NEW PROJECTS BASED ON TECHNOLOGIES OF PJSC SIE NEFTEHIM FOR PRODUCTION OF HIGH-QUALITY MOTOR GASOLINES

JSC SIE NEFTEHIM
Joint Stock Company
Scientific Industrial Enterprise Neftehim

Alexander Shakun
General Director of PJSC SIE Neftehim

CURRENT TRENDS OF MOTOR GASOLINE PRODUCTION

Share of high-octane gasolines according to EURO-5 standards with content of aromatic hydrocarbons < 35 vol. % and benzene < 1.0 vol. % is increased

New EURO-6 standards with content of aromatic hydrocarbons < 25 vol. % and benzene < 0.8 vol. % are appeared

Demand of high-octane motor gasoline non-aromatic components (isomerates and alkylates) is enlarged

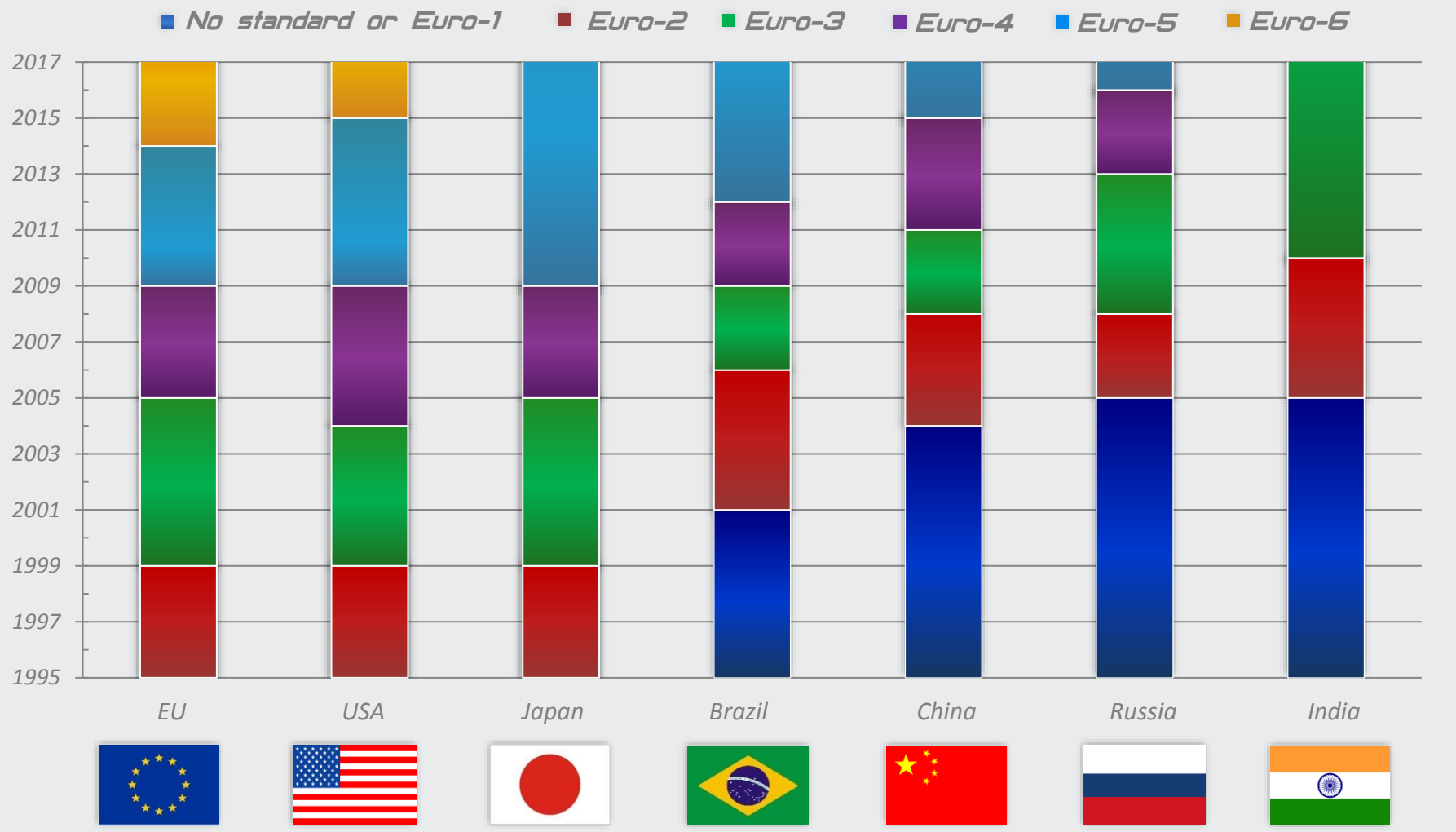
It is required to decrease share of reformates – high-octane aromatic concentrates

NEW HORIZONS OF MOTOR GASOLINE QUALITY

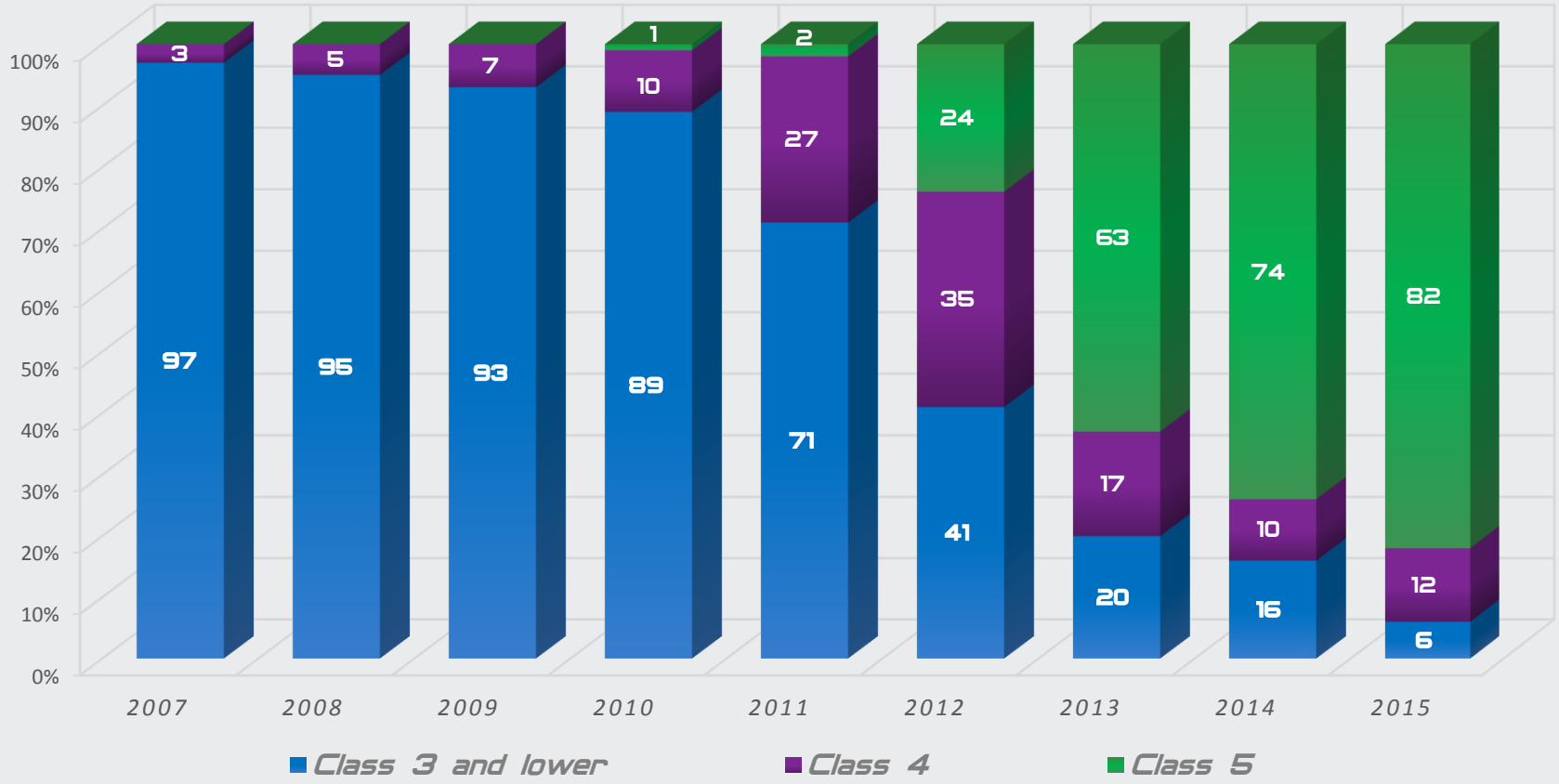
Performances	EURO-2	EURO-3	EURO-4	EURO-5	EURO-6*
Standard's date of validity in European Union	*1995*	*1999*	*2005*	*2009*	*2015*
Standard's date of validity in Russian Federation	*2005*	*2008*	*2013*	*2016*	*-*
Date of production termination in Russian Federation	*till 01.01.2013*	*till 01.01.2015*	*till 01.01.2016*	*-*	*-*
Benzene content, wt. %, no more than	*5.0*	*1.0*	*1.0*	*1.0*	*0,8*
Sulfur content, ppm, no more than	*500*	*150*	*30*	*10*	*10*
Aromatic hydrocarbons content, % vol., no more than	*-*	*42*	*35*	*35*	*24*
Olefinic hydrocarbons content, % vol., no more than	*-*	*18*	*14*	*14*	*11*
Oxygen content, % wt., no more than	*-*	*2.7*	*2.7*	*2.7*	*2.7*
Availability of detergent additives	*-*	*Obligatory*	*Obligatory*	*Obligatory*	*Obligatory*
NOx emissions, g/kW·h	*8.0*	*5.0*	*3.5*	*2.0*	*0.4*

** Performances of motor gasoline according to EURO-6 standard are not definitively established*

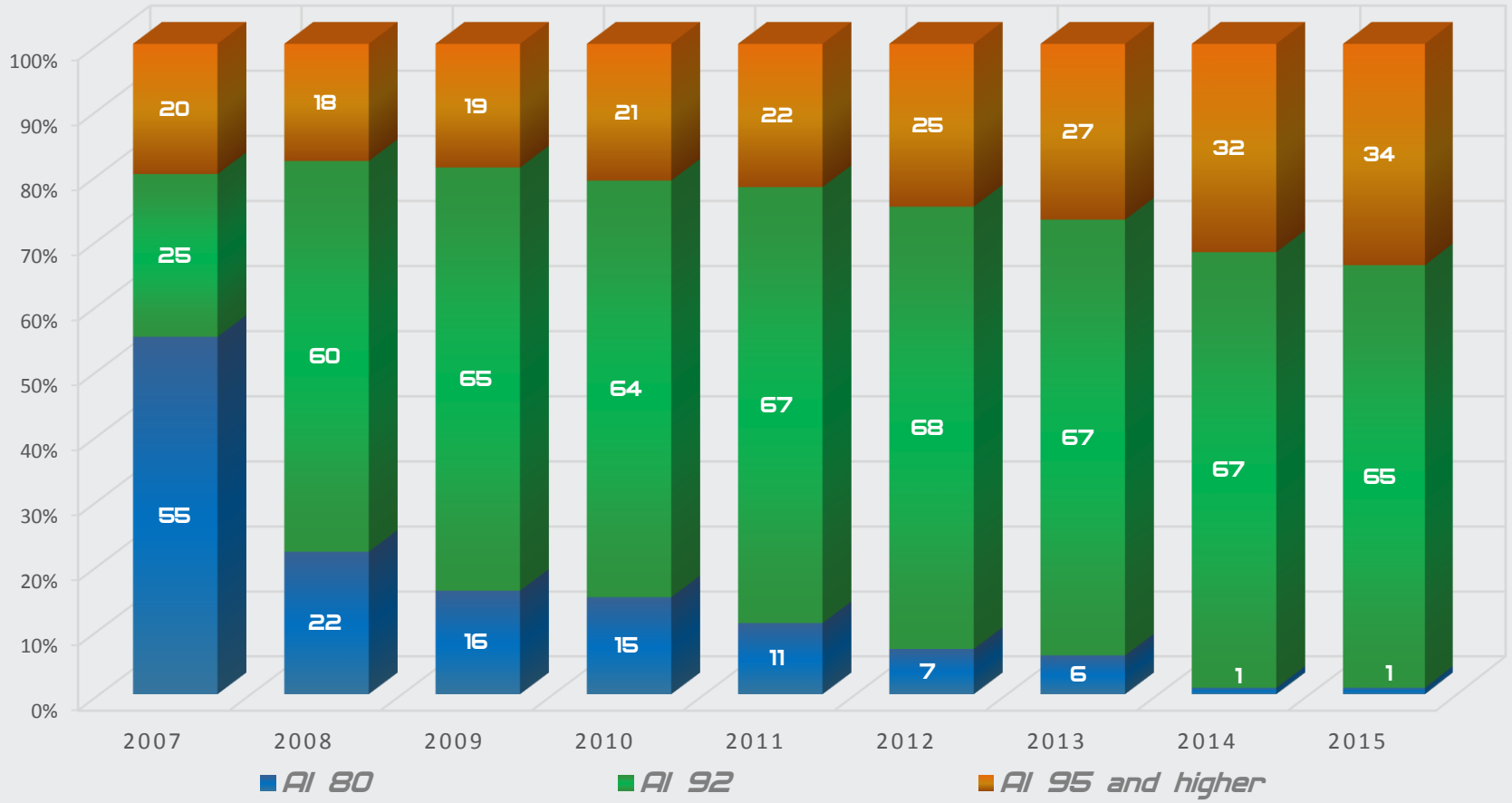
EURO-STANDARDS' IMPLEMENTATION DATE



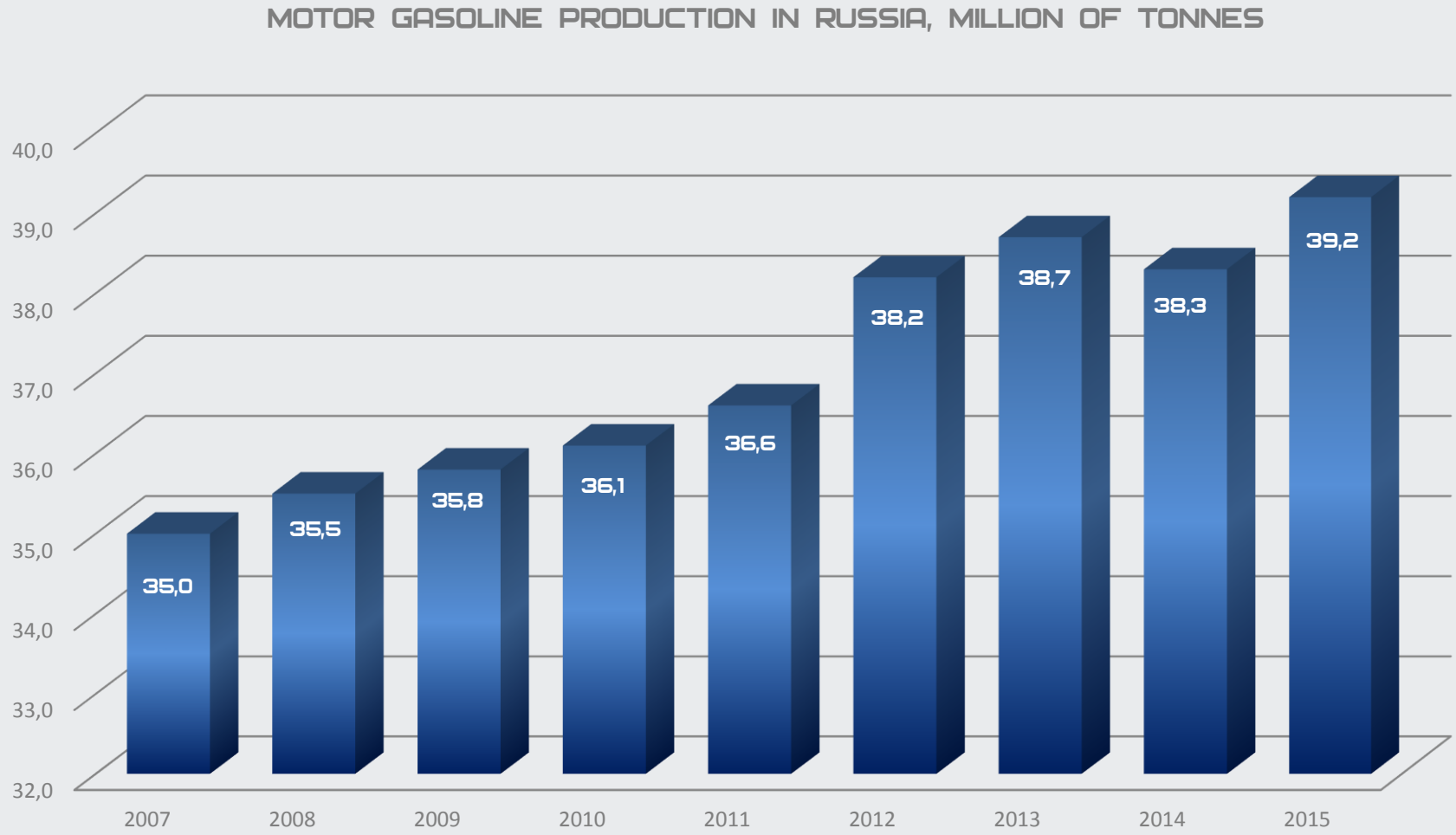
CHANGE OF MOTOR GASOLINE PRODUCTION STRUCTURE BY CLASSES IN RUSSIA OVER A PERIOD OF 2007-2015



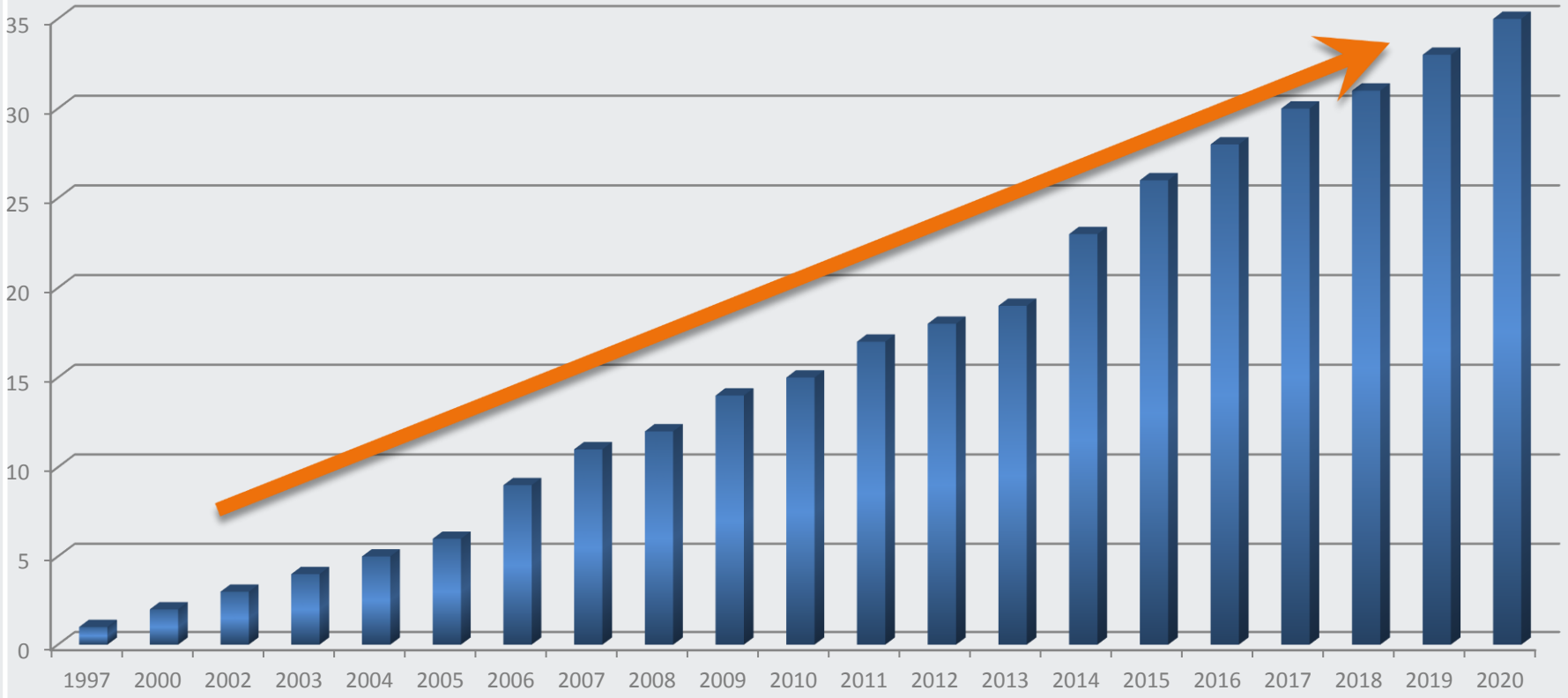
MOTOR GASOLINE PRODUCTION STRUCTURE BY GRADES (RON) IN RUSSIA



DYNAMICS OF MOTOR GASOLINE PRODUCTION CHANGES IN RUSSIA

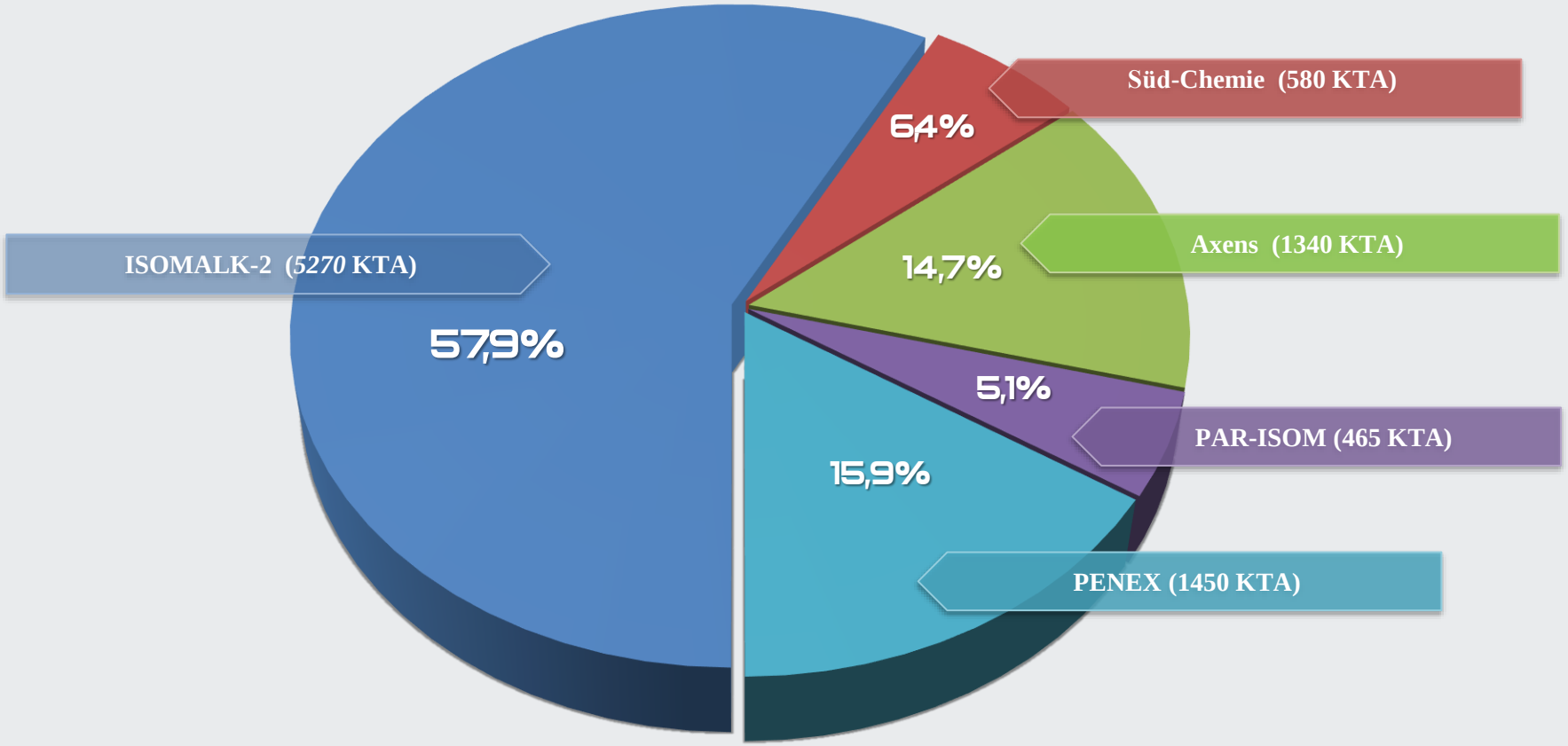


DYNAMICS OF C_5-C_6 ISOMERIZATION UNITS COMMISSIONING IN RUSSIA



SHARE OF DIFFERENT TECHNOLOGIES FOR PRODUCTION OF C_5-C_6 ISOMERATE IN RUSSIA

TOTAL PRODUCTION VOLUME OF ISOMERATE IS ABOUT 9105 KTA



ISOMERIZATION

Isomerization is the main way to increase share of high-octane motor gasolines according to the standards EURO-5 and EURO-6

- Competitive capacity of isomerization over zeolite catalysts has been dropped sharply. There are two competitive low-temperature isomerization technologies in the world market: over highly-chlorinated alumina catalysts and over sulfated zirconia catalysts:

➢ Increasingly refiners give preference to zirconia isomerization catalysts as they are more reliable and more efficient in operation;

➢ Zirconia catalysts field of application has been widened: from C_5-C_6 isomerization to C_4 and C_7 isomerization.

MAIN ADVANTAGES OF C_5-C_6 FRACTIONS ISOMERIZATION TECHNOLOGIES ISOMALK-2

- ✓ Isomerate with octane number up to 92-93 RON and yield of 98% is produced
- ✓ Catalyst cycle length of 10 years and service life up to 12 years have been confirmed in practice
- ✓ Catalyst is stable to the microimpurities of catalytic poisons

13 isomerization units Isomalk-2 have been commissioned by 2015, share of these units in Russian Federation is more than 50%

NEW ISOMALK-2 PROJECTS

- ✓ Kogalymneftegaz (Russia), 15 KTA (III Q 2016);
- ✓ BPCL (Mumbai, India), 620 KTA (IV Q 2016)
- ✓ PJSC TATNEFT (Russia), 420 KTA (IV Q 2016)
- ✓ Lifengda (China), 80 KTA (I Q 2017)
- ✓ HaiLinh HaiPhong Petroleum (Vietnam), 500 KTA (2017)
- ✓ KINEF Ltd. (Russia), 500 KTA (2018)
- ✓ Hengli (China), 2400 KTA (2018)

PJSC TATNEFT, NIZHNEKAMSK, RUSSIA
ISOMERIZATION UNIT ISOMALK-2

OPERATING PERFORMANCES OF THE UNIT:

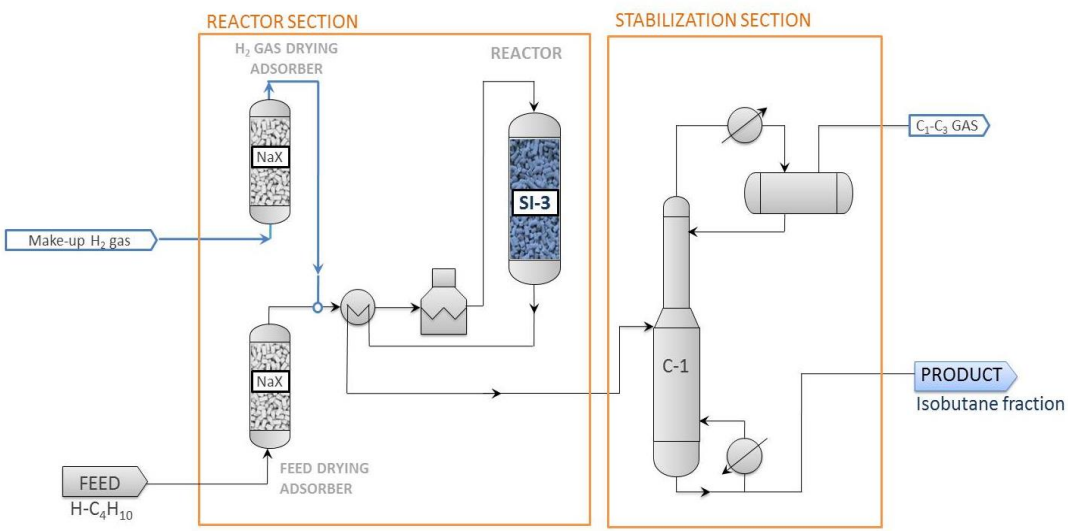
"Once-through" isomerization process scheme with low-branched hexanes recycle	
Feed capacity, t/year	***420,000***
Isomerate yield, %	***≥98***
RON	***≥91.2***

KOGALYMNEFTEGAZ REFINERY, KOGALYM, RUSSIA
PACKAGED ISOMERIZATION UNIT ISOMALK-2

OPERATING PERFORMANCES OF THE UNIT:

"Once-through" isomerization process scheme with low-branched hexanes recycle	
Feed capacity, t/year	***15,200***
Isomerate yield, %	***≥95***
RON	***≥88***

N-BUTANE ISOMERIZATION TECHNOLOGY ISOMALK-3



The first isomerization unit Isomalk-3 was started-up at SSCG (Shenchi, China) in 2015

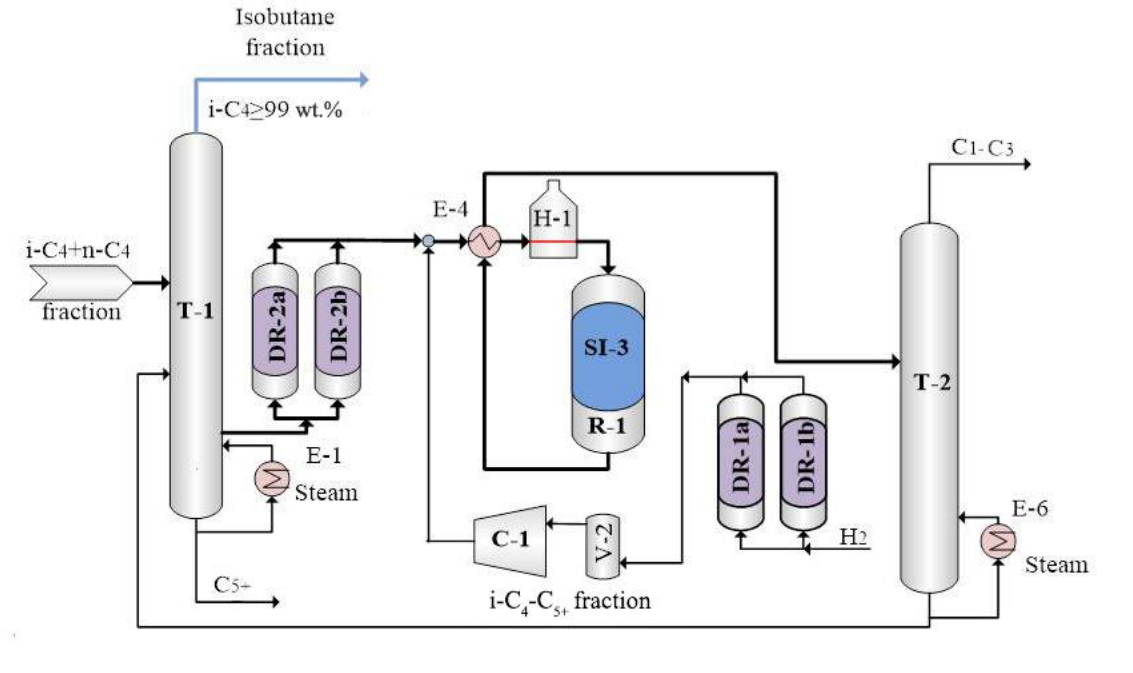
2 new units are under design in China:

- Haike Ruilin Company, 30 KTA – I Q 2017
- Hualu Liaoning Company, 32 KTA – I Q 2017

Typical n-butane isomerization unit Isomalk-3 consists of the following sections:

- **Isomerization feed treatment and drying section** *is designed to remove moisture from isomerization feed; this operation is performed to protect catalyst against water, which suppresses catalyst activity;*
- **Isomerization reactor section** *is designed to perform isomerization reactions from normal butane to isobutane at the active sites of the catalyst at the most favorable conditions for the main reaction;*
- **Hydrogen gas drying adsorbers section** *is designed to remove moisture from hydrogen gas and from nitrogen during catalyst regeneration;*
- **Stabilizer section** *is designed to remove C_1-C_3 hydrocarbons and dissolved hydrogen from obtained product .*

SHANGDONG SINCIER PETROCHEMICAL CO., LTD, CHINA
NEW ISOMERIZATION UNIT ISOMALK-3



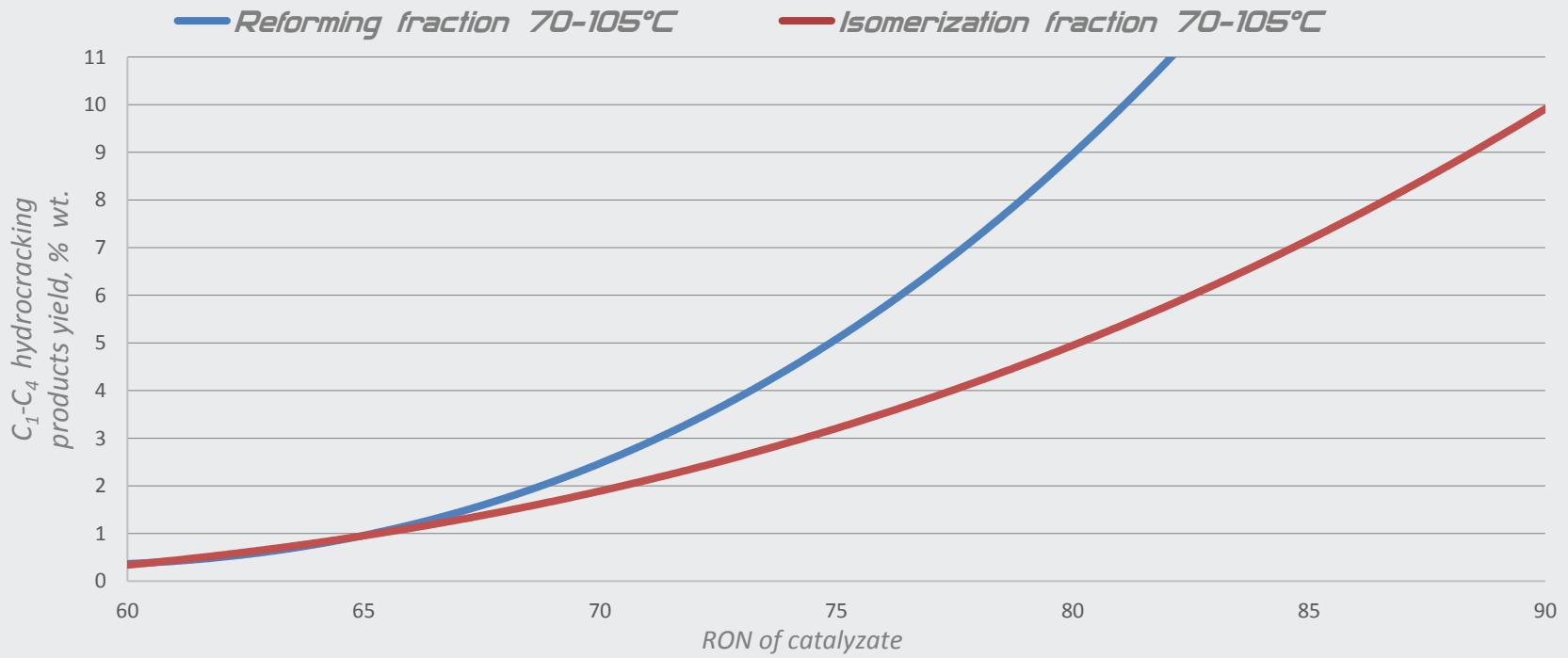
OPERATING PERFORMANCES OF THE UNIT:

Isomerization process scheme with feed deisobutanization and n-butane recycle	
Feed capacity, t/year	*200,000*
C_3-C_5 yield per n-C_4, %	*≥99*
H_2/HC molar ratio, mol/mol	*0.06-0.1:1*
Space velocity in reactor section, h^{-1}	*8-9*

MAIN TECHNOLOGICAL PARAMETERS OF ISOMALK-3 PROCESS

Parameter	Value
Temperature, °C	*160-210*
Pressure, MPag	*1.5-2.0*
Feed supply space velocity, hour^{-1}	*6.0-8.0*
H_2 : butane molar ratio	*0.07-0.10*
“Once-through” n-butane conversion, % wt.	*50-55*
“Once-through” yield of C_3+ hydrocarbons, % wt.	*99*
“Once-through” yield of C_4+ hydrocarbons, % wt.	*94-95*
Total service life of the catalyst, years	*no less than 8*
Catalyst service cycle, years	*no less than 3*

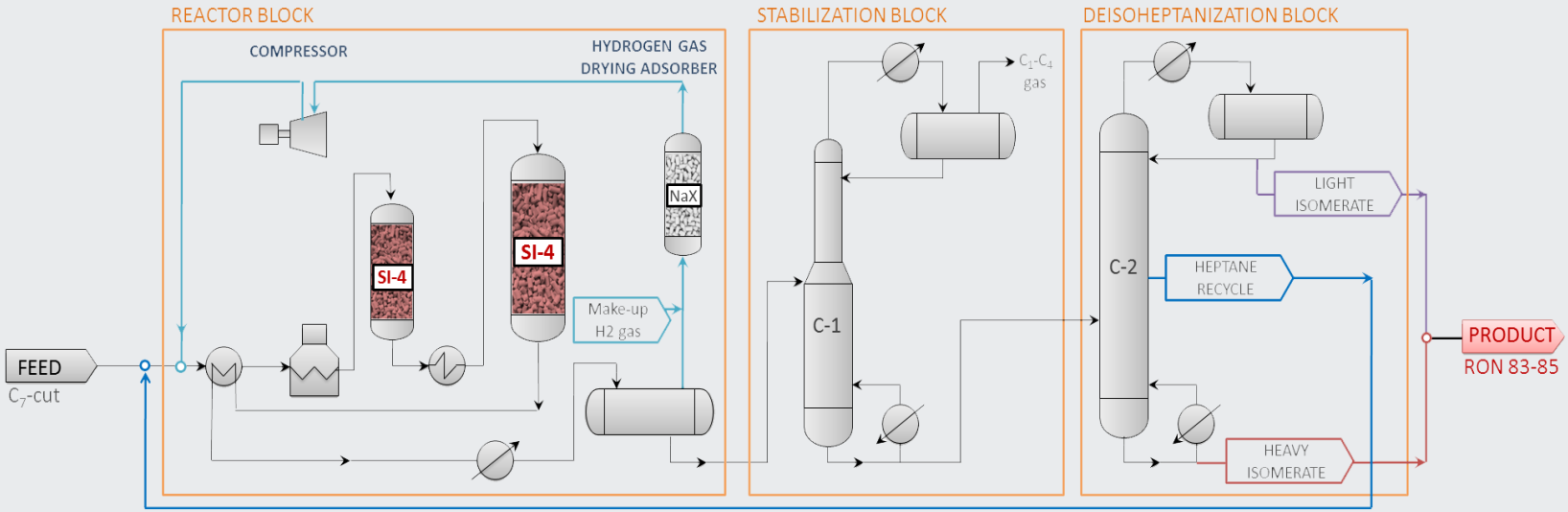
C_7 FRACTION ISOMERIZATION ISOMALK-4 – NEW TECHNOLOGY IN OIL REFINING



ADVANTAGES OF ISOMALK-4 TECHNOLOGY AGAINST REFORMING:

- ✓ Higher yield;
- ✓ No aromatic hydrocarbons in catalyzate;
- ✓ Decrease of expenses for MTBE and alkylate purchasing.

BASIC PROCESS FLOW-DIAGRAM OF ISOMALK-4 UNIT



CONDITIONS TO INCLUDE C_7-FRACTION ISOMERIZATION UNIT TO THE GASOLINES PROCESSING SCHEME:

- Lack of alkylate and other high-octane non-aromatic motor gasoline components at refinery;
- Necessity to increase production of motor gasolines at the expense of higher selectivity of C_7-fraction processing.

CATALYTIC REFORMING OF GASOLINE FRACTIONS

There is no alternative to Platforming for obtaining high-octane motor gasoline component from heavy gasoline fraction 105-180°C yet. However, ever increasing ecological limitations of commercial motor gasolines compositions submit new even more severe requirements to the process:

1) For fixed-bed catalytic reforming units the challenge is issued to transfer to the catalysts being able to have service cycle of 3-4 years in severe mode (96-98 RON). In this case the reformate yield has to be equal to 88% and more.

2) For continuous catalytic reforming (CCR) unit the general requirements to catalysts are as follows: high selectivity together with high mechanical strength.

REFORMING CATALYSTS OF PJSC SIE NEFTEHIM

Reforming catalyst **RC-12** for CCR units

- ✓ High mechanical strength;
- ✓ High activity

New brand of reforming catalyst for fixed-bed units – **REF-125**

- ✓ Notably higher stability and selectivity in comparison with these of previous REF-23 series catalyst

CONCLUSION

- The environmental requirements to motor gasolines are continued to be more severe in all countries;
- It is possible to meet the ecological requirements only in case of expansion of the processes, designed to produce high-octane non-aromatic motor gasoline components;
- General emphases are laid on the high-efficient isomerization technologies of C_5-C_6 fractions, n-butane, and C_7-fraction;
- Russian refinery became one of the leaders in the sphere of construction of new isomerization units;
- Catalytic reforming remains one of the requested processes for production of motor gasolines and aromatic hydrocarbons, at this new more severe requirements are imposed;
- Researches for creation of new more efficient catalysts are conducted all over the world.

CONTACT INFORMATION OF PJSC SIE NEFTEHIM

THANK YOU FOR ATTENTION!

www.nefthim.com

Address: 350007, Russia, Krasnodar region,
Krasnodar, 4 Zakharova St.
Tel.: +7 (861) 267-80-31
Fax: +7 (861) 267-80-40
E-mail: info@nefthim.ru