Directions of increasing business results through complex use of the oil and gas potential

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Abstract. The article is dedicated to the problem of increasing business results through the integrated use of oil and gas potential. The author states that at the present stage of development of the economy of Kazakhstan, it is still of raw material nature. Based on the calculated data of this article, we prove that the effectiveness of the integrated use of oil and gas potential is several times graeter than the output from hydrocarbon exports. The author believes that the advanced processing of raw materials with extracting other components of the Kazakh oil will be much more profitable. Advanced processing option allows achieving the highest output of high-quality motor fuel. The country's economy will receive certain advantages and means for innovative development from restructuring of the oil and gas complex. The author shows that the economic assessment of the potential of a specific oil field of the republic will not be complete if we do not take into account those products which can be extracted from the associated gas, which is extracted together with oil. The necessity of implementation of the development programme of the processing sector in the oil and gas sector is explained in the article.
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Introduction

Since the founding of a sovereign state and gradual development of market relations in Kazakhstan many legislative documents have been adopted to create favourable conditions for attracting foreign capital for the development of the oil industry. In a relatively short time, in this way dozens of joint ventures were created, the main aim of which was to conduct a detailed search and exploration, to develop the identified structures, to exploit the existing fields.

Despite persistent calls for a transition to innovative development, the domestic economy continues to grow mainly due to natural resources industries. Slow development of the innovation process is due to underdevelopment of the most innovative infrastructure and the legislative framework ensuring its functioning, and the absence of significant free capital interested in the development of the innovative business. Therefore, the innovative development of Kazakhstan can only begin with those industries that are able to provide their own investment in their innovation, using yet existing scientific and industrial potential of the country and the opportunities that provide its unique natural resources, i.e. with the oil and gas industry.

Even partial turndown of raw materials export, primarily oil and gas resources, including the replacement of the export products with more advanced processed products, could give a strong start for development of the national innovation economy. It is known that the main economic results are achieved during marketing of the final product, so the owners of resources don't achieve such results, but countries with technologies for final stages of its production. For example, the cost of the component of natural gas – ethane is about 80-90 USD / per ton, ethylene – 600 USD / per ton, the cost of low-density polyethylene is 20 times more than the cost of ethane, and the cost of finished products made of polyethylene (PE pipes) amounts to 2500-3700 USD / per ton.

Almost all Middle Eastern countries – exporters of oil and gas are now rapidly developing its own processing industry for extracted hydrocarbons, trying to secure their future in a rapidly changing world. Russia, being the world's largest exporter of raw materials, has a unique advantage over other exporters not only in the amount of its resources but in the unique scientific and technical potential of the exporting country. It is this combination that gives Russia a chance to go on the path of innovative development, taking advantage of a turning point in the global energy industry and economy, standing on the threshold of profound changes.

In accordance with the real prospects of economic reforms in the Republic of Kazakhstan, the general situation in the use of hydrocarbons has many options for solutions. Today's practice for oil and gas projects, despite the seeming advantages, doesn't contribute to the effective functioning of the oil and gas sector in general.

Comprehensive and rational use of Kazakhstan's hydrocarbon resources allows, firstly, using raw materials for multi-component separation of products, and secondly, influences, using levers of

pricing for essential technical and economic indicators of field development, and thirdly, contributes to the solution of environmental problems.

The most effective way to improve the rational use of oil and gas resources can be selecting other valuable components simultaneously with fuel fractions. Oil from many major oil fields of the republic, extraction and sales of which in most cases is export-oriented, is not used to date as intended in accordance with the physical and chemical characteristics and fractional composition of these oils [1].

For this reason, in sales of crude oil in large quantities there is an amount of additional revenue which is lost, but could be obtained by the extraction of useful components during its processing [2, 3, 4, 5]. For example, such end products as vanadium, nickel, various types of oils, which Buzachinsk and Mangistausk oils contain in a sufficient amount, sulfur compounds in Tengiz and Kumkol oils, are lost. Extracting these products will not only increase the complexity, and hence the efficiency of hydrocarbon resources, but will also eliminate toxic emissions.

Significant holdings of Kazakhstan high-viscosity oils (HVI) with large concentrations of associated elements (vanadium, nickel, etc.) did not contribute to increasing production of oil stock for a long time, due to the fact that vanadium and its compounds have a negative impact on the refining processes, reduce operational quality of petroleum products and corrode equipment. Consequently, depending on the physicochemical properties of Kazakh oil, oil extraction methods and other factors, various options of processing extracted hydrocarbons raw materials can be implemented with primary production of motor fuels, the high index base oils, feedstock for petrochemicals, construction and road bitumen, metals and rare chemical elements [6].

Real possibilities of using HVI as a source of raw materials for starting petrochemical synthesis are promising for the refining industry. The most advantageous option, from the point of view of the rational use, is to extract vanadium, nickel, sulfur, and other useful elements on-site and then to transport extracted oil products to the oil market. A similar operation must be carried out for the entire volume of Tengiz oil. The difference is that from this class of oil sulfur-containing compounds must be extracted to the necessary limit. Extracting exclusively aggressive sulfur compounds from Tengiz oil had been agreed during the formation of the joint venture "Tengizchevroil", since mercaptans significantly reduce the quality parameters of Tengiz oil and affect the process equipment.

Today the republic is forced to sell most of the produced hydrocarbons, due to insufficient investment in its processing. Industrial oil processing in modern refineries is performed by complex multi-stage physical and chemical processing at large-capacity process plants (shops), designed for production of different components or assortments of oil products. There are three main areas of oil refining: fuel; fuel and oil; petrochemical or complex (fuel and petrochemical or oil-fuel and petrochemical) [7].

During oil processing for fuel, oil feedstock is mainly processed into motor and boiler fuel. Crude oil processing at an oil refinery plant working with fuel can be advanced or simple. A flowsheet of the oil refinery plant with simple processing has a small number of different processes and a small range of petroleum products. The output of motor fuels by this scheme does not exceed 55-60% of the mass and depends primarily on the fractional composition of the processed petroleum feedstock.

The option of advanced processing allows achieving the highest possible output of high quality motor fuels by engaging residues of atmospheric and vacuum distillations, and refinery gases in its production. The output of boiler fuel in this option is minimized. The percentage of refining in this case reaches up to 70-90%. Using the option of the fuel and the oil refining, along with motor fuels, various types of lubricating oils are produced. For producing of the latter, oils with high potential content of oil fractions are selected [8].

The most efficient way of using hydrocarbon feedstock is connected with the petrochemical or complex processing, which involves production of various fuels and oils, petrochemical feedstock (aromatic hydrocarbons, paraffins, pyrolysis feedstock, etc.), and in some cases commercial production of petrochemical synthesis. The selection of a particular direction, regarding schemes of crude oil refining and an assortment of produced petroleum products, is primarily based on oil quality, its individual fuel and oil fractions, quality requirements for oil products, as well as their needs in this economic region. Preliminary assessment of the potential oil feedstock can be achieved by a range of indicators included in the technological oil classification.

Chemical processes used in modern refineries are subdivided into: according to the activation method of chemical reactions – thermal and thermocatalytic; according to chemical reactions occurring in them – into the following three groups:

1. Destructive (cracking, coking, pyrolysis, alkylating of olefins by isoalkanes, alcohols, benzene, olefin polymerization, etc.), in which reactions of

decomposition of raw materials molecules into hydrocarbons with low molecular weight occur, and as well as seal reactions (condensation, alkylation, polymerization) with high molecular weight products being formed;

2. Hydrogenated (hydrotreating, hydrocracking, hydrocatalytic reforming, hydrogenation, isomerization, hydrodewaxing), which are conducted in a hydrogen atmosphere supplied from the outside or generated in the process;

3. Oxidating (steam or steam-oxygen conversion, gasification, oxidative pyrolysis, Clauss process, carbonation by oxidative condensation) reactions involving oxidants (oxygen, water vapor, carbon dioxide, sulfur oxides, etc.) with oxides of carbon, hydrogen, elemental sulfur, bitumen, etc. being formed [9].

Until recently simple processing oil plants working with fuel were built in areas where there are no other sources of fossil fuels (coal, natural gas), and fuel oil (residue of oil refining) was used to supply power plants.

Firstly, light distillated fractions are extracted from oil, which are later refined using secondary processes - catalytic reforming, isomerization, hydrotreating. In the scheme of the plant, obtaining liquid paraffin (raw material for biochemical production and bitumen) is also specified.

Petroleum products are also used as raw material for a variety of petrochemical synthesis. Petrochemical productions in some cases are constructed as a part of a refinery. Independent petrochemical plants are also created. These plants receive raw materials from refineries by rail, truck or pipeline.

It should be noted that advanced oil processing requires a higher degree of saturation of secondary processes. These processes not only can increase the output of the desired products, but also elevate their quality. Of course, the more advanced the level of oil processing, the bigger the unit capital and operating costs are. However, inflated costs for advanced processing of raw oil will be recouped through producing an additional amount of petroleum products (primarily motor fuels) which are more valuable than residual oil. Table 1 shows the trade balances of the refineries with various schemes of refining.

Extremely unfavourable economic situation in the country occurred as a result of the huge difference between production of marketable products, mainly fuel, at domestic plants and import of similar range products from near and far foreign countries, negatively affects the ratio of export and import operations. For example, the amount of foreign exchange revenues from hydrocarbon raw materials exports is ten times more than the amount coming from the export of refined products, and the volume of exports of refined products in monetary terms is half the volume of its imports.

Table 1. Options of the output of the final product in petroleum refining

Components	Fuel option		Fuel-oil option
	with simple processing	with advanced processing	
Received oil, %			
Desalinated oil	100.00	100.00	100.0
Water for producting of hydrogen	—	1.55	—
Oil additives	—	—	0.50
Total	100.00	101.55	100.50
Obtained oil, %			
Automobile gasoline	15.25	22.65	15.19
Hydrotreated kerosene	9.72	9.72	9.72
Diesel:			
summer	15.46	25.55	21.26
winter	7.06	7.06	—
Benzene	0.57	0.57	0.57
Toluene	0.58	0.58	0.58
Solvent	0.14	0.14	0.14
Liquefied gases:	1.58	2.56	1.58
including			
Isopentane for petrochemistry	0.40	0.60	0.40
Liquid paraffin	0.41	0.41	—
Petroleum coke	—	2.40	—
Bitumen for roads and construction	6.76	5.76	5.76
Raw materials for carbon production		0.95	—
Boiler fuel	40.08	15.59	37.33
Lubricating oils	—	—	3.86
Solid paraffin and ceresin	—	—	0.88
Elemental sulfur	0.14	0.63	0.14
Fuel gas	2.05	3.10	2.19
Carbon dioxide	—	1.80	—
Wastes and losses	0.80	1.88	0.90
Total	100.00	101.55	

Notes – Source: [10]

The paradox lies in the fact that Kazakhstan imports even basic petroleum products, although the total capacity of the three domestic refineries (18.5 million tons per year) is sufficient for domestic oil needs of the republic.

Thus, a situation occurs, where Kazakhstan while exporting hydrocarbon feedstock, in turn, is importing advanced processed goods derived from the same refined hydrocarbon feedstock. If we consider the products acquired as a result of advanced processing of hydrocarbon feedstock, the amount of imported goods in this position will rise repeatedly.

Through the prism of existing realities, we can say that "The program of import substitution" when applying to oil and gas processing and petrochemical industries is a top priority. Consequently, the general line of development of the industry should be the formation of oil and gas complex with an extensive network of oil and gas processing and petrochemical industries with the necessary infrastructure.

In this regard, the question arises: how much oil must be extracted in the fields of the republic considering the following factors:

- A reasonable volume of exports of raw materials,
- Maintaining established links with external processors,
- Meeting the needs of own processing facilities operating today, and those that will be built in the future.

Finding the solution to this problem is an important task, because real prospects for effective business results are possible only when primary raw materials (oil, condensate, natural and associated gas) are involved in the advanced processing of the final products. Implementation of such a direction is possible in cases when new processing facilities are built, being targeted for long-term delivery of quality uniform raw materials.

Economic results of possible options, received only during simple oil refining, allow comparing them with the size of revenue, which may come from the sale of crude oil on the international market. At the same time, completely different financial results can be obtained with the direct processing of this raw material. As can be seen from the calculated data (Table 2), the benefits will not be in favour of selling raw materials: using the first and second options of processing, the total value of products, extracted from the incoming volume of oil, is 30% higher than the revenue from the sale of raw materials, using the third and fourth options, the value is 16% higher.

The calculated data allows us to focus on the unconditional economic benefits that the republic's economy receives from oil and gas industry restructuring even if only simple processing of feedstock is used. It should be noted that in Kazakhstan, processing facilities are focused mainly on fuel use of raw materials, which results that only a half of the incoming oil refining is used for its intended purpose, while the rest of it in the form of fuel residue is sent for incineration as a boiler fuel.

In this regard, the analytical approach to the nature of the received data in terms of determining the degree of efficiency of processing is of particular interest. In each of the above options, first petroleum distillation products are present, which in oil refining practice, in turn, represent raw material for the following, more advanced product selection process. We are talking about vacuum gas oil, tar, fuel oil. Depending on what problems need to be solved when involving them in destructive processes, a range of end products, produced from them, can vary significantly.

For example, if we direct vacuum gas oil for fractional separation in the catalytic cracking process, we can further obtain about 800 tons of gasoline in the amount of 137 million U.S. dollars. According to the other option of the fractional separation, we can obtain 512 tons of gasoline and 526 tons of diesel fuel from gas oil, worth about 180 million U.S. dollars. In addition, for each of these options a broad fraction of light hydrocarbons (NGL) is separately extracted in an amount about 134 tons, which further increases the total economic output by 16-20 million.

The use of advanced processed hydrocarbons feedstock can increase the output of gasoline by more than 1.2 million tons, using one option, for a total amount exceeding 235 million U.S. dollars. Using the other option, you can extract additional 524 tons of kerosene and 900 tons of diesel fuel with a total economic valuation of 245 million dollars. Similar results are obtained in case of processing fuel oil.

Summing up the above, based on the developed schemes of complex use of hydrocarbons, and taking into account material balances of the processes, we may note in the first approximation that, for example, the potential value of one ton from the series of the oil fields of the republic is 1.5-2 times higher than selling crude oil.

Table 2. Economic results of oil refining in an amount 6 million tons per year

1st option of an output of end products in the processing of raw materials		
Petroleum products	The output, th. tons	Production value, thousands of U.S. dollars
Gasoline	1308.0	225000.0
Kerosene	756.0	130000.0
Diesel fuel	1584.0	269000.0
Vacuum gas oil	1338.0	220000.0
Tar	1002.0	90000.0
Total		936000.0
2nd option of an output of end products in the processing of raw materials		
Gasoline	1308.0	225000.0
Diesel fuel	2340.0	397800.0
Vacuum gas oil	1338.0	220000.0
Tar	1002.0	90000.0
Total		933800.0
3rd option of an output of end products in the processing of raw materials		
Gasoline	1308.0	225000.0
Kerosene	756.0	130800.0
Diesel fuel	1584.0	269200.0
Fuel oil	2340.0	224600.0
Total		849600.0
4th option of an output of end products in the processing of raw materials		
Gasoline	1308.0	225000.0
Diesel fuel	2340.0	397800.0
Fuel oil	2340.0	224000.0
Total		847400.0
Note - Table compiled by the author based on the source [7]		

This economic assessment of the potential of a specific oil field of the republic will not be complete if we do not take into account those products which can be extracted from the associated gas extracted together with oil. Currently, a large amount of associated gas is flared, although a part of the gaseous raw material extracted from the subsoil is not less valuable than oil, and for petrochemical plants it is the preferred raw material component. Given the fact that due to high gas factor the volume of associated gas makes up to about a half of the separated oil, no doubt there is a possibility for starting the appropriate processing industries due to the available raw materials.

Achieving effective economic results can be implemented in the case if the primary raw materials (oil, condensate, natural and associated gas) are involved in the advanced processing of the final products. For example, the company KAZTEK, using tolling agreements, carried out refining at the production facilities of "Ufaneftekhim", Pavlodar refinery and Atyrau refinery. At the same time crude oil supplied by OAO "Uzenmunaigaz" was processed at the Atyrau refinery, same quality Western Siberian oil was processed at the Pavlodar Refinery and "Ufaneftekhim". Note that the Pavlodar refinery is by far the most modern in the Republic of Kazakhstan, and the factory of OAO "Ufaneftekhim" refers to the midsize class. Schemes which were carried in refining at these enterprises are reflected in Table 3.

Table 3. Comparative results of refining, %

Petroleum products	OAO "Ufaneftekhim"	Pavlodar Refinery	Atyrau refinery
Gasoline AI-93	–	–	1
Gasoline AI-92	9.4	–	–
Gasoline A-76	15.88	26.0	8.0
Diesel fuel (summer)	34.7	29.0	29.5
Fuel oil M-100	29.9	28.0	39.3
Liquefied gas	1.0	3.0	0.17
Heating oil	–	–	7.0
Coke	–	1.0	3.0
Sulfur	–	0.9	–
Petroleum bitumen	2.1	2.0	–
TS-1	–	2.0	2.0
White spirit	–	–	0.5
In / gasoil	–	–	4.5
Losses	7.0	8.1	5.0
Note – The table is based on the data of the company "KAZTEK"			

Table 3 shows that the level of advanced processing on the most modern plants of Kazakhstan is much lower than in Russia. In accordance with international standards, the technological level of Russian refineries cannot be classified as modern, but now Russian oil and gas companies successfully develop and implement programs of development of advanced processing of hydrocarbon raw materials.

The implementation of the development program of the processing sector in the oil and gas industry of Kazakhstan should not be postponed until better times, when there will be real prerequisites of a purely financial character. While repressing the development oil and gas processing and petrochemical industries, only a half of the incoming

oil for refining is used for its intended purpose, while the rest of it is sent for incineration as a fuel.

The basis of the economic strategy of the republic should be the creation and development of oil refineries, chemical, petrochemical and other productions that require identifying new approaches and trends in the development of oil and gas complex, the transition to advanced and complex processing of hydrocarbon resources. These areas are an important part of the national program of import substitution, and therefore, changing of the raw material orientation of the economy today remains the most important priority of the economic policy of Kazakhstan. From these positions the modern approaches for the development of strategies for the creation and development of the processing industry are formed.

Modern industry of Kazakhstan requires changing the proportions between the extracting and processing industries in ferrous and nonferrous metallurgy, chemical and fuel industries, which are based on the unique deposits of mineral resources in the region. Further effective development of the national economy requires a reorientation of the industry for an advanced, complex processing of raw materials and an increase in sales in the market of end products. For this purpose, each of the basic industries needs its own programme for improving the ratio of production between extracting and processing industries. Increase in the proportion of secondary processes is necessary in the oil and gas industry. This is a promising way to obtain additional sources of fuel.

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