SIBUR for Clients
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FROM R&D TO PRODUCTION

Russia accepted a number of challenges that can be solved only by adopting hi-tech processes.

SIBUR’s portfolio of innovations

SIBUR is among the country’s few businesses investing in in-house intellectual assets. Developing and introducing proprietary technologies is what we focus on. A successful example of this effort is a technology for producing alpha olefin, a co-monomer used to synthesise high-margin polyethylene grades.

NIOST's Laboratory for Petrochemical Synthesis.

PROPRIETARY PRODUCTION TECHNOLOGY FOR ALPHA OLEFINS IS A MAJOR SCIENTIFIC ACHIEVEMENT. ON THE BACK OF THAT, SIBUR WILL BE ABLE TO PRODUCE MODERN POLYETHYLENE GRADES, REGARDLESS OF ANY LOGISTICS RISKS AND SANCTIONS.

Polyethylene containing alpha olefins can be used to make heavy-duty products for low and high temperature environments. On top of that, it is chemically resistant to acids, alkalis, and other chemicals. For instance, in the global petrochemical industry, high-density polyethylene containing alpha olefins is used to manufacture modern medical devices, laminated and stretch films, hot food packaging, water pipes, and much more.

Proprietary production technology for alpha olefins is a major scientific achievement. On the back of that, SIBUR will be able to produce modern polyethylene grades, regardless of any logistics risks and sanctions, and expand its licence assets.

“NIOST employees have created a method to make alpha olefin using a special catalyst, which became more selective through additional activation. This helped to substantially boost the technology's effectiveness, and we pioneered it,” says Vladimir Bushkov, one of the technology’s developers and the project owner.

A facility fr om scratch

Conceptual studies of alpha olefin technology started at NIOST back in 2007. Efforts involved experts from various industries – scientists, engineers, economists, and managers. Over the years, the technology has grown from a lab curiosity to a pilot plant.

Alexey Bashirov, Chief Engineer, and Evgeny Popov, Units Shop Manager.

At the initial stage, it is hardly possible to understand how the reaction will work out in production, what equipment issues may arise, what feedstock and energy consumption will be. All of this raises investment risks. In most cases, therefore, technological developments need to scale up. We scaled up the alpha olefin production technology in three stages:

IN THE GLOBAL PETROCHEMICAL INDUSTRY, HIGH-DENSITY POLYETHYLENE CONTAINING ALPHA OLEFINS IS USED TO MANUFACTURE MODERN MEDICAL DEVICES, LAMINATED AND STRETCH FILMS, HOT FOOD PACKAGING, WATER PIPES, AND MUCH MORE.

• Stage 1: we tried various catalyst components, operating modes, and identified key patterns of the processes using a lab unit capable of making 1 kg of the product per day;

• Stage 2: we created a model unit wh ere the product was manufactured up to 1 kg per hour in continuous mode. For the first time, developers encountered a number of technological issues that could not be seen during the lab research. We strived to eliminate the identified issues, boost the target product yield and process stability;

• Stage 3: we built a pilot unit boasting a capacity of 300 tonnes per year. It helped us to confirm process scalability, our capability to make finished product of the required quality, to test and streamline technical solutions, and to optimise feedstock consumption. At this stage, an experimental batch was enough for the polyethylene manufacturer to do full-fledged production tests.

It took us several hundred million roubles to design and build the pilot plant. As part of the project, the following facilities were constructed on the R&D centre's site: a separate building of the catalyst production facility, outdoor facilities, compressor building, closed flare unit; the technological chain of the pilot units shop was completely reconstructed. Design and construction was managed by a dedicated project management office.

"Building the pilot plant was costly. Legal requirements for industrial facilities running for decades and for pilot plants operating within a year or two to make a pilot batch are the same," said Airat Khusainov, head of the project's construction team in 2014–2016. "Design is not a creative type of work any more, its mission is to meet all regulatory requirements, even if they have nearly nothing to do with efficiency or safety. That problem relates to Russia's engineering industry in general and is partly responsible for the high cost of in-house solutions."

Unit's control centre. NIOST's team at work: Alexey Borodachev (Operator, units shop), Andrey Lesin (Shift Manager, units shop), Alexander Meling (Expert, project management), Ayrat Husainov (Head of Project Management), Evgeny Popov (Units Shop Manager) and Oleg Arkatov (Expert, project management).

Patent protection

Throughout the design stage, the Intellectual Property team at NIOST was in charge of its patent and legal support.

First of all, at the beginning of lab research they examined patents held by other companies at that moment and monitored all new patents and applications. It helped them to avoid infringing existing patents and to develop a proprietary technology different from those offered by other companies.

Patent protection was yet another major task for the patent and legal support.

"We came up with the first inventions at an early design stage. At that point, NIOST researchers only started to explore the process in the lab and were quite fast to capture important patterns that enabled them to devise an effective catalyst system featuring a unique mix of components. It became the cornerstone of further research," said Maria Bogomolova, Head of Intellectual Property at NIOST.

Nonetheless, most patentable solutions were created at the scale-up stage, when the R&D centre staff faced the issues of proceeding from the lab phase to the pilot plant, and found new ways to settle them step by step. Specifically, these were new additives, authentic solutions to minimise side chemical reactions, alternative designs of reactor equipment and the reaction product separation system, etc.

The unit from the outside.

Pilot run

IN 2017, WE SHIPPED THE PILOT BATCH OF ALPHA OLEPHINS TO KAZANORGSINTEZ, WHICH MANAGED TO PRODUCE COMMERCIAL POLYETHYLENE.

The pilot unit was completed in April 2016. Developers did their tests, improved the technology, optimised catalyst composition, and tested components from different suppliers. All these efforts became the inputs for designing a production unit jointly developed with Technip France, our engineering partner.

“We benchmarked the technology against comparable solutions globally and believe it is competitive," commented Fabrice Betton, head of the design and scientific calculations, Technip France (Lion).

In 2017, we shipped the pilot batch of alpha olephins to Kazanorgsintez, which managed to produce commercial polyethylene compliant with all the requirements for quality and polymerisation process efficiency.

“This is the outcome of joint efforts put in by a close-knit and committed team of ENTHUSIASTS (and I am using this word on purpose) in research, operation, engineering, and management. People were really passionate about the project, always on the lookout for new solutions, improvements, and opportunities. Working on the project was a bright example of natural team building by a common goal,” said Airat Khusainov.

Kazanorgsintez, low-pressure polyethylene production and processing facility. Photos: kazanorgsintez.ru

Next step

The Investment Committee has already decided to begin developing design documents for the production unit. We are looking into an opportunity to build it on one of SIBUR’s production sites. NIPIgaspererabotka was chosen as the general designer.

“The Investment Committee resolved to begin designing a normal alpha olefin production. Design documents will be developed and submitted for regulatory approval in 2019. To this end, we built a team of professionals, namely design, procurement, and budget control experts. We appreciate genuine commitment of our colleagues from NIOST and NIPIgaspererabotka to the project,” said Konstantin Lebedev, the project’s manager.

The R&D centre keeps streamlining the technology. We invest most efforts in making our patent protection stronger both for the technology at large, and for specific technical solutions. We pursue a research on the development of methods to synthesise catalyst system components: it will help us to optimise the cost of the finished products.

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