

ISOMALK — MOVING FORWARD AHEAD OF GLOBAL TRENDS

Changes in trends in the world and regional markets of motor fuels are sometimes completely unpredictable. A few years ago, it seemed that the development of massive «dieselization» trend, so dominant in the EU, would lead to a drop in demand for gasoline.



It seemed that diesel engines solved both the problem of reducing CO₂ emissions and increasing efficiency, making the diesel fuels the trade-off solution that would allow the world's motor vehicle to survive quite well until electric cars would become cheap and efficient enough to replace internal combustion engines (ICEs).

However, the scandal with the Volkswagen cars motor tests results rigging that broke out in the autumn of 2016 in the U.S.A., like a snowball effect, affected and shocked all diesel car manufacturers, above all, of course, in the EU. A number of European auto manufacturers resulted adding to the list of troubled vehicles.

Major banning of diesel vehicles for the super-harmful emissions of nitrogen oxides (NO₂), revived in many countries interest and importance of control over production and blending of high quality high-octane gasoline components.

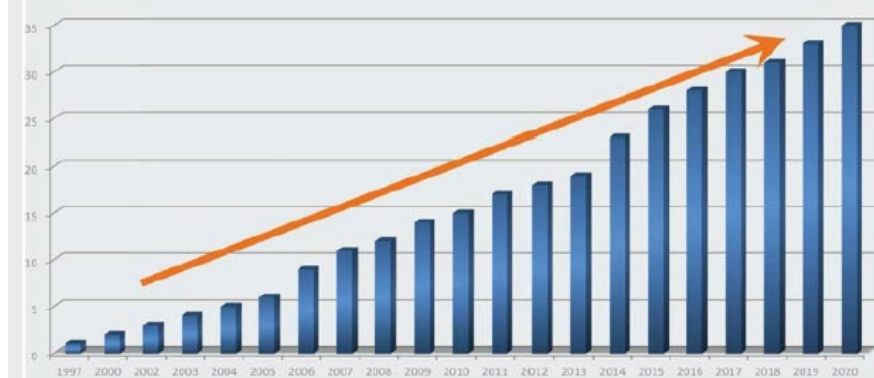
The topic of production of high-octane gasoline components for quite some time was the subject of heated discussions in Russia too.

Many, with an eye to the EU, insisted that

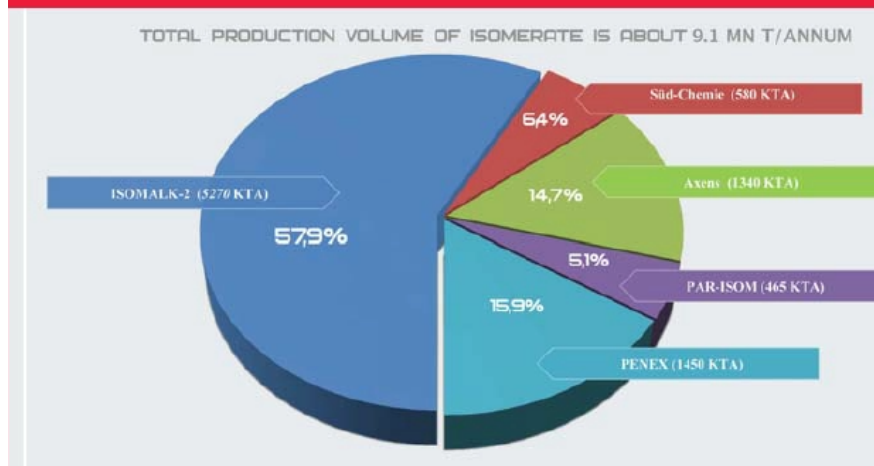
it was necessary to hurry up with increasing diesel fuels output at the refineries in Russia.

However, there were also specialists who soberly realized that no foreign fuel campaigns would be able to change in a year or even ten years the steady trend of gasoline consumption growth in a large northern country.

Dynamics of C₅-C₈ isomerization units commissioning in Russia



Share of different technologies for production of C₅-C₈ isomerate in Russia



One of such realists is the President of the Krasnodar company Scientific Industrial Enterprise (SIE) **Neftehim Alexander Nikitovich Shakun**, whose team of specialists developed the Isomalk technology for the production of the most high-quality and popular component of high-octane gasolines — isomerate.

During the years of discussion, SIE Neftehim worked hard, and developed Isomalk technology to become the leader in technologies import substitution, having introduced Isomalk at 11 refineries in the Russian Federation, as well as in Romania, Ukraine, India and China. SIE Neftehim continues development and implementation even though today Isomalk technology in Russia already produces more components of high-octane gasoline than under the licenses of all foreign licensors put together.

OILMARKET magazine met with Alexander Shakun to ask a few questions about the key trends in the production of high-octane gasolines and the priorities of this market segment development.

OILMARKET: Hello, Alexander Nikitovich, how do you assess the situation with the production of high-octane gasolines in Russia and in the world?

Alexander Shakun: Since 2012, the volume of production of high-octane gasoline blends of class 5 (hereinafter K5 — OM.) has significantly increased in Russia. In 2015-2016 there was a 4.1mn t production boost (+ 12.4%) — an unprecedented growth, even though during the same period, the production of diesel K5 increased by 9.1mn t (+ 16.3%).

These figures were in line with the global dynamics, when the production of gasoline in the world in 2015-2016 increased by more than 50mn t or more than 5.5%.

Naturally, in Russia the production of high-octane gasoline blends — A-95, A-92 and A-98 — showed the highest pace of production growth, in the first half of 2017 those blends represented respectively 51%, 29% and 1% of the total output.

OILMARKET: In the light of global trends — slow down of the massive diesel fuels use, the need for high-quality gasoline components is also stimulated by the transition of many leading world manufacturers, first of all Japanese ones — Mazda, Nissan, Suzuki, Toyota — to innovative petrol engines with variable compression.

Those innovations allow to give power and efficiency of petrol engines to the levels often exceeding the performance of the best diesel engines. They consume 4-5 liters per 100km run for cars with engine capacity of 1.4-1.6-2 liters and power of more than 120-150 hp.

However, all this is achievable only if high-quality modern gasolines are used. Do you think these trends will strengthen the demand for isomerate and the construction of new plants using Isomalk technology?

Alexander Shakun: All these trends, of course, increase the demand for quality components of gasoline. However, even without these trends at many refineries both in our country and abroad, there is a shortage of isomerate, caused by a number of technological and production problems.

There are two main schemes for compounding modern high-octane gasolines -Option I — Production of A-95 with the addition of isomerate, reformate, FCC gasoline, alkylate and components such as MTBE and TAME; Option II — Production of A-95 with the addition of isomerate, reformate, and, again, MTBE and TAME.

Both schemes have their drawbacks.

The key disadvantages of *Option I* are: a high content of olefins and sulfur in catalytic cracking gasoline, as well as a limited amount of alkylate on the market.

In *Option II*, the main disadvantage is the increased content of aromatic hydrocarbons due to the high proportion of reformate.

In addition to the problems with the actual technological schemes of compounding, many refineries have technical problems due to: • Deterioration of fixed-bed reformer performances due to catalyst coking and out-of-schedule shutdowns caused by poisoning. The share of fixed-bed reformers is still high; • Out-of-schedule shutdowns of isomerization units due to highly-sensitive poisoning and excessive corrosion; • High share of reformate with increased aromatics content in motor gasoline production.

OILMARKET: *How would you summarize the challenges that the presence of these problems poses to the technology developers for the production of gasoline components?*

Alexander Shakun: The modern problems of oil refining in the production of high-octane gasoline in accordance with the EURO-5 standard are the following:

- Increase of reforming catalysts' service cycle in fixed-bed reformers up to 3-4 years of «severe operation» with production of 97-99 RON reformate;
- Enhancement of reformate yield in operating fixed-bed reformers up to 90-92% due to minimization of catalyst coking and pressure decrease;
- Enhancement of CCR units operation due to improved catalyst selectivity and strength;
- Increase of isomerization unit turnaround period up to 6 years;
- Increase of period between regeneration for isomerization units up to 12 years;
- Maximization of non-aromatic isomerate share by means of C7-cut redistribution from reforming feed to isomerization feed;
- Construction of n-butane isomerization units to obtain feed for alkylate and MTBE production.



OILMARKET: *You note that most of the problems that arise with the production of high-octane components are dealt with the catalysts problems. What innovations does SIE Neftehim offer in improving the reliability of catalysts?*

Alexander Shakun: Among the latest modifications of the reforming catalysts produced and supplied by LLC SIE Neftehim are two brands — REF and RC. The REF catalyst is designed for operation in fixed-bed service in the mode of up to 100 RON, has regeneration period of 4 years, a service life of at least 8 years and the yield of reformate of up to 90%; The RC catalyst is designed to work with continuous catalyst regeneration (CCR), up to 110 RON, the catalyst's designed life span is 8 years, and the reformate yield is up to 92%; It is important to understand that for all catalytic processes, and especially for catalytic reforming, scientific and technical support is required from the production of the catalyst to the design, construction, start-up and operation of the units.

Our company provides all necessary support at all those stages. And here's important detail. While for a long time in the oil refining there were only 2 technologies of the CCR — supplied by the companies UOP and Axens. Now I can inform you that in 2017, along with «Lengiproneftekhim» design company in St Petersburg, we started designing the first industrial installation of the Russian CCR technology.

OILMARKET: *Let's return to the topic of isomerization catalysts. SIE Neftehim is recognized leader in the Russian oil refining industry in the production and supply of catalysts for this process. What is the situation in this segment in this sphere at the end of 2017 — the beginning of 2018?*

Alexander Shakun: The shares of various isomerization technologies in Russia are as follows — see the Table. At the same time, the total capacity of isomerization units in Russia is 9.105mn t/year

OILMARKET: *Obviously, the market is voting for the oxide sulfated isomerization catalysts, what are their advantages?*

Alexander Shakun: The key advantages of oxide sulfated isomerization catalysts are the following:

- Long term service life and service cycle;
- Possible activity restoration via regeneration;
- Tolerance to H₂O and sul-fur traces;
- Low corrosiveness.

These advantages translate into a number of record indicators

- 12 years service life achieved over SI-2 catalyst;
- 12 years service cycle with out regeneration has been achieved over SI-2 catalyst;
- Catalyst SI-2 totally restores its activity after removal of impurities from feed and hydrogen gas.

OILMARKET: You mentioned the importance of using the *n*-butane isomerization technology of to obtain valuable high-octane components. In the SIE Neftehim portfolio you have this Isomalk-3 technology- what is the situation with its implementation in Russia and in international markets?

Alexander Shakun: A lot of work has already been done in this direction: • In 2015, Shandong Sincier Petrochemical Co., Ltd (China) installed the Isomalk-3 with the feedstock capacity of 200,000t per year, as part of the MTBE production complex; • In 2016-2017 licensing and construction launched of two more Isomalk-3 units in China; • In 2018 constructed facilities launch is expected along with plans to develop several more Izomalk-3 units.

OILMARKET: You also mentioned the isomerization technology of the C₇ fraction (70-105°C) or Isomalk-4. What are the advantages of this process?

Alexander Shakun: First of all, I would like to note once again that this is the technology of the future, the nearest one. Its relevance already arises with the increase in the share of high-octane grades of gasolines in accordance with the EURO-5 standard. And the demand for this technology will increase many times with the transition of the world oil refining to the EURO-6 standards. As you know, in the USA, Canada gasoline is produced according to the standards similar to EURO-6. There were reports of the Euro 6 gasoline production in Europe.

The technology Izomalk-4 allows to:

- Raise the octane number of the fraction 70-105 ° C not via aromatization, as it happens in reforming units, but via isomerization of paraffinic hydro-carbons. At the same time, indirectly, due to the heavier boiling of the reforming units feed-stock, this boosts the reformat yield, and, accordingly, ultimately increasing the motor gasoline output;
- Reduce MTBE production costs or even completely reject it, as in some countries it is already banned for environmental reasons.

OILMARKET: Alexander Nikitovich, summarizing what you have already said, what technological priorities aiming to increase the production of high-quality components of modern gasoline would you put at the forefront today?

Alexander Shakun: Increase efficiency of high-octane gasoline production in line with the standards of EURO-5, and in the future according to the standards of EURO-6, gasoline fractions producing technologies have to be improved in the following directions: • Creation of catalysts for fixed-bed units with long term service cycle (up to 4 years) for «severe» (up to 99-100 RON) operation; • Creation of catalytic compositions for reforming units that allow to reduce the content of aromatic hydrocarbons in the reformat while preserving the octane number; • Creation of CCR reforming catalysts with enhanced mechanical strength and selectivity; • Further increase of the pentane-hexane fractions isomerization units share operating on oxide sulfated catalysts, providing unit service cycle up to 8 years and more; • Construction of *n*-butane isomerization units to provide feed for alkylation and MTBE units. New technology Isomalk-3 providing stable unit operation has been introduced; • Transfer of 70-105°C cut from reformers to isomerization units for refineries with limited alkylate amount. C₇-cut isomerization technology Isomalk-4 has been developed.

Today we can say that all necessary technologies to produce gasoline blends compliant with EURO-5 and EURO-6 in the future have been developed in Russia.

The shares of various isomerization technologies in Russia

Table 1

Isomerization technology provider	Share in total isomerizate production in Russia, %
Zeolite catalysts (Sud-Chemie)	6
Chlorinated catalysts (UOP, Axens)	31
Oxide sulfated catalysts (SIE Neftehim and UOP)	63



Pictured: N-butane isomerization unit using Isomalk-3 technology at Liaoning Hualu Specialty Asphalt Co, (Liaoning Province, PRC).



Pictured: In February 2017, Isomalk-2 isomerization unit, having capacity of 680 KTA, was commissioned at the refinery territory of Bharat Petroleum Corporation Limited (Mumbai, India) with the direct participation of SIE Neftehim, LLC experts.

The unit is intended to process pentane-hexane fraction according to Isomalk-2 technology for production of isomer-ate, having octane number of no less than 84, and food-grade hexane.