

SIE NEFTEHIM, LLC

CATALYTIC TECHNOLOGIES DEVELOPMENT & IMPLEMENTATION



CATALYTIC TECHNOLOGIES DEVELOPMENT & IMPLEMENTATION



Dear Partners!

Welcome to the information catalog of Scientific Industrial Enterprise Neftehim!
SIE Neftehim is the Russian engineering company. For over 60 years, we have been developing and implementing the petroleum refining technologies.

SIE Neftehim is one of the largest manufacturers of the isomerization and reforming catalysts in Russia. The total installed production capacity is up to 1,000 tons/year.

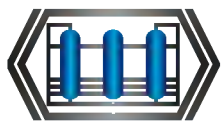
Our mission is widespread distribution of the modern effective catalysts and technologies to improve the motor gasoline quality.

We have implemented more than 80 projects, including projects in Russia, Europe, China, India, and other countries.

SIE Neftehim has its own scientific and laboratory facilities, modern equipment, knowledge and expertise for constant enhancement of the catalysts quality and searching for the new effective solutions.

We are always open for cooperation!

Alexander Shakun
President and CEO



ACTIVITIES

Catalyst supplies

Licensing

Basic Engineering Design

Technical support

at all implementation stages

Isomerization of C₄, C₅-C₆, C₇ cuts

Isomalk-2, Isomalk-3, Isomalk-4 technologies
based on SI-catalysts

Reforming CCR, SRR

Reforming catalysts
RC-catalysts, REF-catalysts

Isoplat technology

combines isomerization
and reforming technologies

Xylene isomerization

based on IK-catalysts

Hydrogen gas treatment

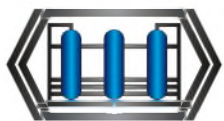
based on MCat-catalysts

Hydrogenation

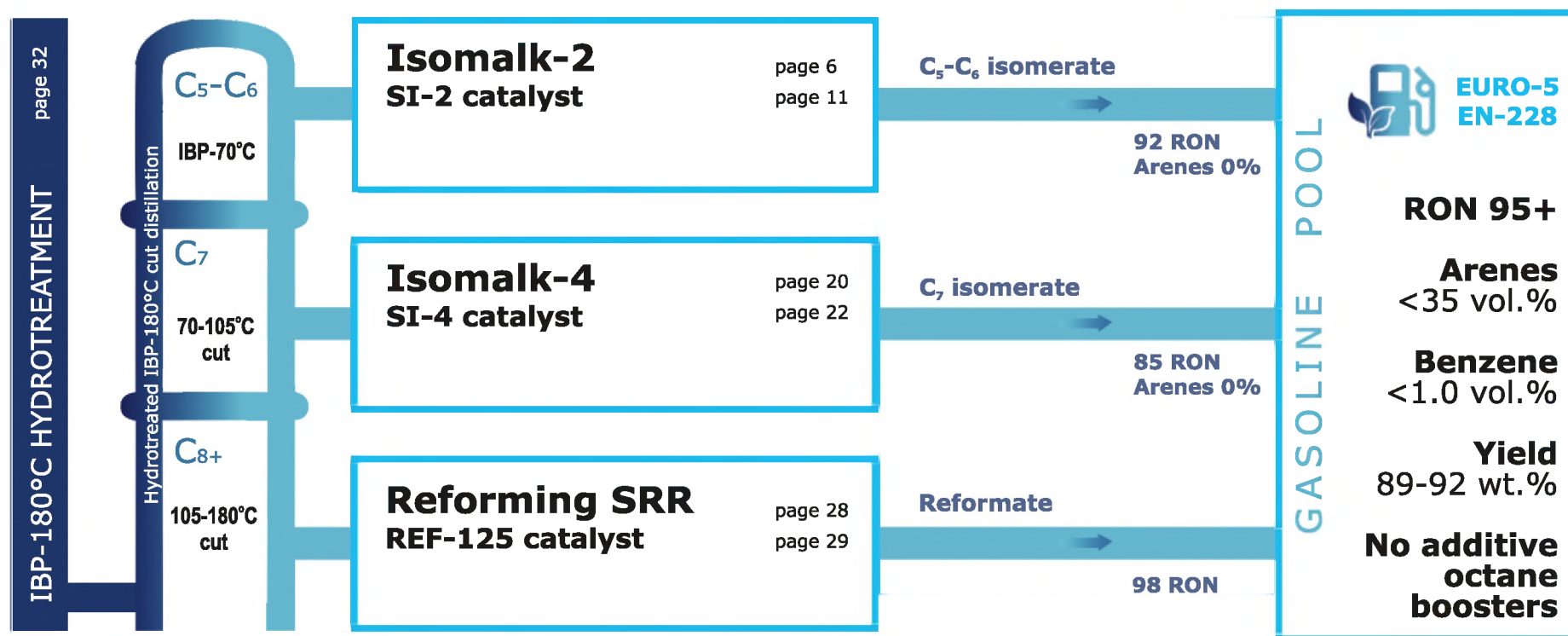
based on HCat-catalysts

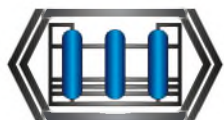
Hydrotreatment

based on DS-catalysts

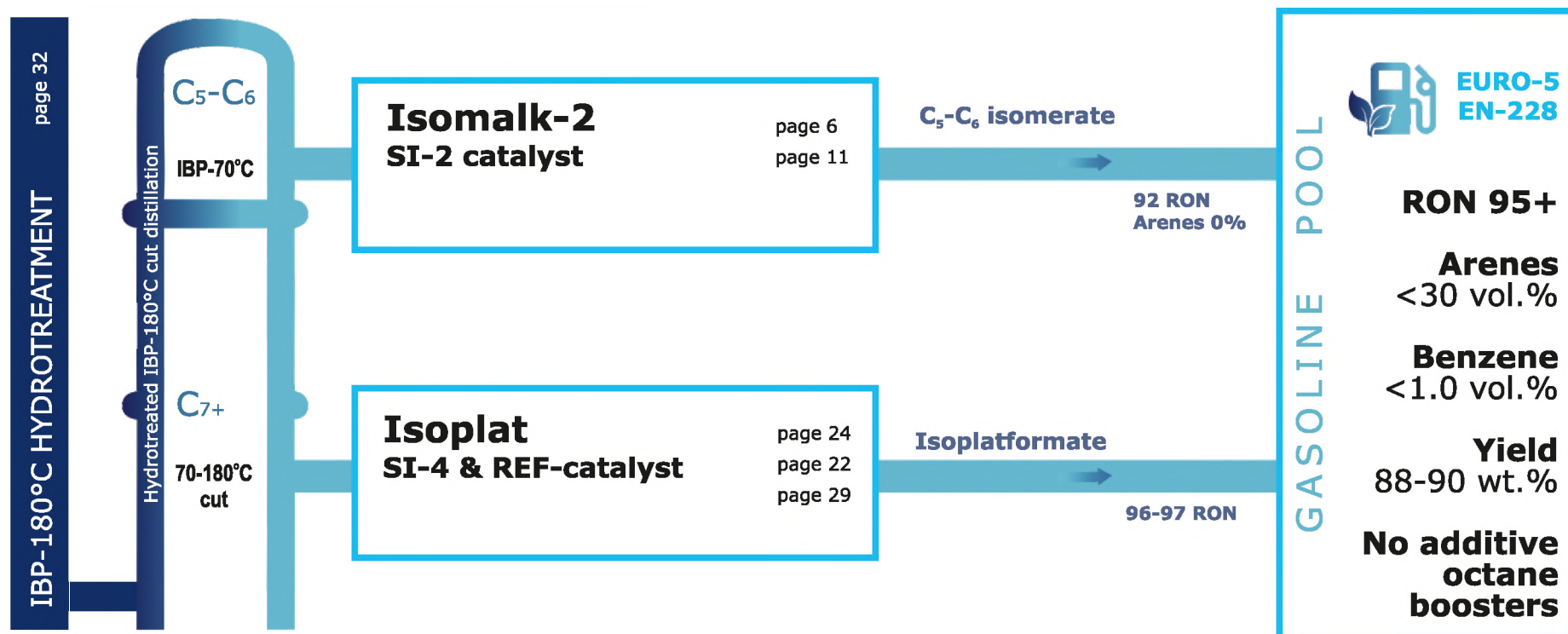


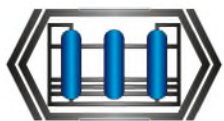
OPTIONS FOR WIDE NAPHTHA PROCESSING TO PRODUCE GASOLINE AS PER MODERN ENVIRONMENTAL STANDARDS





OPTIONS FOR WIDE NAPHTHA PROCESSING TO PRODUCE GASOLINE AS PER MODERN ENVIRONMENTAL STANDARDS





ISOMALK-2 based on SI-2 catalyst



More than 15 years
commercial operating experience



More than 1,000,000 hours
total SI-2 catalyst commercial operation



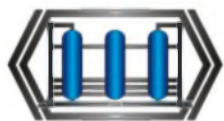
More than 30 references
Russia, USA, EU, China, India, Middle East countries



More than 50% of gasoline
is produced in Russia based on Isomalk-2 technology



Isomalk-2 unit



ISOMALK-2 benefits

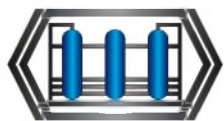
no chlorine agents supply	→	reduced OPEX; no dry gas treatment section
no aggressive reagents	→	low corrosivity of equipment, no wastes for recovery or disposal
no deep drying of feed	→	no feed drying section with molecular sieves
no deep purification of feed to remove sulfur and nitrogen	→	no hydrogenate adsorptive post-treatment section to remove sulfur and nitrogen traces
process stability	→	guaranteed operating performances during the total catalyst service life
high activity and selectivity	→	product yield 98 wt. % with up to 93 RON, minimal energy consumption
no formation of low octane C ₇ + hydrocarbons comparing with the technologies based on chlorinated catalysts	→	higher octane number of total isocomponent comparing with the technologies based on chlorinated catalysts
deeper opening of naphthenic rings	→	lower OPEX due to recycle reduction

up to
93 RON

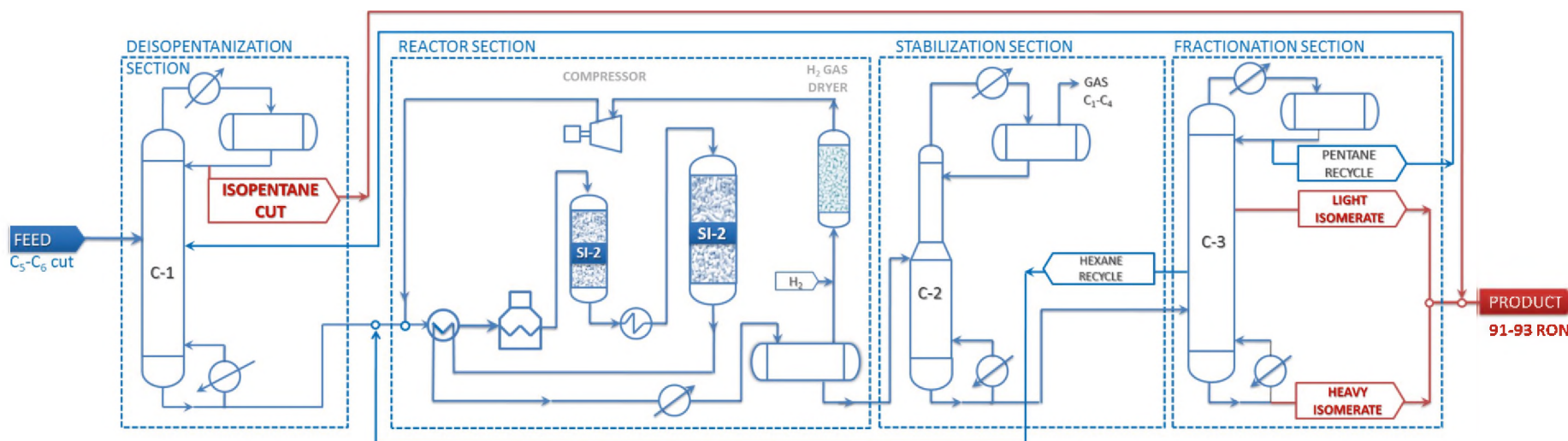
PIN 130+

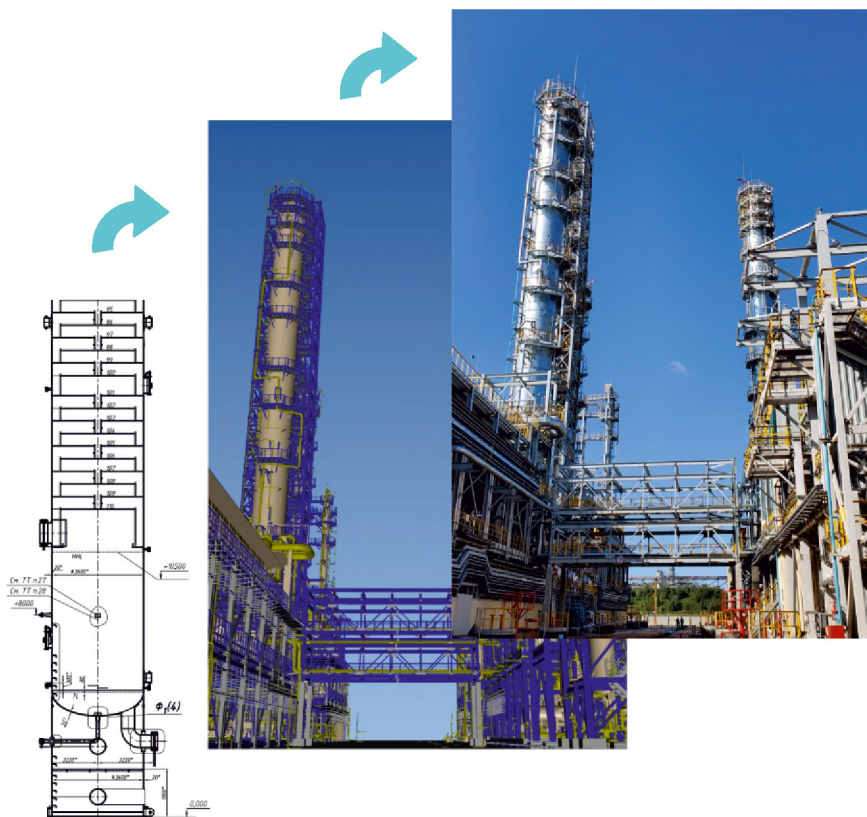
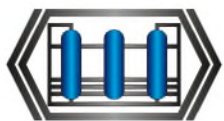
**HIGH
CATALYST STABILITY
TO CATALYTIC POISONS**





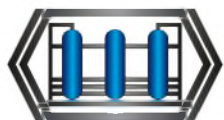
Isomalk-2 isomerization unit
basic process configuration with feed deisopentanization,
recycle of pentanes and low-branched hexanes





Typical execution period
of Isomalk-2 design is 2-3 years

Виды работ	I year				II year			
	I Q	II Q	III Q	IV Q	I Q	II Q	III Q	IV Q
1. Basic Engineering Design	■							
2. Detailed Engineering Design		■	■	■				
3. Equipment ordering and supply		■	■	■	■	■	■	
4. Site preparation		■						
5. Construction		■	■	■	■			
6. Installation			■	■	■	■	■	■
7. Pre-commissioning								■



SI-2 catalyst

**Low-temperature non-chlorinated
oxide catalyst SI-2**

**Much higher tolerance to water, sulfur, nitrogen, and
other catalytic poisons**

comparing with chlorine-containing catalysts

Service life - more than 12 years

Achieved catalyst service life - 14 years

Ability to regenerate - 8-10 regenerations
without activity loss

Catalyst service cycle is more than 6 years provided
that technology requirements are observed

Process upsets do not lead to irreversible activity loss

High isomerization activity and selectivity performances
superior to those of chlorinated catalysts

Tolerance to fluctuations of feed rate

SI-2B catalyst

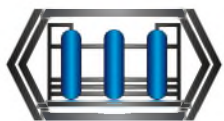
**advanced modification
of commercially proven SI-2 catalyst**

It is created specifically for change-out in the units
based on chlorinated catalytic systems.

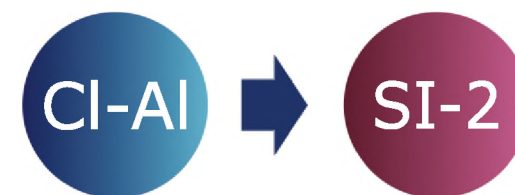
**Complete refusal
of using chlorinating agents**

**Energy savings
over 20%**

Lower risks



Experience of isomerization unit conversion from chlorinated to SI-2 catalyst

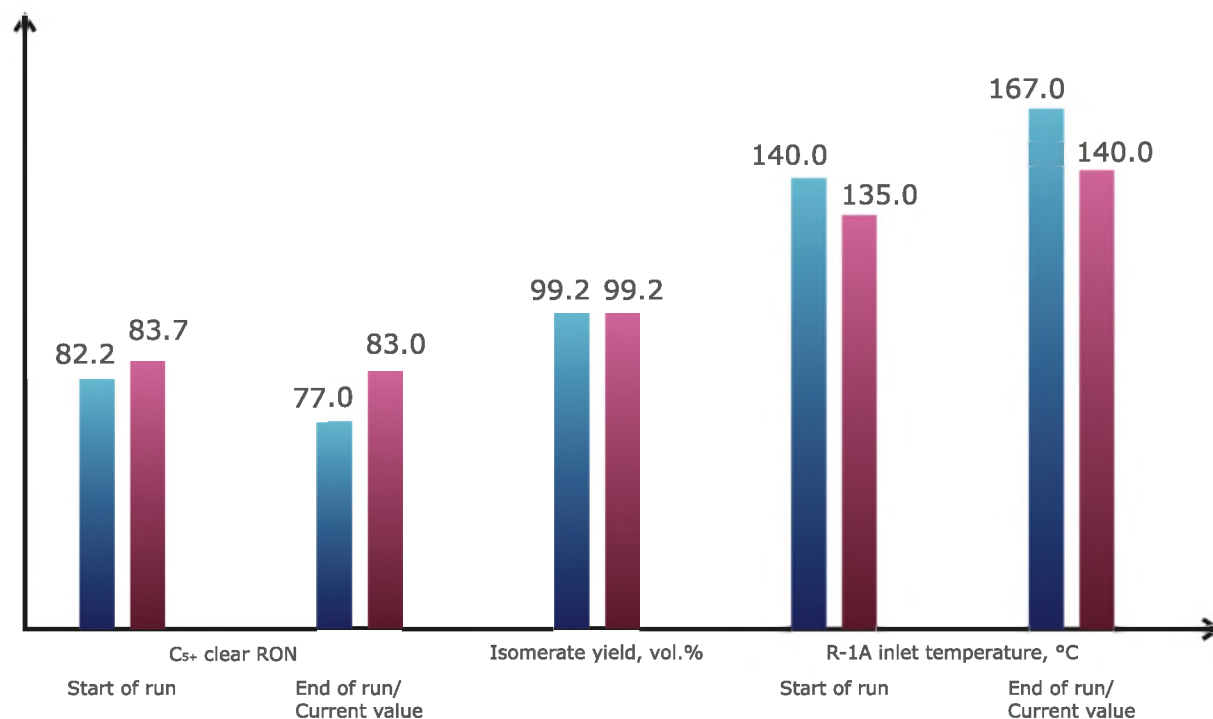


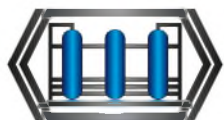
More than 12 years
expected service life of SI-2 catalyst

5 years
current service life of SI-2 catalyst

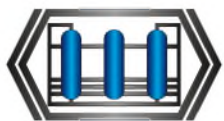
Reduced energy costs

No corrosion and caustic wastes
in the unit





Parameter	Isomalk-2 SI-2/SI-2B (oxide)	Chlorinated catalyst technologies
Reactor section inlet temperature, °C	120 - 160	120 - 160
First reactor inlet pressure, MPa	2.5 - 3.5	3.2 - 3.6
Feed rate, hour ⁻¹	2.0 - 3.5	1.0 - 1.5
H ₂ /HC molar ratio	1.5 - 2.5 : 1/0.07-0.30 : 1	0.07 - 0.25 : 1
Maximum RON of total isocomponent	up to 93	up to 92
Catalyst service life, years	more than 12	4-5
Ability to regenerate	yes	no
Feed adsorptive post-treatment to remove water, sulfur, and nitrogen impurities	no	yes
Chlorinating reagent supply	no	yes
Tolerance to breakthrough of catalytic poisons	recoverable activity	irreversible deactivation
Sensitivity to H ₂ O impurities, ppm	up to 5	up to 0.05
Caustic treatment products, caustic wastes	no	yes
Risk of corrosion product	no	yes
Relative OPEX as compared with Isomalk-2	1.0	1.2



ISOMALK-3



Producing valuable feed

for MTBE synthesis: > 99 wt. % purity isobutane



Eco-friendly technology

no dangerous reagents



Robustness and simplicity

significant reduction in isobutane production cost

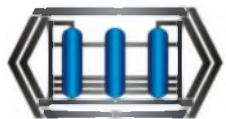


Proved solutions

4 operating units,
including one of the most high-capacity units in the world
(Sinopec Jinling Petrochemical, 480 KTA)



Isomalk-3 unit,
Sinopec Jinling Petrochemical
Nanjing, China, 2019



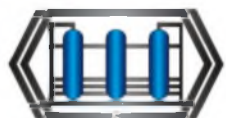
ISOMALK-3 over SI-3 catalyst

<u>no chlorine-containing reagent supply</u>	➡ no dry gas treatment section
<u>no aggressive reagents</u>	➡ low corrosivity of equipment, no wastes that require disposal or landfilling
<u>no deep purification of feed to remove sulfur and nitrogen</u>	➡ no hydrogenate adsorptive post-treatment section to remove sulfur and nitrogen traces
<u>process stability</u>	➡ guaranteed operating performances during the total catalyst service life
<u>catalyst with doubled service life</u>	➡ SI-3 catalyst service life is 8-10 years
<u>high robustness</u>	➡ stable catalyst activity even after process upsets

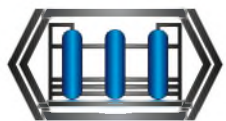
**purity
iC₄H₁₀ > 99%**

**HIGH
CATALYST STABILITY
TO CATALYTIC POISONS**

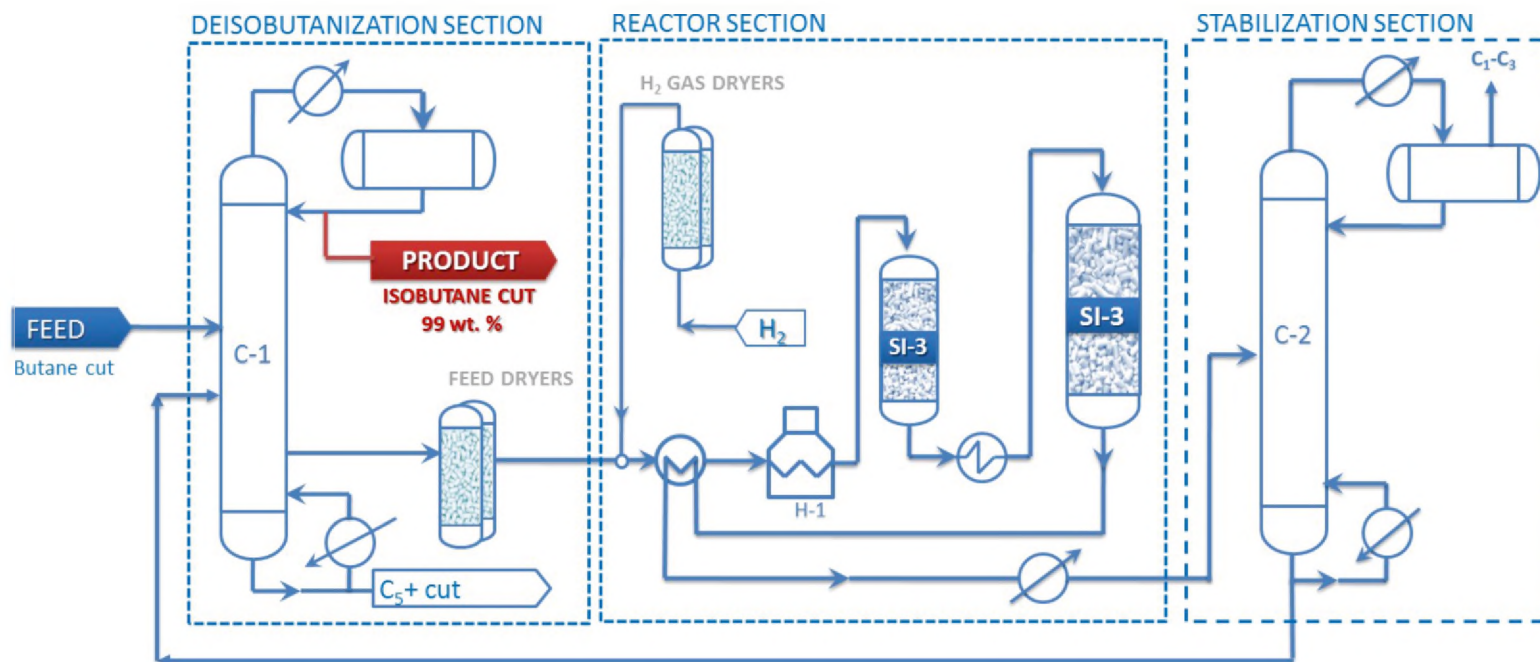
**UP TO 20%
ENERGY SAVING**

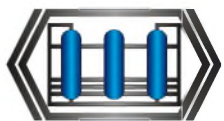


Parameter	Isomalk-3 SI-3 cat.	Technologies over chlorinated catalysts
Adsorptive post-treatment stage	yes	yes
Process temperature, °C	160-210	160-210
Pressure, MPa	1.5-2.0	2.5-3.2
Feed rate, hour ⁻¹	6.0-8.0	6.0-8.0
H ₂ :butane molar ratio	0.07-0.15	0.07-0.15
"Once-through" conversion of n-butane, %	50-55	55-60
"Once-through" yield of C ₃ + hydrocarbons, wt. %	99	99
Total service life of the catalyst, years	8 - 10	2-4
Catalyst sensitivity to feed impurities	mild	high
Effect of moisture breakthrough on the catalyst	recoverable activity	complete deactivation
Ability to restore the catalyst activity	yes	no
Chlorine compounds supply	no	constant
Caustic treatment of acid gas	no	yes
Wastes requiring special handling	no	yes
Chlorine impurities in the product	no	yes



ISOMALK-3. Process configuration





ISOMALK-3. Implemented small-scale projects



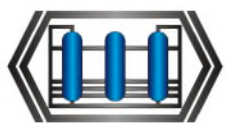
Isomalk-3 unit,
China

Rated capacity – 30 KTA



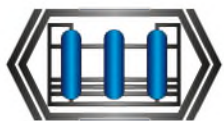
Isomalk-3 unit,
China, 2018

N-butane isomerization
reactor section feed capacity - 30 KTA



ISOMALK-3. Large-scale projects





ISOMALK-4



Increase of motor gasolines production
reduced aromatics



Environmentally friendly technology
no hazardous chemicals



Technology reliability and simplicity
no proprietary equipment



Promising technology
no world analogues





ISOMALK-4 - promising technology for C₇ cut isomerization

increase of isomerate share
in IBP-180°C cut processing



production of additional amount of non-aromatic
motor gasoline component with high octane number

improvement of reformers operating
performances



increased reformat yield;
< 1.0% benzene in reformat

process stability and simplicity



equipment implementation is common to Isomalk-2

high activity and selectivity of the
process



increase RON of C₇ cut
up to 85 RON with 95% yield

Isomalk-4 technology is flexible and
suitable for small- and large-scale
refineries



applicable in a wide capacity range

possible implementation through
revamp of existing capacities

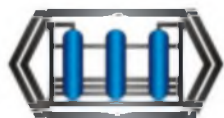


low CAPEX

up to **85 RON**

Yield
up to **95%**

**HIGH
CATALYST STABILITY
TO CATALYTIC POISONS**



SI-4 catalyst

Low-temperature oxide

**Tested and ready
for commercial introduction**

Service life is 8-10 years

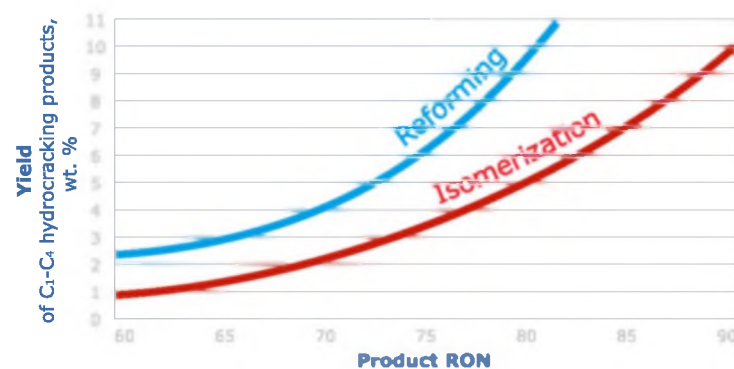
Ability to regenerate
Catalyst service cycle is more than 6 years
provided that technology requirements are
observed

Stable catalyst activity even after process upsets

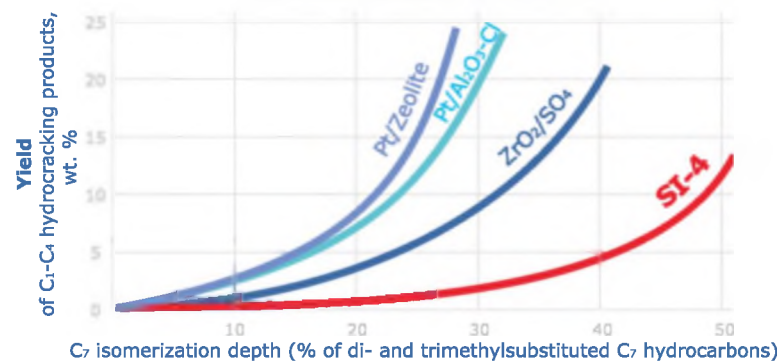
**High tolerance to water, sulfur, nitrogen, and
other catalytic poisons**

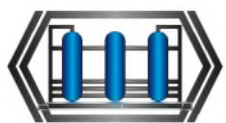
No chlorinated agents and caustic wastes

70-105°C Cut Reforming VS Isomerization

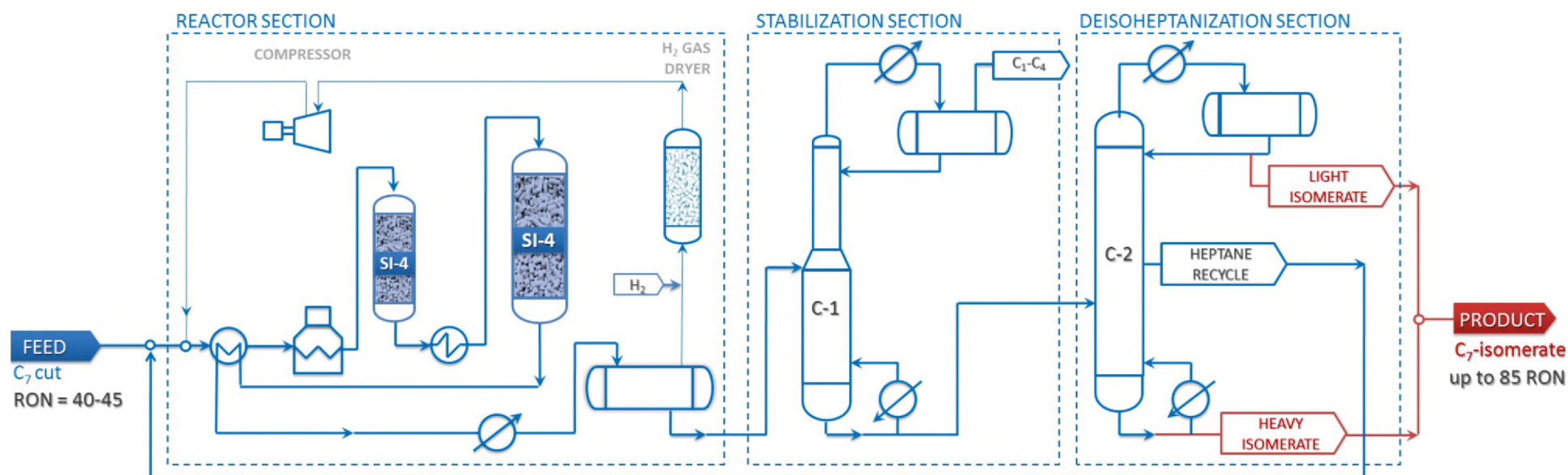


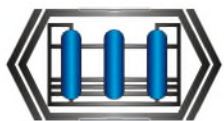
C₇-Hydrocarbons Isomerization Selectivity Over Different Catalysts





ISOMALK-4 - basic process configuration with recycle of low-branched heptanes





ISOPLAT - efficient processing of 70-180°C cut

Up-to-date development

no world analogues

Combination of isomerization and reforming technologies

increased product yield, low aromatics

CAPEX and OPEX optimization

common compressor, cooler, separator, and stabilization column for isomerization and reforming processes

Possible implementation in the existing reformers

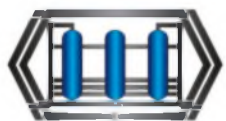
through revamp

High-quality product

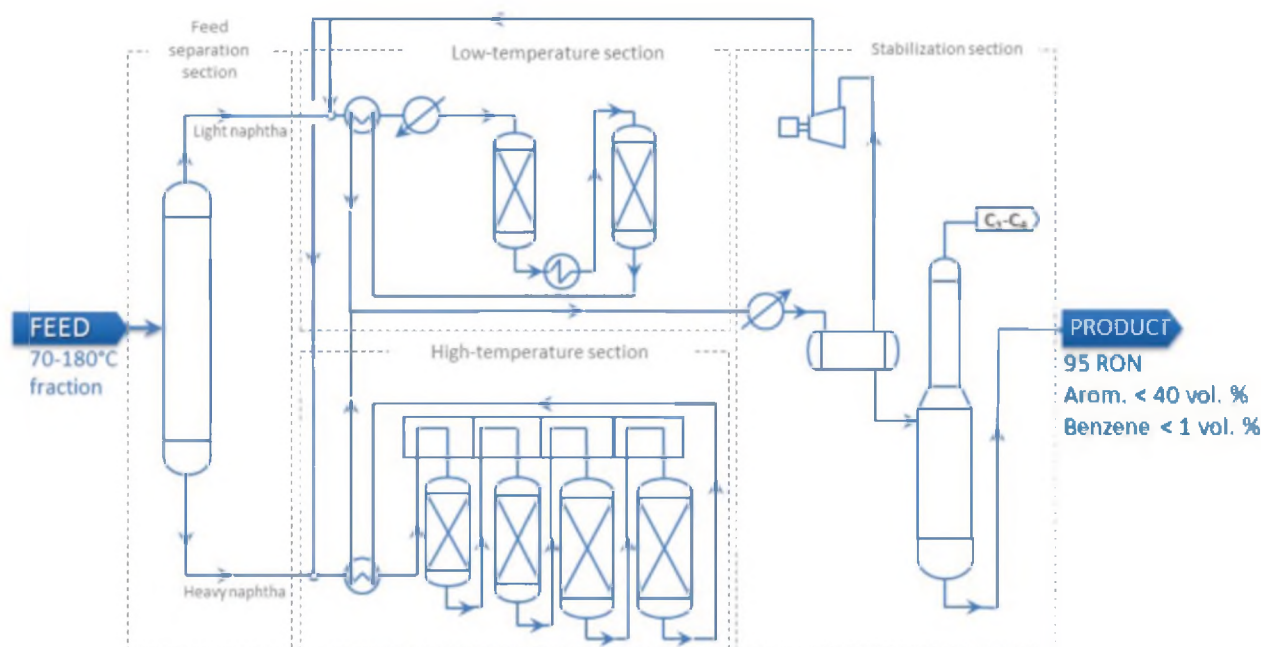
SI-4
isomerization catalyst



REF
reforming catalyst



ISOPLAT basic process configuration



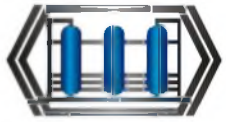
Light naphtha Isomerization

over SI-4 catalyst
in separate units or combined
sections
with reformer



Heavy naphtha Reforming

reforming catalysts providing higher
iso-hydrocarbons/low-octane
straight-chain hydrocarbons ratio



Reforming CCR over RC-catalysts



Patented Technology

commercial production up to 1,000 tons/year



**Compatibility with most
of commercial CCR catalysts**

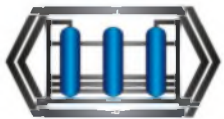


Three-party control of production process
provides high quality of products

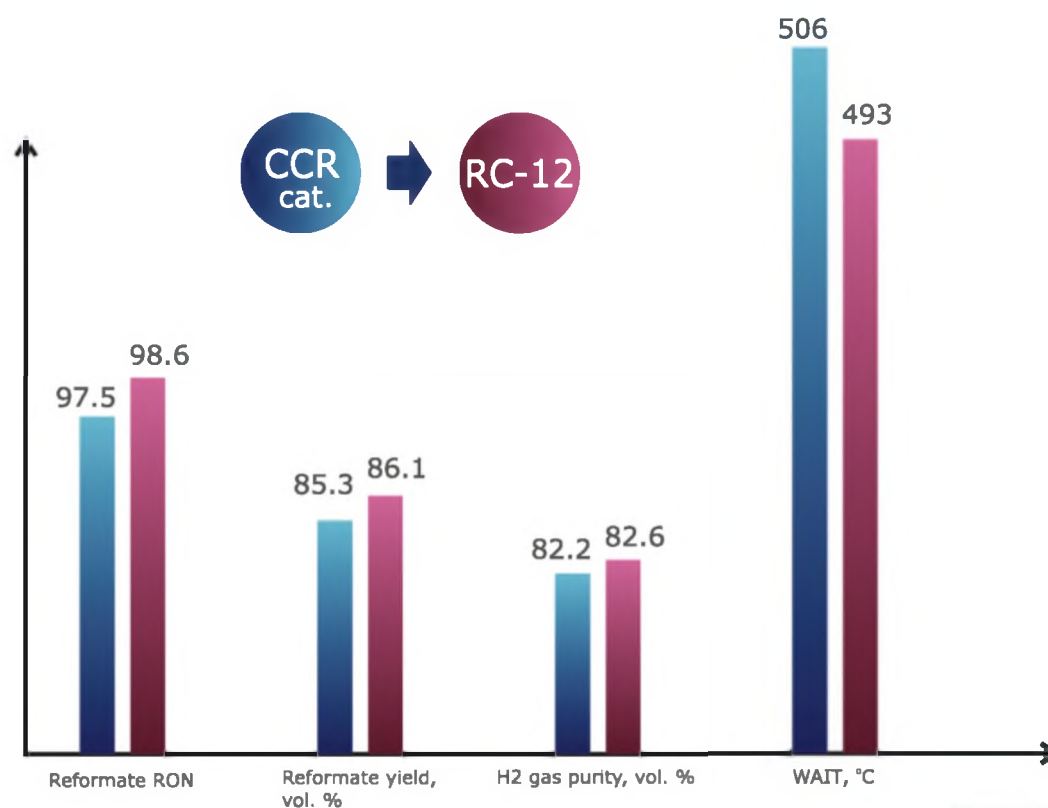
RC-catalyst

**highly active catalyst
for aromatic component
production**

**with maximum
yield and RON**



CCR unit conversion to RC-12 catalyst (Middle East)

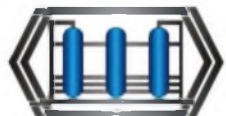


Maximal C₅+ and hydrogen yield
due to high selectivity

Severe operation mode
low coke formation

Process operation flexibility

Long effective service life
minimal decrease of surface area;
high mechanical strength,
no attrition and fines



REF^{Ultra}, REF-125, REF-130 reforming catalysts for fixed-bed reformers

High catalyst stability

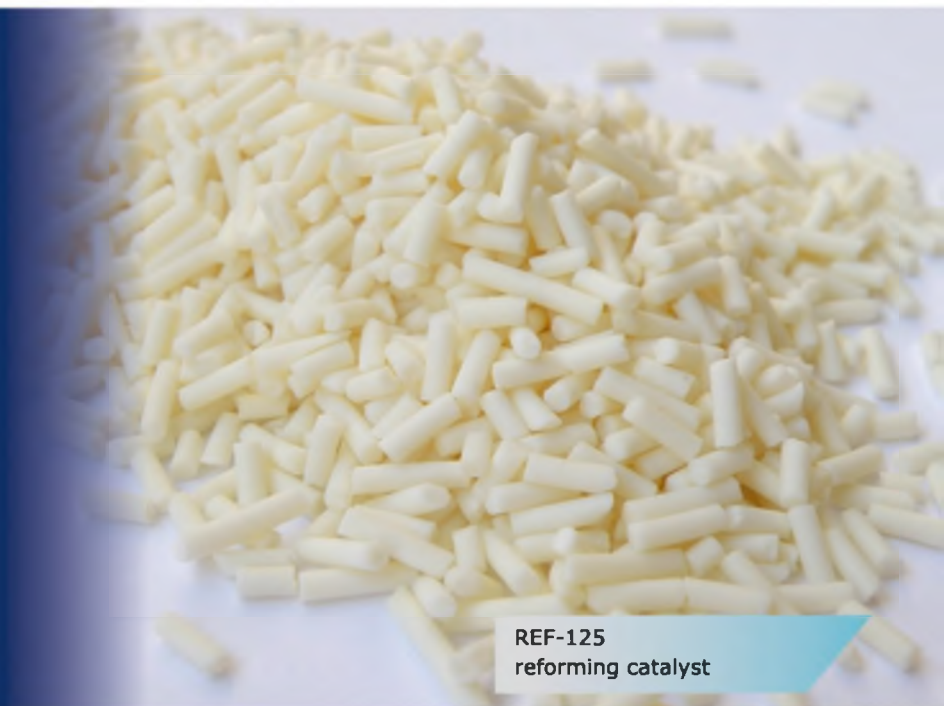
Catalyst operating
service cycle up to 4 years;
possible operation at low pressure

Up to 99 RON reformat

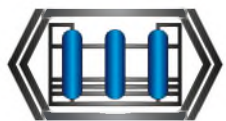
Reformat yield is higher by 1 wt. %
at comparable operating conditions

Increased hydrogen yield

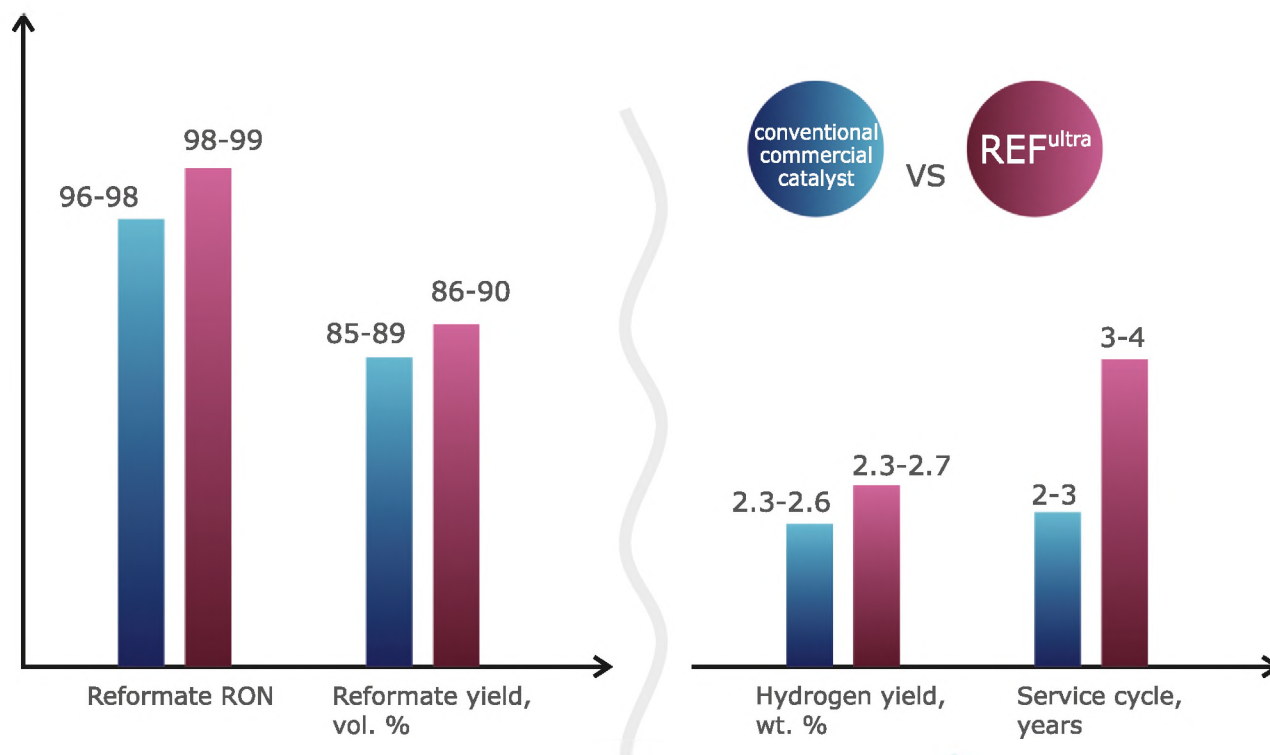
due to higher operational stability and selectivity



REF-125
reforming catalyst

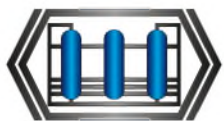


REF^{Ultra}, REF-125, REF-130 reforming catalysts for fixed-bed reformers



More than
60 years

SIE Neftehim
experience
in reformers
operation



Catalysts



Catalyst production at proprietary commercial facility

Nizhegorodskie catalysts, LLC factory (Nizhniy Novgorod, Russia)
under the license of SIE Neftehim, LLC



Supplies and warranty service

are provided by the Licensor - SIE Neftehim



Any quality deviation of the catalyst is eliminated

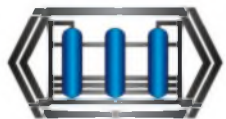
parallel quality control of each produced batch
in the laboratories of Nizhegorodskie catalysts and SIE Neftehim



24/7 pilot tests of each catalyst batch

with the duration of more than 200 hours





IK-112 xylene isomerization catalyst

High conversion performances
in terms of ethylbenzene

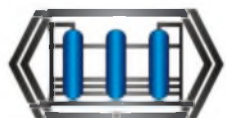
Low losses
of target C₈ aromatics

High activity
operation at feed rate up to 6.0 h⁻¹

Increased stability

IK-112

**highly active
Pt-containing
catalyst
to produce
ortho- and paraxylene**



DS-catalysts - naphtha hydrotreatment

**New generation
of catalysts**

DS-20 (NiMo)

DS-21 (CoMo)

DS-120

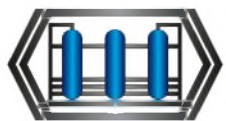
**high stability
comparing with previous modifications**

**Necessary feed pre-treatment
for naphtha isomerization
and reforming units**

5 commercial units
commercial experience

0.1-0.5 wt. ppm
residual content of sulfur and nitrogen
in hydrogenate

280-320 °C
operating temperature range



MCat-catalysts CO and CO₂ methanation

catalyst

MCat-17

high stability
no need to regenerate
service life > 10 years

**Comprehensive hydrogenation
of CO and CO₂**

**Catalyst activity
is recoverable**

Operation at low temperatures

HCat-catalysts benzene hydrogenation

catalyst

HCat-18

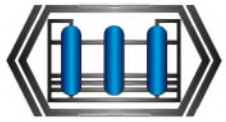
high stability
no need to regenerate
service life > 10 years

Comprehensive hydrogenation of benzene
benzene hydrogenation depth is much higher than that
of conventional Pt-alumina hydrogenation catalysts

**Increased tolerance
to sulfur breakthrough in feed**
reliable protection of the main catalyst in isomerization
units with pre-hydrogenation sections

Low operating temperature
>90°C

Commercial production



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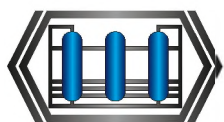
Catalytic Technologies Development
& Implementation

Services

- Licensing
- Basic Engineering
- Detailed Engineering
- Licensing support of Detailed Engineering and construction
- Equipment supply
- Catalyst production and supply
- Unit start-up and operation support



Isomalk-2 unit,
China



Our competencies

24/7 development of new catalysts and technologies
in proprietary research laboratory
Krasnodar, Russia

**Proprietary production facility
with modern process equipment**
Nizhniy Novgorod, Russia

Constant three-stage production quality control
only superior quality products

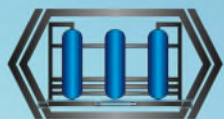
Individual customer-oriented approach
Basic Engineering is prepared in SIE Neftehim's head office;
each project is adapted for a specific production and
customized

Subcontractors work control

We work only with the skilled and job-proved subcontractors
for preparation of engineering and design documentation

Technical support within the total licensed period

- constant compliance control of design and construction works in terms of technology requirements;
- our skilled professionals are involved in pre-commissioning works;
- customer personnel training for safe and effective unit operation;
- continuous monitoring, phone and e-mail consultations



SIE NEFTEHIM, LLC

350007, Russia, Krasnodar,
Zakharov st., 4
+7 861 203-20-20
info@nefthim.ru

nefthim.com

2020

