogen, he said. On-site power generation could be used with hydrolysis to reduce hydrogen costs further, he said.

The original Buss loop reactor system for hydrogenation used two loops—a liquid phase loop and a gas phase loop, D. Urosevic explained.

In the early 1980s, this was modified by using an external gas loop with the mixing nozzle of the reaction mixer mounted on top of the converter. This system is used primarily for fish oils. The current reactor with gas loop has three main advantages: hydrogen partial pressure remains constant during hardening; water and its effects on the hardening process and catalyst are greatly reduced; and blowing-off is eliminated, improving product quality while decreasing hydrogen loss, pollution and other undesirable effects. Buss heat recuperation units eliminate need for heating energy, Urosevic said, and cooling water cost is virtually eliminated. He described several configurations using the new technology.

Modern continuous rendering systems' total operating costs are about 60-70% of those of the traditional batch cookers with continuous dryers, J. L. Berge said. The new systems use moderate

Members of the French committee helping to organize the conference and AOCS representatives and staff met for an informal dinner Friday after the conference. Here, AOCS Executive Director Jim Lyon (standing at right) practiced his French and gave out gifts of appreciation to French associates.

Centrico and Westfalia shared an exhibit booth at the conference.

heating without steam and incorporate other energy efficient techniques, including using recovered heat from the vapors of the continuous solids drying processing. In the future, renderers may use electrical discharges or enzymatic processes to condition animal tissues prior to pressing, he said. In water evaporation, mechanical recompression could reduce costs further.

Environmental technologies

In a session on air pollution control, Leroy Venne of Cargill Inc. noted that the best way to control hydrocarbon emissions at a solvent extraction plant is to reduce hexane loss in processing. In controlling hexane loss in wastewater, the control point is the boiler and solvent-water separator, where proper operations can keep losses to 15 ppm. The oil stripper is the key control point for oil, with levels as low as 750 ppm achievable, Venne said. The desolventizer-toaster controls hexane loss in meal, and, with six to eight minutes of live steam stripping and retention time of 25 minutes or more and other proper operations, residual solvent in meal can be kept at 750 ppm, although the number may vary from 400 to 2,000 depending on the type of oilseed and type of equipment used. The mineral oil system will control hydrocarbon emissions from the main extraction vent. The unit should have a capacity of 140 cubic meters per hour of vent vapor per 1000 tons per day of plant capacity, Venne said. Including fugitive losses, hexane loss should be approximately one kilogram of solvent per metric ton of oilseed processed, he said.

Odor pollution from effluent water in edible oil deodorizing operations can be avoided if two conditions are met, A. Athanassiadis said. First, highly efficient scrubbers should be used to capture the maximum volatile vapors, coming from the deodorizer, in liquid form, and then scrubbing vapor at low temperature will solidify the escaped organic vapors and odor-carrying volatiles from the first scrubber. Those measures should provide sufficiently clean barometric water to avoid water pollution and odors, Athanassiadis said.

In a discussion of odor control at oleochemical plants, G. Kraatz described several processes used, but said incineration and biological processes are the most promising ways to control odors, as they do not create additional by-products or a secondary treatment problem. Incineration is more expensive and is feasible only if the odorous air can be fed to an existing suitable combustion facility. Further research is needed on bioprocesses to adapt them to the oleochemical industry. Three potential systems are biofiltration, bioabsorption—trickling filter process, and bioabsorption—activated sludge process, Kraatz said.

Minimizing wastewater loads basically requires good maintenance procedures and an awareness that each pound of product lost actually costs the equivalent of 1.66 pounds of oil in lost oil and treatment cost. In processing, the major points for potential loss are acidulation, deodorization and tank car or truck washing, Norm Witte said. Pressure acidulation is reported in one plant which allows higher temperatures, thus improving product yield and lowering waste loads, Witte said. If steam refining becomes a viable alternative to caustic refining, this would also reduce waste treatment loads, he noted. In deodorization, two new commercial systems use surface condensers instead of barometric condensers, Witte said, resulting in higher fat concentrations. Using a surface condenser cooled by a refrigerant should provide an even higher concentration, he said.

M. J. Boyer described physical/chemical processes for treating edible oil wastewaters and provided an economic evaluation of various systems. Processes available include gravity oil separation, equalization, dissolved air flotation, filtration, acid hydrolysis and a variety of other techniques that have had limited success in edible oil waste treatment, Boyer said. His studies indicate that acid/hydrolysis treatment is economically justifiable for virtually every oil handling facility.

B. A. Janson described use of a combination anaerobic-aerobic treatment system for treating wastewaters to remove organic materials. In such systems, the less costly anaerobic portion is followed by the aerobic portion to improve effluent quality. Anaerobic treatment at an olive oil plant with a capacity of 35 tons of olives per day can produce biogas with a heat value of one ton of fuel oil each day, he said. Palm oil processors treating 20 tons of fresh fruit bunches per hour, operating 12 hours a day, produce biogas with a heat value corresponding to two tons of fuel oil daily.

In the environmental section on by-products, M. Schneider described the composition, source and processing of phospholipids, then followed with a discussion of their applications. Applications include use as emulsifiers for functional purposes and as active substances for dietetic value. Certain neurological diseases, he noted, are caused by a lack of a neurotransmitter, acetylcholine. Phosphatidylcholine is often administered, rather than pure choline or choline salt, as it is absorbed and converted more readily. Phospholipids have been administered to treat atherosclerosis and various liver function disorders, he said. Phospholipids will reduce low density lipoprotein levels and increase high density lipoprotein levels. Liposomes, formed with phospholipids, are being developed as organ-specific drug carriers, Schneider said.

Soapstock represents 1-2% of total product value in an efficient refinery with low oil loss, John Woerfel said in a paper read by Roy Carr. An inherent by-product of caustic refining, soapstock can be sold raw for use in producing soap or fatty acids, or it can be acidulated to concentrate the contents and stabilize the soapstock, Woerfel noted. Some refiners find it more economical to sell raw soapstock, he said. Processing improvements and use of noncaustic refining methods should reduce future volume of soapstock production. Woerfel described soapstock uses in animal feeds, soap production and fatty acid production.

Oil may be recovered from spent

bleaching earth by three processes, J. M. Klein said: hot water with additives, pressurized hot water or chlorinated solvents. Solvent extraction should be done within 24 hr of the end of filtration, Klein said. Using perchloroethylene can reduce oil content in spent bleaching earth used in rapeseed processing from 46% to 8.5% with one extraction or under 2% with two extractions. Similar results were reported for soybean, corn, sunflower and peanut spent bleaching earths. Klein said solutions of sodium carbonate proved successful on used filter aids, but not for bleaching clays. High pressure extraction proved most effective using NaOH, he reported. An economic analysis indicated the most economic courses would be to sell spent clay to an outside agency or, if the refiner has an extraction plant, to incorporate the clay in the meal cake to the extent government regulation may permit. The pressure process is the better choice when it is impossible to dispose of the clay as it is, Klein said, as a fairly defatted product is obtained and thus pollution is avoided.

Reclamation of spent hydrogenation catalysts was discussed by Frank Hennion, who listed possible methods as solvent extraction to recover fats and oils; hydro- and pyrometallurgical processes to upgrade and extract nickel, clays and filter aid; and cogeneration for the production of steam and electricity. Hennion described incineration systems used by three companies that purchase spent nickel catalysts for reclamation. Hennion discussed bench scale tests on froth flotation to recover nickel from incinerated catalyst, acid leaching for the same purpose and ammonia leaching. A pilot-scale test of the ammonia leaching reported nickel yields in excess of 92%. Hennion noted that while nickel is the most valuable component in spent catalyst, it is less than 10% of the total weight. Future economic reclamation efforts will need to consider using the total spent catalyst contents as a resource, he said.

Deodorizer distillate originally was collected to prevent pollution but now has become an economic by-product as a source of tocopherol (vitamin E) and of sterols for pharmaceutical uses, Robert L. Winters said. Processing systems, the type of equipment used and type of feedstock will affect distillate characteristics, he said. Increased demand for vitamin E and sterols will provide continuing markets for distillates, he said.

Sunday evening featured an opening reception in the exhibit hall.

Oilseed meals

In a thorough review, Keith Smith examined advances in using soybean products as animal feed. Smith explained nutritional and processing concerns in producing soybean meal for poultry and swine, then noted research continues on ways to improve soybean meal utilization in ruminants. The relatively new use of "full-fat" soybeans in livestock diets was discussed. Availability and absorption of amino acids in the small intestine of dairy cattle seemed to be best from extruded whole soybean diets, rather than from soybean meal or whole soybeans, Smith said. Heat treatment of soybeans has been shown necessary for dairy calves, he said. Feeding raw soybeans to growing-finishing pigs reduces performance.

Lynn Jones reviewed advances in feeding cottonseed products in the United States, particularly for monogastric animals such as poultry, swine, horses and fish. Jones also reviewed studies with glandless cottonseed meal. Researchers are studying how and why protein or lipid material may escape digestion in the rumen of cattle and reach the lower intestine, Jones said, but for dairy cattle there is no indication that protein escape means better production. Increasing fat content of rations has been studied but may result in lower milk fat content, as excessive dietary fat may interfere with fiber digestion needed to produce milk fat, Jones said.

K. El Shazly described use of cottonseed meal as feed in Europe, noting the protein is of good quality, but may be low in specific amino acids. Cottonseed meal with 32% digestible protein is widely used in feeding monogastric animals. El Shazly presented considerable data on nutritive contents and value of cottonseed meal prepared under varying processing conditions.

Rising European sunflower acreage has led to increased availability of three types of sunflower meal: undehulled meal with 28% protein and 25-28% fiber; partially dehulled meal with 35-37% protein and 18% fiber; and double-dehulled sunflower meal with 40-42% protein and 12-14% fiber, C. Ruckenstein said. Dehulling systems were explained. Feeding research is a continuing activity, Ruckenstein said, but noted that work thus far has shown that high protein sunflower meal is recommended for swine and poultry, that dehulled sunflower meal can replace 50-60% of the soybean meal in dairy rations and 25-50% of the soybean meal for swine. Some feed mills have been reluctant to incorporate sunflower meal in mixed feeds because they are not sure it will be available

consistently on a year-round basis, Ruckenstein said.

In a report on rapeseed meals and residues, H. Kozlowska noted that Canadian work in producing low-glucosinolate varieties has increased rapeseed's potential use as a meal source. Studies still are needed on phenolic components of rapeseed meal, she said, including sinapine which she linked to production of tainted eggs by laying hens. Most world rapeseed production presently is of high glucosinolate varieties, requiring toasting of the meal, even up to 50 minutes, Kozlowska said. The toasting can reduce nutritive value of the amino acid content, however, and one alternative process to preserve amino acid content involves steaming rapeseed before processing. Recent work on removing seed hulls before processing via a fluidizing apparatus results in improved oil quality and meal with higher protein content, she said.

J. Delort-Laval described two chemical treatments for oil meals designed to improve their value. An ammonia treatment process for peanut meal destroys or inactivates aflatoxins in the meal. In the process, a 16-meter steam-jacketed reactor with an anchor impeller rotating at 60 to 100 rpm is loaded with five to six metric tons of meal. Ammonia is introduced under 1 to 3 bar pressure; meal moisture content is 15–17% and the temperature was 90–95 C, applied for 15 minutes. Excess ammonia is removed under vacuum. Aflatoxin content was reduced 95%, nitrogen content increased and solubility declined; deamination by rumen microorganisms declined and there was a partial destruction of cystine (depending on operating conditions). The process is now used at three peanut oil mills in Senegal and a feed mill in Britanny. Delort-Laval also described development of a process using formaldehyde to protect protein from rumen digestion, which resulted in 75% of the protected proteins escaping rumen degradation. Treated meals showed better milk yields from dairy cattle; replacement of one kg oil meal by the same amount of treated oil meal yielded an additional one kg of milk per cow per day, he said.

E. W. Lusas presented a thorough review of the development, processing and uses of glandless cottonseed protein. Glandless cottonseed contains very low levels of gossypol, an antinutritional factor that limits feed and food uses of meal from traditional cottonseed. Lusas discussed feeding tests with laying hens, growing-finishing pigs, catfish and shrimp. He presented data on use of kernels and glandless cottonseed flours in food items, their nutritional value and the processes used to produce such items. Processing and use research has been conducted in Egypt, French-speaking Africa, India and the United States, he noted, with investigations of some type reported in Colombia, Israel, Mexico, Pakistan, China, Peru and the Soviet Union.

In his presentation on desolventizing techniques, Glenn Brueske noted that the rapid rise in energy costs of the early 1970s marked a watershed for desolventizing operations. Before that, steam and energy were relatively cheap; after that period they became major cost items. In the mid-1970s, the first big change was the development of the desolventizer-toaster-dryer-cooler (DTDC) by Heinz Schumacher, Brueske said. This design was improved by Schumacher in the early 1980s to accommodate rapeseed processing. The new design provided higher heat transfer rates per square foot and a countercurrent sparge steam flow. Predesolventizing, using new Schnecken screws ahead of the DT, reduces DT sparge steam requirements and the residual hexane content of the meal before it enters the DT. As an alternative to the Schnecken tubes, flat hot DT trays can be installed in the dome area of the desolventizer, Brueske said, but this is not as efficient. Steam usage can be reduced about a third from the pre-DTDC era, Brueske said.

Emile Chone reported on a study of the economic return for dehulling, particularly for rapeseed and sunflower. The results showed that if there is a low price ratio between soybean and cereals, dehulling becomes profitable for rapeseed and sunflower meals; a high cost ratio of soybeans to cereals decreases the economic return for dehulling. Dehulling appears to be more consistently cost-efficient for sunflower than for rapeseed, Chone said.

Process control

In a panel presentation on process control, several specialists described use of automation and computerization in extraction plants and refineries. M. Wrigley described options in automating unit processes or an entire extraction plant. E. Lusas described work in developing a computer model of a cottonseed processing plant. With regard to refineries, N. Smallwood described the development of a fully automated refinery, including equipment, software and personnel training. R. Gadomisk described the benefits of a fully automated refinery, including reduced labor costs and energy consumption and improved quality control. J. Eaton described automation of a soybean oil refinery. H. Stage discussed financial trade-offs in semiautomation versus full automation.

Quality control

Near infrared spectroscopy (NIR) is a viable analytical technique both on-line and off-line to measure constituent levels in soybean meal, R. D. Benson reported. Background data should include as much information as possible to allow for process and sampling variations, he said. In closed computer-driven control loops, the use of NIR will require additional transducers or a processing consistency amenable to single input control algorithms.

E. G. Perkins gave a thorough review of modern analytical instrumentation designed to reduce the time needed to perform traditional analytical tasks, or to automate such analyses. The discussion covered intrumental techniques for solid fat index by NMR, determination of unsaturation by infrared spectroscopy, oil stability and quality, color, melting point, trace metal monitoring, fatty acid composition, glyceride composition and determination of minor components. Perkins also described advanced instrumentation and

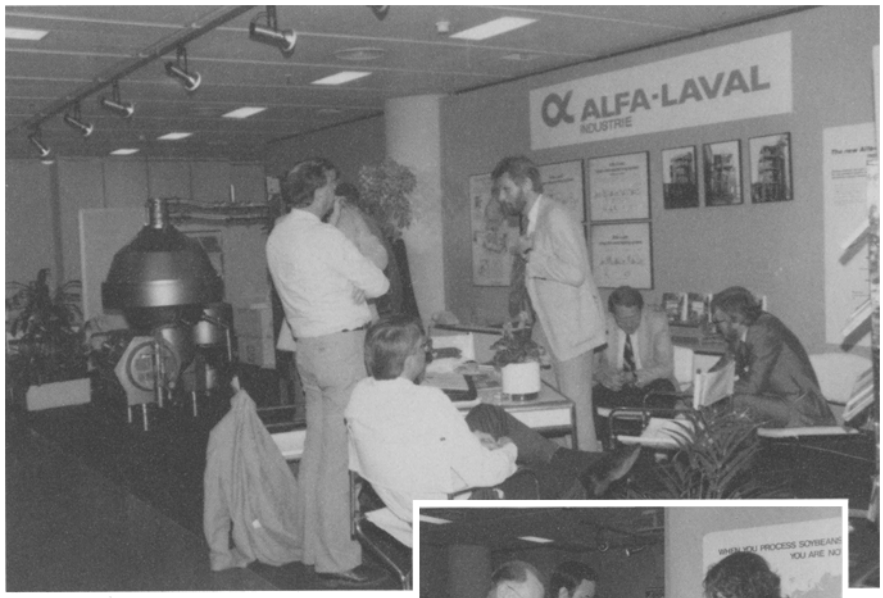
linkage of computers to analytical instruments and to each other, together with data handling.

Computerization and lab instrumentation were discussed by M. Matlock, who described systems available for purchase as "turnkey" systems as well as ways to develop one's own system by networking minicomputers and analytical instrumentation. Matlock described in detail how his lab has used DEC PDP-11 and VAX-based minicomputers, including hardware, interfacing devices, communications and security.

P. Y. Vigneron described efforts to provide on-line analysis in refineries to monitor neutralization and bleaching. For neutralization, Vigneron described use of the "Titrautomac," designed to determine on-line the total acidity of oil before or after neutralization or caustic excess in the oil-alkali mixture. The instrument can perform about eight analyses each hour. Results on crude oil correlate well with traditional methods, he said, while with phosphoric pretreated oils there was not always good agreement. Caustic excess measurement correlated acceptably, he said. On-line bleaching measurements with colorimeters and turbidimeters were discussed.

S. Kroll provided a detailed description of how his laboratory developed three independent automatic data processing systems for its analytical department, water laboratory and microbiological department. The systems handled quality control of raw materials and supervised refining processes, fat modification, margarine and shortening production, and quality control of finished products. Kroll described how each system worked to reduce manpower, improve quality control and aid management. Kroll then described plans to upgrade the three systems into a new centralized system to provide a fully automatic interactive working data transmission system.

Michel Blanc described the reaction of an official analytical chemist to the automation and computerization of laboratory work. Blanc noted that official analysts often are required to use approved methods, which usually means the more time-consuming traditional methodology. Automated methodology offers a quick analysis for routine lab work, he said, but in cases of commercial dispute, the traditional reference methods must be used. He applauded recent adoption by ISO, IUPAC and AOCS of an NMR method for oil content.



A shot of the Alfa-Laval booth.

Rita Batens (right) of the American Soybean Association's Brussels staff assisted visitors to ASA's exhibit booth.

Olive oil

Hedi Guerbaa's paper on international regulations covering the products of the olive reviewed the 25-year-old International Olive Oil Agreement, its purpose and its accomplishments. The council that implements the agreement has established criteria for different grades of olive oil, evaluated and promoted work on analytical methodologies including sampling, established standards for table olives, prepared standard contracts for trading of olive oils and olives, and conducted other activities to promote olive products. Guerbaa noted that more than 98% of world olive trees are in the Mediterranean basin, with more than 90% of the olives produced being crushed for oil, the rest being marketed as table olives. Annual international trade in oil from olives is valued at nearly $350 million, while annual table olive exports are about $250 million.

J. M. Martinez Suarez described the characteristics of the olive and the processing systems used and how these may affect the quality of olive oil. Cleaned, ripe olives are first milled to free the oil globules in the resulting paste-like material. Mixers agglomerate the oil globules into larger drops. Separating out the oil may be done by filtration, hydraulic press and/or centrifuge. Separation of liquid phases may be by decanting or centrifuging, which is being used more and more as it is faster and reduces contact time between oil and impurities in the liquid phases. Martinez Suarez further described oil storage, quality control, chemical characteristics, organoleptic characteristics and by-products of olive oil.

G. Piersali discussed advances in

extraction technology, focusing primarily on the latest methods used in preparation and in extraction. In preparation, a system will contain an olive-charging hopper, a screw elevator and a hammer crusher with amalgamation basins placed one above the other. Paste is extracted using a centrifuge system that separates water, oil and husk (solid materials). Electronic control and computerization are being used to achieve automatic supervision and automated processing, Piersali said.

B. Berra provided a report on studies of the nutritional and biochemical aspects of olive oil. The oil is well absorbed, shows a high degree of digestibility and exhibits a more effective cholagogic action on liver than most vegetable oils, he said. The oil controls cholesterol levels by means of its glyceride composition and the action of minor components, Berra reported, saying his studies showed a decrease of LDL and an increase of HDL in patients receiving an olive oil-rich diet.

Biotechnology in oil production

P. K. Stumpf described biosynthesis of fatty acids in plants and where this occurs, then suggested some areas for future investigation. One area is the regulation of fatty acid biosynthesis, including identifying which enzymes are involved or whether presently unknown regulators control the process. Another area is the mechanisms that precisely control lipid composition of a phenotype, including which enzymes are involved. Molecular biology may help answer where specific fatty acid synthesis enzymes are produced and what controls the enzyme synthesis. Future discoveries may be important in not only plant sciences but also animal sciences, he said. Lipoxygenases may play a major role in forming small amounts of oxygenated polyunsaturated fatty acids such as prostaglandins or leukotrienes, he noted.

In reviewing the potential for production of fats and oils by microbial sources, C. Ratledge noted such production is of interest primarily because of the rapid rates of growth of microbial organisms, their ability to produce diverse products from a wide range of starting materials, and ease of manipulation to increase yields. Ratledge reviewed work on use of bacteria, algae, yeasts (then discussed modification of yeast oil) and molds. Studies on how reactions occur will lead to work on how to control the reactions, which may eventually lead to an economic process for biotechnological production of single cell oil, he said.

In a report on genetic manipulation of oil crops, R. K. Downey noted that applications of biotechnology may reduce by one-third to one-half the time required to develop new plant varieties with specific desired characteristics. Rapeseed has been the oil crop most responsive to past biotechnological intervention, Downey said. He went on to discuss possibilities and limitations in use of tissue and protoplast culture, *in vitro* selection of mutants, protoplast fusion and gene transfer.

G. Pelletier discussed cytoplasmic hybridization in cruciferae, made possible by protoplast fusion and plant regeneration. Hybrid cytoplasms combining atrazine-resistant chloroplast from *B. campestris* and *R. sativus* were obtained and are being studied for effects on yield, he reported.

Vic Knauf forecast that herbicide-resistant rapeseed is likely to be the first genetically engineered commercial oilseed, followed by herbicide-tolerant cotton, soy and sunflower. Learning which enzymes specifically control various phases of fatty acid synthesis could lead to use of genetic engineering to increase levels of that enzyme in the seed during seed development, presumably increasing fatty acid synthesis. As an example, Knauf said controlling the expression of cacao genes in sunflower could generate an oil containing higher levels of cocoa butter-quality triglycerides.

Biotechnology—biotransformations

G. Renard described a new method for detection and determination of lipase activity. The system uses a spectroscopic method based on the development of a yellow color of the Ellman reagent in the presence of a thiol.

Synthesis of esters by lipases must compete with simple chemical esterification processes, R. D. Schmid noted in his report on studies of synthesizing esters with lipases. Consequently, such biotechnological methods show possibilities only when asymmetric carbon atoms are formed, labile esters have to be handled or lipase selectivity creates products which otherwise are difficult to obtain. Lipase does perform esterification and transesterification with a wide range of substances, he reported. Immobilization techniques are used to produce high operational stability of lipases.

Enantioselective synthesis of fatty acid esters by lipases was discussed by J. Baratti. Optically pure cyclohexanols, such as menthol, could be prepared from a racemic mixture by a simple enzymatic method, he reported. Prochiral diols also were enantioselectively esterified or hydrolyzed by the lipases. The technology could be important in the field of specialty chemicals, he said.

S. Ishida reported on partial biohydrolysis of glycerides by lipase. He described a new process for biohydrolysis which he called "solid phase hydrolysis." The reaction occurs in an unstirred and W/O emulsion system, he said, in contrast to usual lipase reactions carried out on liquid oil. The amount of monoglycerides accumulated in the reaction product was 6-7%, compared to the 1-2% normally achieved in stirred reactions, he said.

T. T. Hansen discussed development of a new immobilized lipase for interesterification and ester synthesis. The enzyme is 1,3-specific and thus produces tailor-made triglycerides not available by normal interesterification, he said. It has a particle size of 200 microns, facilitates its use in a solvent-free continous column system, and showed a half-life up to approximately 1,600 hr at 60 C, which would correspond to a productivity of five tons of fatty substances per kilogram of enzyme preparation.