

The hydrocarbon processing industry in Siberia

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1. Siberia: Brief geographical and economic overview

Siberia is a rather historical term merely related to administrative and territorial patterns in the Eastern Territories of Russia. In Russian literature this term is most frequently used when applied to the territory east of the Urals and up to the borders of the Sakha Republic (in the East and North-East) and Amur Oblast (in the East).

The area of Siberia is about 10 million square kilometres. The population on January 1st 1992 was 24.4 million: 15.2 million in Western Siberia and 9.2 million in Eastern Siberia. The 'economic strength' of the territory in Russia can be characterised by the data shown in Table 1.

The economy of the territories adjacent to Siberia varies greatly in its structure, problems and

specific way of solving them. However, there are some common features for all the territories. These are:

- * the very significant weight of 'nature-exploiting' industries based on the use of nature and the resource potential of the territory;
- * the hearth character of the industrial development: the industrial 'belt' is represented by the territory adjoining the Transsiberian Mainline and several points of industrial development in the areas of mineral resources extraction;
- * the weak interrelation between primary production of natural resources and their use on the territory of Siberia as the raw materials for hi-tech products.

These features could not but cause (and continue to) a row of quite significant economic consequences:

Table 1
Estimated average share of Siberian industry in total industrial output of Russia in 1993, %%

	Western Siberia	Eastern Siberia	Siberia's share
Main groups:			
Raw materials	34.4	9.9	44.3
Primary goods	5.7	12.0	17.7
Industrial goods	30.4	4.5	34.9
Consumer goods	7.2	4.6	11.8
Agricultural products	8.0	3.5	11.5
Main products:			
Coal	34.7	23.3	58.0
Oil	67.0	0.0	67.0
Gas	85.0	0.0	85.0
Aluminium	10.0	80.0	90.0
Wood	7.9	16.9	24.8
Refinery products	8.8	10.3	19.1
Chemical fibres	15.6	13.4	29.0

Source: Author's estimates based on current state statistics

- * the high capital intensity of the majority of the 'nature-exploiting' industries and, consequently, the great difficulty of solving the problems whilst maintaining economic potential and implementing new projects without direct participation from the Federal Government;

- * the high degree of dependence on the fluctuation of the world markets of raw materials (in particular, most seriously it was demonstrated in 1993 when the export of light metals was reduced);

- * the 'non-reproducibility' of the economic structure: as mineral resources are exhausted, the economic base of socio-economic development for the territory is 'narrowed'.

All the above features are applicable in full measure to industries dealing with utilization and processing of hydrocarbons.

2. Hydrocarbon resources in Siberia: General overview

The availability of hydrocarbons in Siberia can be understood from the data given in Table 2. This table has a more illustrative character and is based on the author's estimates from different sources dated 1991 and 1992. From Table 2 it can be seen that a significant portion of the potential resources of hydrocarbons is concentrated in Western Siberia, predominantly in Tyumen and the Tomsk Oblasts.

What is most important for the development of the petro- and gas chemical industry — very large resources of ethane-bearing gas which comprise over 40% of all gas resources. Here, the reserves (identified and indicated resources) of ethane-bearing gas from the fields in the North of Western Siberia are estimated to be over 4 trillion cubic meters — the Urengoy and Yamburg fields are estimated to contain 2 trillion and 1 trillion cubic meters, respectively.

The eastern territories of Siberia (Krasnoyarski Krai and Irkutsk Oblast) have also significant resources of hydrocarbons. At the same time, for Eastern Siberia the discovered reserves are not as impressive as those which remain undiscovered — the main reason is the initial stage of exploration activity and more capital cost intensive character of the infrastructure development (in comparison with 'old' producing areas, like Western Siberia).

Presently, the reserves located in Western Siberia are in active development: oil production is already in a stage of decline and gas is close to this phase. Without dwelling upon the reasons for such a situation, it should be mentioned that characteristics of hydrocarbons in Western Siberia have been:

- * outstandingly high rates of resource extraction in the period when the field reached the projected level of production;

- * the considerable lag of hydrocarbons utilization and processing facilities behind the rates of

Table 2
Distribution of resources of oil, gas and condensate in Siberia.

Resources	Total Resources	
	Discovered	Undiscovered
Western Siberia		
1. Oil, mln t	20650	42360
2. Gas, bln cum.	41400	61500
3. Condensate, mln t	1600	8500
Eastern Siberia		
1. Oil, mln t	310	8250
2. Gas, bln cum.	950	26800
3. Condensate, mln t	50	1750

Source: Author's estimation based on: ZapSibNIGNI materials (Western Siberia); Presentation at the All-Russia Conference on Economic Development of Siberia: "Oil and Gas Complex of Eastern Siberia and Sakha Republic: raw Materials and Formation Concept", - Novosibirsk, UIGGM SB RAS, SNIIGGIMS, IK SB RAS, 1993 (Eastern Siberia).

hydrocarbons production; high impact on the environment;

* orientation of complete delivery outside of the total amount of raw materials produced out of the region (satisfaction of the intraregional needs in processing products included).

One of the most important features of the current stage is the increase in the specific weight of 'non-profile' hydrocarbons to the total volume of field being exploited and drawn into development (with the increased content of ethane, condensate and high viscosity components).

The fields of Eastern Siberia are represented by several locations in the middle and north-western part of Krasnoyarsk Krai and in the northern and north-eastern part of Irkutsk Oblast. The most characteristic feature of the hydrocarbon composition of the field in this area is the high He content.

The degree of involvement of various parts of Siberia in the development of hydrocarbon resources is mainly related to the accessibility to development, time of discovery, and preparation for development. The transition to the development of the Siberian fields in the mid-60s has had a decisive influence on the development of hydrocarbon utilization and processing facilities in the region. However, at the same time, for a long period the development of the industries based on oil refineries and the use of 'by-products' as feedstocks, has had a propensity (and continues to have up to the present time) for the industries established in the 'pre-oil' period.

3. The state of the hydrocarbons utilization and processing industry in Siberia

This industry has passed at least three main stages in the course of its development:

Stage I (the 50s–mid 60s): establishment of the oil refinery facilities based on the oil brought into the region.

Stage II (early 70s–late 80s): formation of processing facilities based on the oil from the fields of Western Siberia.

Stage III (late 80s–early 90s): formation of processing facilities based on light hydrocarbons produced in the fields of Western Siberia.

Current situation: reorientation of processing industry facilities due to requirements of the market oriented economy; preparation for the development of the fields in Eastern Siberia. This breakdown is conditional enough but it permits the specification of the most essential features and points related to the development of the hydrocarbon processing industry in Siberia.

In the author's view, the most convenient would be to consider the problem in the 'Oblast' (province) cross-section.

3.1. Omsk Oblast

Production began in the Omsk Refinery in 1955: this refinery reflected the stride to bring production close to consumers — which is why the Omsk Refinery was constructed far from the main oil producing area of that time (Urals and Volga region). The choice of Omsk was justified by its central geographical location in the region, availability of a developed system of railroads, availability of vacant sites in the suburbs, labour, water, and other resources.

The main indicators characterising the Omsk Refinery, are given in Table 3. At present the capacity of processes deepening oil processing comprise 24% of the total oil processed. One of the reconstruction directions is increasing the share of the above to 35%. This will provide a degree of processing of 83%. An additional 1.5 million tons of motor fuel could be produced which will decrease the acute situation with moving out the oil residuals. Another modernisation objective is the higher quality of the output production of non-ethylised gasoline. For this purpose it is proposed to construct a sulphurous alkylation unit based on hydrocarbon gases.

The development of the petrochemical industry proper in Omsk has been influenced by such factors as difficulties with olefin transportation, strive for vertical integration of various processing stages as well as the agglomeration effect taking

Table 3
Basic indicators of Siberian refineries in 1993.

Indicators	Refineries			Total
	Omsk	Achinsk	Angarsk	
1.Oil processing mln t	19.2	5.7	17.6	42.5
2.Processing extent, %%	72.3	69.2	69.3	
3.Gasoline, mln t	3.8	1.1	2.9	7.8
4.Diesel fuel, mln t	5.8	1.7	5.0	12.5
5.Kerosene, mln t	1.1	0.3	1.7	3.1
6.Fuel oil, mln t	4.7	1.7	4.8	11.2
7.Benzene+xlols, mln t	0.4	0.0	0.1	0.5
8.Lubricants, mln t	0.4	0.0	0.1	0.5

Source: Russian Ministry of Fuel and Energy - current statistical overview.

place with the creation of integrated production facilities. Presently in this location there are concentrated substantial capacities not only for oil refining, but also for production of synthetic rubber, technological carbon, automobile tires, detergents, plastics, paints.

3.2. Irkutsk Oblast

Development of the facilities for the processing of, initially, coal and then oil has resulted in the formation here of one of the largest regional petrochemical complexes: Angarsk-Usolie-Ziminski [1].

At present it includes: the Angarsk Refinery (see Table 3) and related petrochemical facilities, plants producing Cl-bearing compounds located in Usole-Sibirskoe and Sayansk, and several micro biological facilities. Enterprises of the complex consume Western Siberian oil (delivered by pipeline from a distance of more than 3000 km), local coal from Cheremkhovo, rock salt and limes as well as the residuals of the local timber processing plants. Based on the processing of Western Siberian oil a chain of petrochemical industry facilities has been established: plastics (polyethylene, polystyrol), organic alcohols, ammonium, ethylene and polyethylene by pyrolysis of liquid hydrocarbons. The relationship between the complex enterprises exist mainly in two directions:

supplies of ethylene from the Angarsk Petrochemical Combine to Sayansk (for the following PVC production);

supplies of methanol and polypropylene to Usole-Sibirskoe (production of epichlorine).

The formation and development of the above relationships has been stipulated by the construction of ethylene production facilities at the Angarsk Petrochemical Combine (to date these facilities are outdated and their modernisation should be realised).

Many oil processing and petrochemistry processes at this plant require large amounts of feedstocks, heat and energy: hydrogen, nitrogen-hydrogen mix, 'synthesis gas' (the mix of carbon oxide and hydrogen). The above feedstocks are produced from light oil processing residuals. The switch of the Angarsk Petrochemical Combine to natural gas from the field of East Siberia would provide not only better economic indicators of practically all facilities, but would also free a considerable number of production sites for the construction of modern production units, and would improve the environmental situation. Important here is the fact that the transition of given production units to the use of 'natural' hydrocarbons will, at the same time, make it possible to solve a large number of interrelated problems (including reduction of oil supplies from Western Siberia).

3.3. Krasnoyarski Krai

In the territory of the Krai is located the one and only new refinery constructed in the former USSR on the territory of Russia in the 80s: Achinsk Refinery (see Table 3). This plant has an inte-

grated unit for primary oil processing with an attached gas fractionating unit. The raw material for this plant is low-sulphurous oil from Western Siberia supplied through a trunk pipeline. Presently this facility provides only primary processing, producing light oil products, fuel oil (or mazut), and bitumen. The production site of Achinsk Refinery is quite promising from the viewpoint of locating ethylene (and its products) production unit. The choice of pyrolysis feedstocks will be determined by the scale and time of development of the oil and gas fields in Krasnoyarski Krai (Takhomo-Yurubchenskoe field, in the first place). On Krai territory there are also several chemical plants: those for synthetic fiber and rubber (butadiene is supplied from Omsk), tire plant, etc. In accordance with the initial programme of construction and development of the above industrial enterprises it was presumed that the feedstocks for the first two will be the products of profound wood processing supplied by the timber industry

3.4. Tyumen and Tomsk Oblasts

In the late 60s, owing to the development of oil and gas production in Western Siberia, gas processing plants were constructed directly in the areas of production. In the period from the mid-70s to the present time a total of eight plants have been constructed with a total capacity of 25 billion cubic meters [2].

From the very beginning of oil production in Western Siberia the dominant view held was that associated gas was a 'superfluous' resource that only complicated field development and schemes of oil collection and preparation. As a result, the capacities of gas processing plants were put into operation with a 10 year delay and this (on average) as compared to oil production: the latter was started in 1965 and the first gas processing plant was put into operation only in 1975.

The output of gas processing plants are 'dry' (processed or 'de-gasolined') gas and ShFLU. The latter is comprised of propane and butane (comprising between 45–80% of the total)

together with heavier hydrocarbons, mainly C₅ and C₆. These plants are not really gas processing plants at all, but merely 'preparation units' for gas transport. By the mid-70s the following scheme of utilising gas processing products had been formed: dry gas was supplied via trunk pipelines as fuel to the thermal power stations (in Tyumen Oblast one of the largest in the world — Surgut Thermal Power Station — GRES), metallurgical and chemical plants of Kuzbass, and to the gas pipelines Urengoy Chelyabinsk and Urengoy Centre. ShFLU is mostly used as feedstocks for the petrochemical industry at the Tobolsk (Tyumen Oblast), Nizhnekamsk, Novokuybyshevsky Petrochemical Combines and at the Chaykovski Synthetic Rubber Plant (European Russia).

Construction of the Tobolsk Petrochemical Combine was started in Tyumen Oblast in the late 70s with the purpose of solving the problem of ShFLU utilization. Currently this combine incorporates the following production facilities: a central gas fractionating installation using ShFLU with a capacity of 3 million tons/year (actual capacity is 2.5 million), and an installation for producing butadiene from butane, with a capacity of 180000 tons per year. The formation of the above plant was aimed at the production of butadiene and isoprene to supply to the plants of the European part of the country. At present, the butyl rubber production facility is close to completion which is justified by the availability of isobutane and the relatively compact production technology. One of the perspective development directions for the Tobolsk Combine is the transition from a synthetic rubber production facility to an integrated petrochemical plant with a broad production mix.

Tomsk Combine is one of the few petrochemical plants in Russia that increased its output in 1993 due to the growth in the production of methanol that is in high demand on the world market. It is planned to increase production volumes of this compound. Canadian companies participate in this project.

Unfortunately, up to the present time 'dry' natural gas — one of the most reliable and long-term sources for the development of the petrochemical

industry — is not used in Siberia. Owing to a decrease in the volume of remote transportation of natural gas and the location of some production facilities based on it in the direct vicinity of gas production areas, it is possible to dramatically reduce (by 20–50% according to various estimates) the cost price of the output. Here a large number of options can be considered for the pattern of the petrochemical complexes (e.g. based, in the first place, on the production of methanol and ammonia). And it is expedient to add measures of interregional character to the entire totality of the technological relationship based on methanol processing.

3.5. Siberia's hydrocarbon processing industry: current situation

The most general inferences relative to the formation features and development of the utilization of hydrocarbons and processing facilities in Siberia are as follows:

- * the presence of substantial changes in the production pattern within individual industrial centres with a growth in the volume of processed feedstocks and further sophistication of their composition;
- * a greater sophistication in the interrelationship between various regional hydrocarbon processing centres: e.g., relationships like Tomsk–Angarsk, Omsk–Krasnoyarsk;
- * the presence of considerable inertia in the interregional flows of hydrocarbons: in spite of the economic expediency of creating new centres and modernising (and perhaps closing) the old ones;
- * the poor conditions for supplying production facilities with the main type of hydrocarbon feedstocks;
- * the considerable growth in the production of ethane, LNG, gas condensate (despite of oil production decrease);
- * the lack of facilities based on methane processing which would make it possible to produce various products which are in short supply with quite low production cost;

- * the impossibility of expanding the processing facilities in industrial centres like Omsk, Angarsk, Krasnoyarsk, Kemerovo due to the extremely high ecological pressure on the environment;

- * the appearance and rapid growth of the problem related to technical requirement and technological reconstruction of the existing production facilities: the Federal Government does not act as an investor anymore.

4. New times: new approaches

The present situation in the utilization of hydrocarbons and processing industry is characterised by the following factors:

(1) The existence of old centres (Omsk, Angarsk, Krasnoyarsk); their capabilities are exhausted and considerable restoration is required to maintain their performance.

(2) The existence of several new centres; their formation is far from completion (Tobolsk, Tomsk, Achinsk).

(3) A rapid decrease in the financial possibilities of the Federal Government (and the, as yet, weak financial opportunities of the regional authorities) to satisfy the needs of development and reconstruction of those industries.

(4) 'Localisation' of the problem of producing facilities oriented exclusively at the local market (first of all, producing relatively simple output from a technological point of view).

(5) Aggravation of the problems of economically effective production meeting the conditions of the world market situation (which makes more and more impact on the internal market).

5. Development of hydrocarbon processing is one of the directives of the long-term development strategy for Siberia

Hydrocarbons provides a unique opportunity to bring about the modernisation of the production pattern of Siberia and its territories, economic

infrastructure components both productive and non-productive.

The basic logic of structural transformation at the regional level should be the following sequence:

hydrocarbon production

↓

hydrocarbon processing

↓

development of other processing industries

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establishment of a reproductive pattern for the regional economy

‘The motion’ is gradually been shifted and emphasis is being moved from the development of production of non-reproducible mineral resources first to their processing, then to the development of processing and hi-tech industries,

and, finally, to the creation of a reproducible pattern for the economy (based on the use of reproducible resources and high-tech industries). The role of the region in the development of the facilities for integrated utilization and processing of hydrocarbons is quite important. And these ambitious tasks will only be realised on the basis of new technologies and with the integration of resource potentials and specific regional economic advantages.

6. References

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- [2] M. Sagers and V. Kryukov, The Hydrocarbon Processing Industry in West Siberia, *Post-Soviet Geography*, 34 (2) (1993) 127–152.