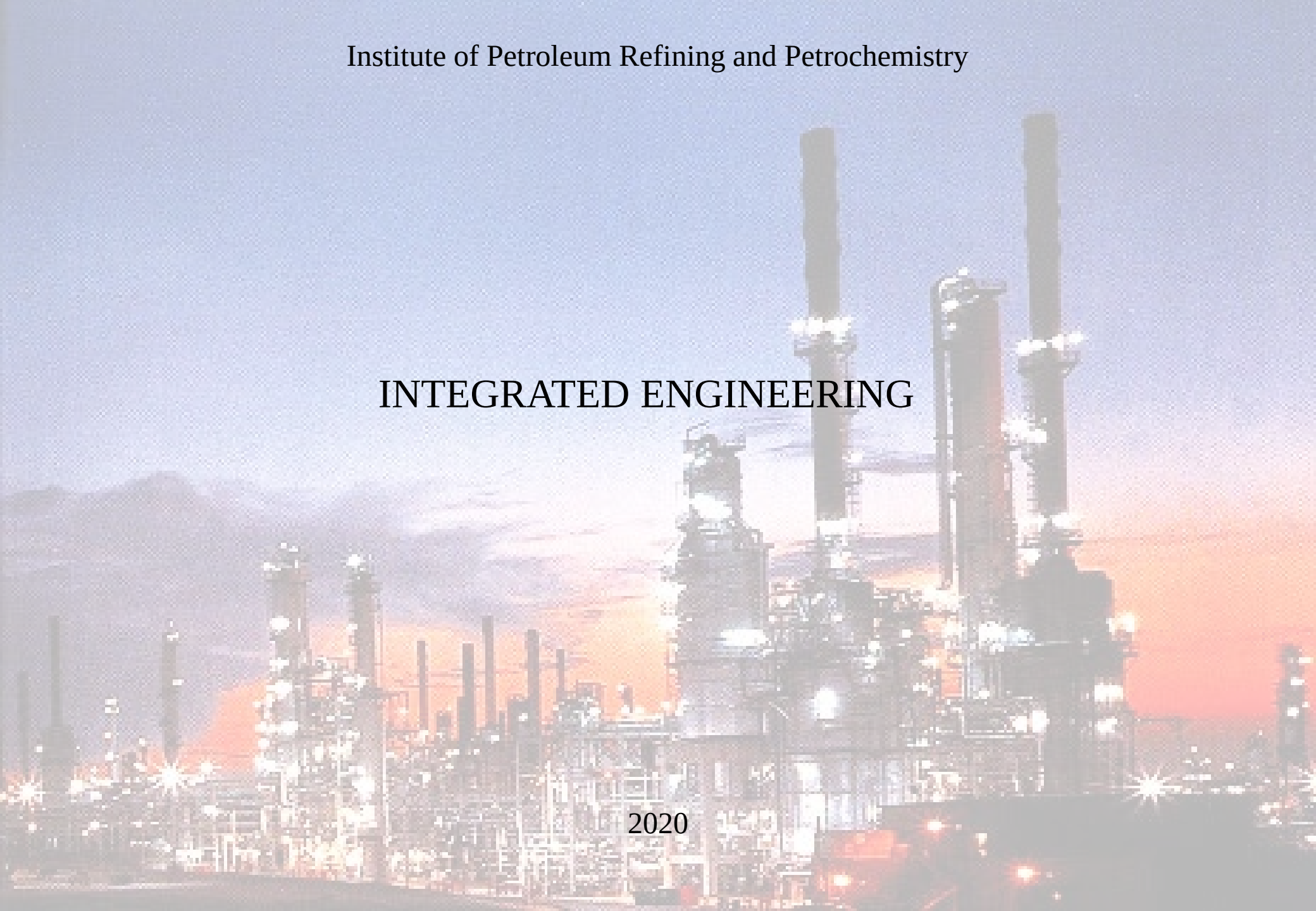
Institute of Petroleum Refining and Petrochemistry



INTEGRATED ENGINEERING

2020

Engineering center competence

- The study of raw materials for the selection of optimal processing technology
- Technological audit of all oil refinery units
- Development of proprietary technologies to increase processing efficiency
- Granting own licenses
- Conceptual preliminary research and master development plans
- Computer aided design, project data management (PDM) and database management using the AVEVA PDMS and AVEVA NET Portal software products
- Process Engineering (PED)
- Turnkey construction of facilities
- Project Advisory Management (PMC) and customer training

The main topics of work

- Research and complex schemes of oil and gas condensate processing
- Preparation of oil for transportation and processing
- Preparation and processing of associated petroleum gas
- Low-tonnage oil and gas condensate processing complexes
- Rectification of oil, oil products and gas condensates
- Catalytic processes for the production of motor fuels
- Processing of oil residues (delayed coking, visbreaking, thermal cracking, deasphaltization, demetallization)
- Production of oil bitumen, pitches, sintering additives
- Calcination of petroleum coke
- Production of oils and lubricants
- Gas purification processes, processing of hydrogen sulfide into elemental sulfur
- Water supply, sanitation and treatment of waste water and gas emissions
- Oil sludge and waste oil processing
- Production of corrosion inhibitors and ASPS, lubricating and drilling additives, additives and modifiers for road bitumen, bitumen mastics, emulsions and compositions
- Automation of technological processes and enterprises

Reference-list

	Name	Technical-economic feasibility study/calculation	Licenses/basic projects	Construction projects	Reconstruction projects
Primary processes and processing of residues	Rectification of oil, gas condensates and their fractions	9	3	40	13
	Delayed coking and coke calcining		3	31	9
	Viscosity breaking and thermal cracking	2	8	10	17
	Production of bitumen	7	3	41	11
	Deasphaltization		1	2	4
Secondary processes, gas cleaning	Isomerization and alkylation	1		3	2
	Reforming			1	6
	Production of oils	3	3	7	1
	Elementary sulphur		2	7	3
	Hydrofining of diesel fuels, vacuum gas oil		2	4	12
	Hydrocracking			2	6

Reference-list

	Name	Technical-economic feasibility study/calculation	Licenses/basic projects	Construction projects	Reconstruction projects
Plant offsite facilities and infrastructure	Airport fuel service complex		1	3	3
	Automobile filling stations			3	2
	Plant offsite facilities	2	1	9	4
	Sewage water treatment, sludge utilization	4	4	10	9
Petrochemical processes	Production of monomers	1		3	13
	Production of aromatic hydrocarbons				3
	Production of polymers			4	1
Storage and transportation	Tank farms		2	2	9
	Estacades	2		11	18
	Main pipelines		3	1	7

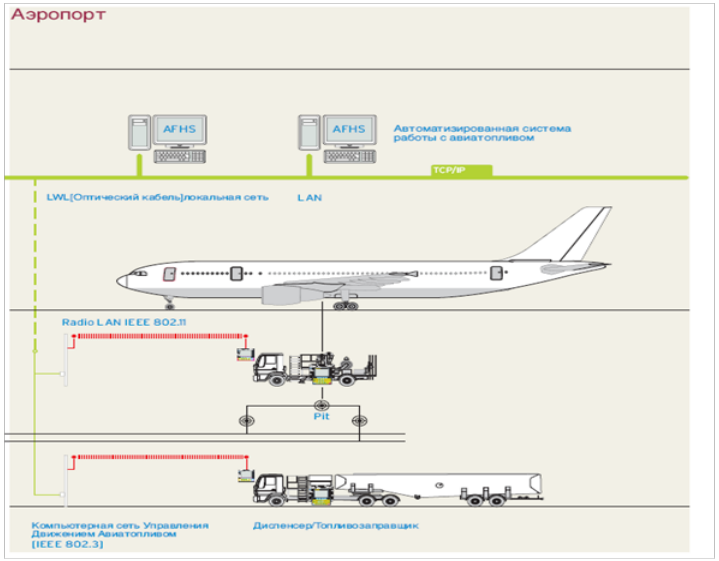
Fuel complexes in airports

Vnukovo:
- Fuel storage complex (tank park, estacade, pumping stations)
- Hydrant system (34 aircraft parking stations)

Sheremetievo:
- Reconstruction of the central pumping fuel complex
- Hydrant system of Terminal D (67 aircraft parking stations)
- Integrated automatized system of the central filling system and tank park

Domodedovo:
- Fuel pipeline from the receiving storage complex to the pumping filling station (5 km under the runway)

Pulkovo:
- Fuel storage complex (tank park, estacade, pumping stations)
- Aircraft fuel dispension stations



ENMAR

Аэропроект

ENKA

M+F Mess- und Fördertechnik Gwinner GmbH & Co

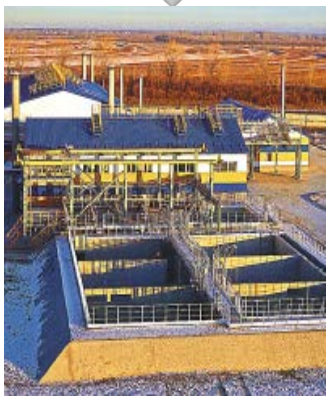
Bovis Lend Lease

ПРОГРЕССТЕХ PROGRESSTECH

JSC Antipinsky refinery construction phase III

Treatment facilities for the entire complex and cooling water supply unit

January 2014

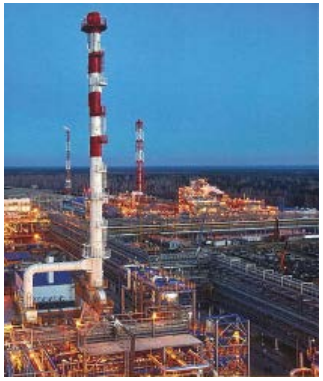


January 2014

ELOU-AT3 – capacity up to 5 MTPA

Diesel fuel hydrotreatment plant (Workflow I) with a capacity of up to 3 MTPA

October 2015



October 2015

Free sulphur production plant with a capacity of 30 KTPA

Hydrogen production plant with a capacity of 25 KTPA

October 2015

General Designer: Institute of Petroleum Refining and Petrochemistry

Electrical desalting plant unit-3 (3,7 mln tons/year)

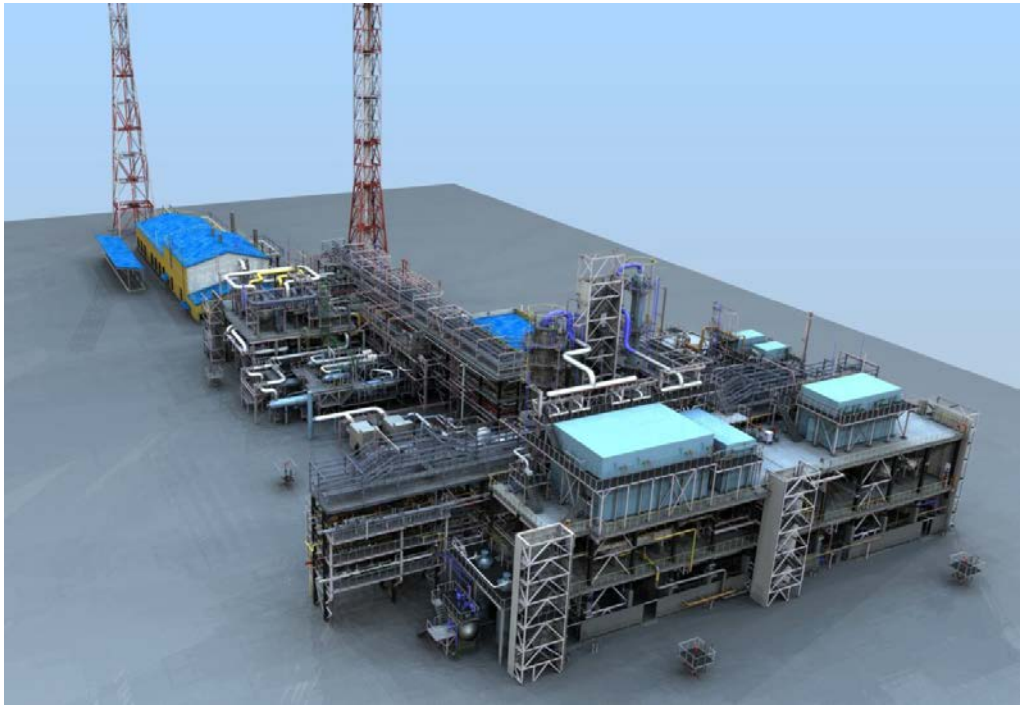
- Flexible scheme for the processing of diverse types of oil
- Acquisition of liquefied gases
- Gasoline stabilization
- Ecological impact lower by 20 %

Basic project: Institute of Petroleum Refining and Petrochemistry

Designing: Institute of Petroleum Refining and Petrochemistry "NefteKhimEngineering"

Production of elementary sulphur unit (30 th. tons/year)

Antipinsky oil-processing plant (Tyumen)



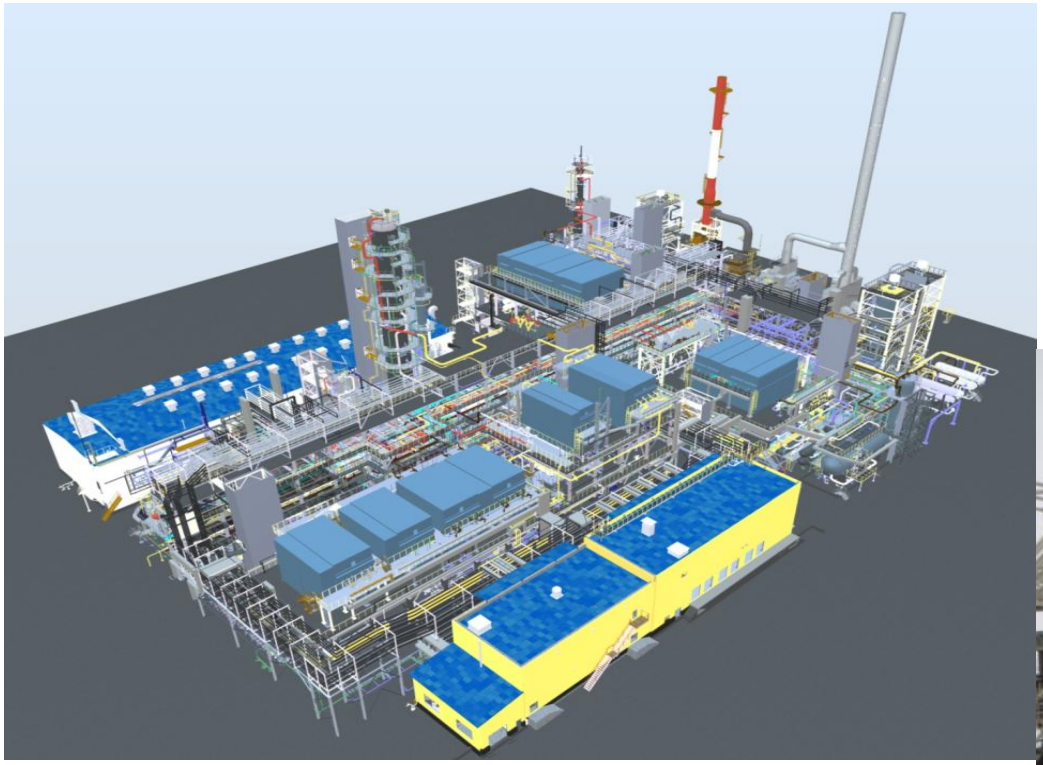
- Degree of conversion - 98%
- Based on the use of Russian catalysts

License holder: Institute of Petroleum Refining and Petrochemistry

Designing: Institute of Petroleum Refining
and Petrochemistry
“NefteKhimEngineering”

Diesel fuel hydrofining unit (2,6 mln/year)

Antipinsky oil-processing plant (Tyumen)



License-holder: Haldor Topsoe

Designing: Institute of Petroleum Refining
and Petrochemistry
“NefteKhimEngineering”

Delayed coking unit (2 mil tons/year)

“Taneko” company (Nizhnekamsk)

- Furnace overhaul interval – rose in 1.5 times
- Atmospheric discharge – reduced by 20 %

License-holder: Institute of Petroleum Refining and Petrochemistry

Designing: “LUKOIL-Nizhegorodniinefteproekt”

Circulation water supply system (12 th. cubic meters/hours)

"Taneko" company (Nizhnekamsk)

- Occupied area is 3-5 times lower than for the analogous units
- Performance efficiency is higher by 25-35 %
- Energy costs are lower by 15 %

Designing: Institute of Petroleum Refining and Petrochemistry

Tar viscose breaking unit (2,4 mln tons/year)

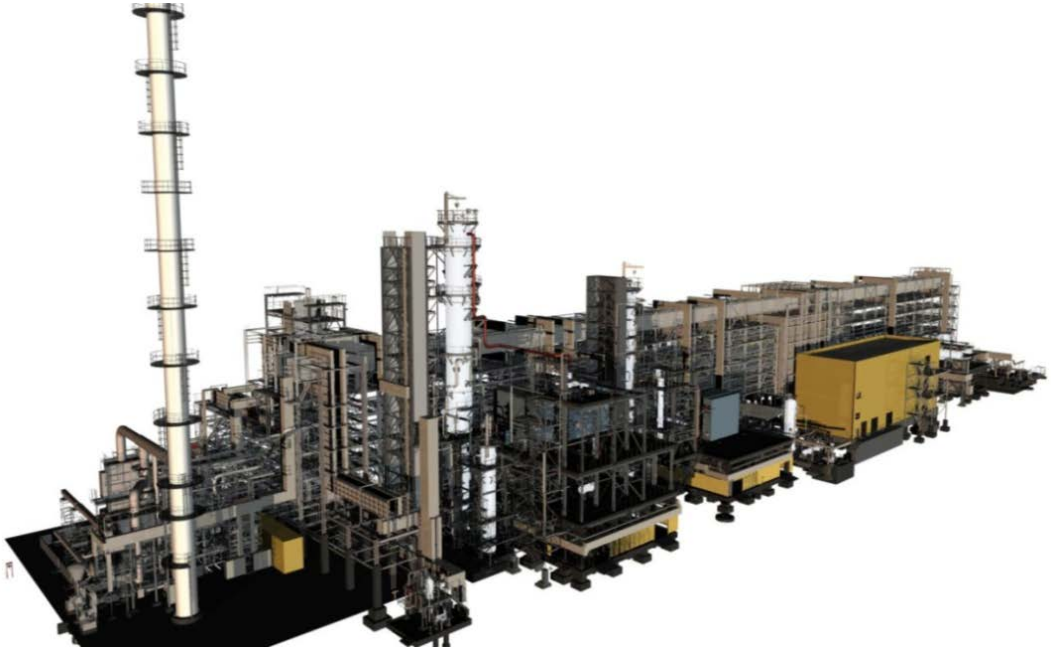
“Taneko” company (Nizhnekamsk)

- The reactor ensures the regime of «ideal displacement»
- Organic turbulator
- Minimization of acid flows

License, basic project, designing, exploitation documentation, supply of the main technological equipment, contract supervision: Institute of Petroleum Refining and Petrochemistry

Isodewaxing and isofishing sections of complex hydrocracking unit (250 th.Tons/year)

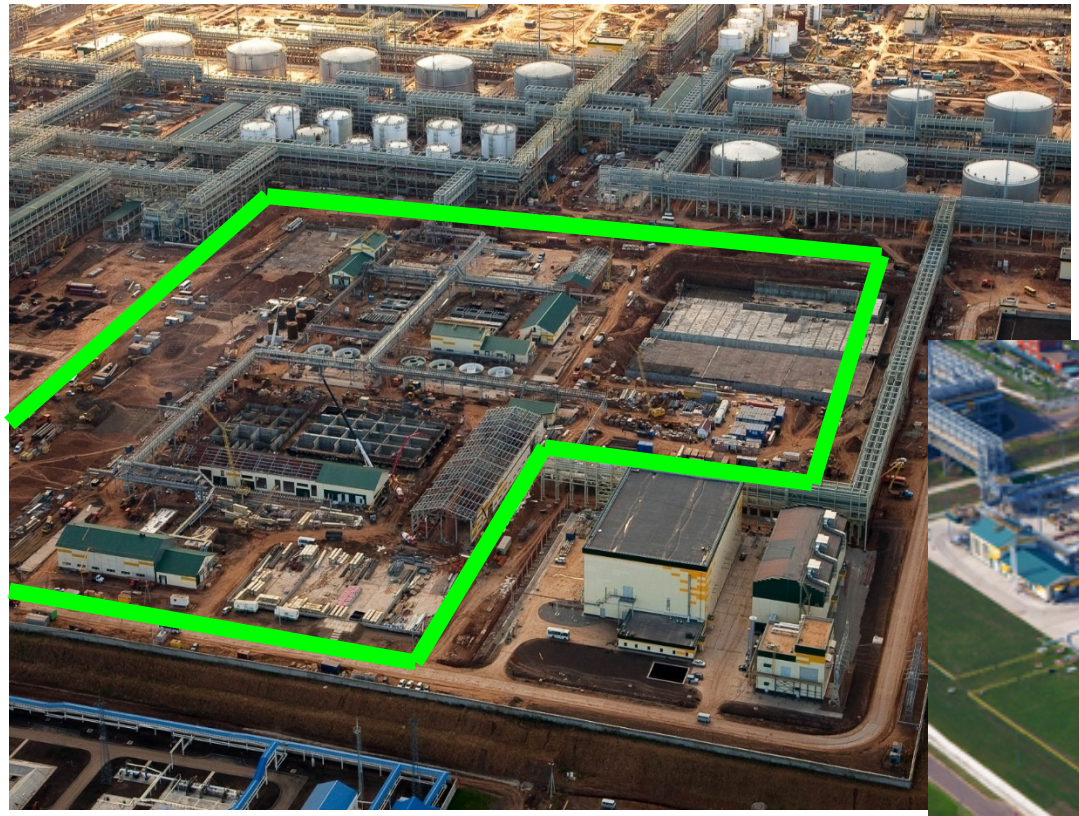
“Taneko” company (Nizhnekamsk)



Basic project: Chevron Lummus Global
Designing: Institute of Petroleum Refining and Petrochemistry

Treatment facilities (2,7 th. cubic meters /hour)

“Taneko” company (Nizhnekamsk)



- Closed cycle of sewage treatment with the zero discharge
- Occupied area is lower than the analogous cases in 4-6 times

Technological solutions and designing:
Institute of Petroleum Refining and Petrochemistry

Treatment facilities (3,5 th. cubic meters /h)

Bashneft-Ufaneftekhim (Ufa)

- Treated water maximum return for production is up to 100 %
- Modern solutions for salt removal and selective heavy metal removal.
- Maximum permissible concentration normative values of the fish farm are achieved without additional treatment unit.

Basic project: GE
Designing: Institute of Petroleum Refining and Petrochemistry

Tar deasphaltization unit (300 th. tons/year)

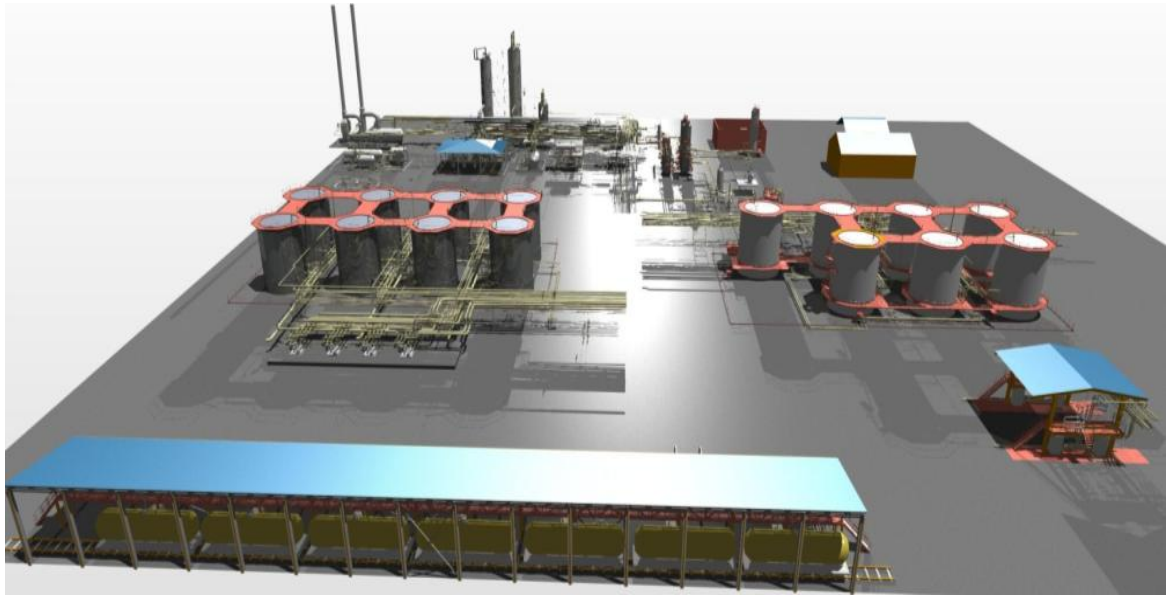
"UFANEFTEKHIM" (Ufa), Reconstruction

- Productivity – higher by 45 %
- The amount of output – higher by 3-4 %
- Specific energy consumption - lower by 40 % (including steam consumption is 5,7 times lower)
- Concentration of hydrogen sulphidein the circulating solvent dropped from 2% to 0,01%
- Reduction of metal intensity to 10 %
- Reciprocating compressors changed to ejector-type compressors

Technology developer: Institute of Petroleum Refining and Petrochemistry
Equipment designer: Institute of Petroleum Refining and Petrochemistry and FGUP "NPP Motor"
Designing: LLC «Bashgiproneftechim»

Bitumen production unit (300 thousand tons/year)

«Gazprom Neftekhim Salavat» (Salavat)



- Air consumption – lower by 35%
- Energy costs – lower by 25%
- Atmospheric discharge – lower by 15%
- Extended the range of productivity and nomenclature

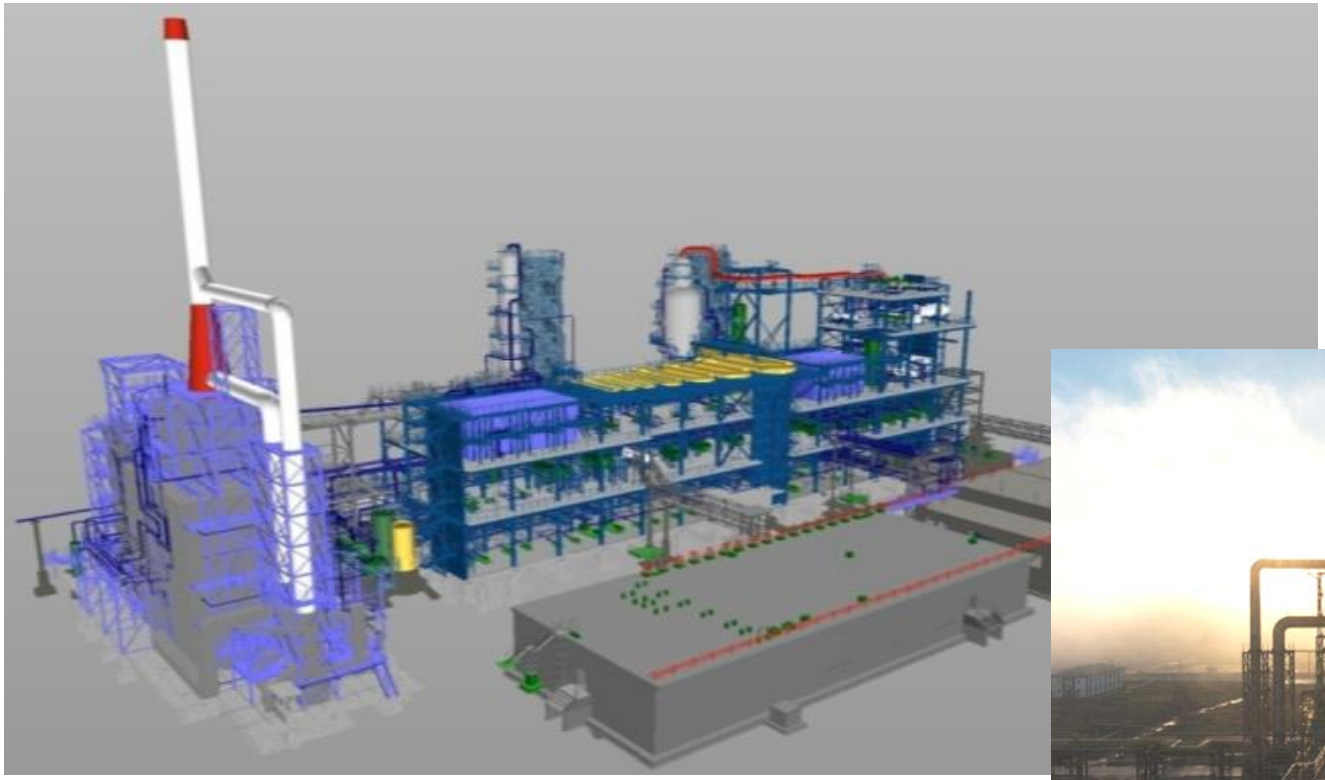
License and basic project: Institute of Petroleum Refining and Petrochemistry

Designing: “Bashgiproneftekhim”
“Vostokneftezavodmontazh”

Construction: “Vostokneftezavodmontazh”

Tar viscose breaking unit (1,5 mln tons/year)

«Gazprom Neftekhim Salavat» (Salavat)



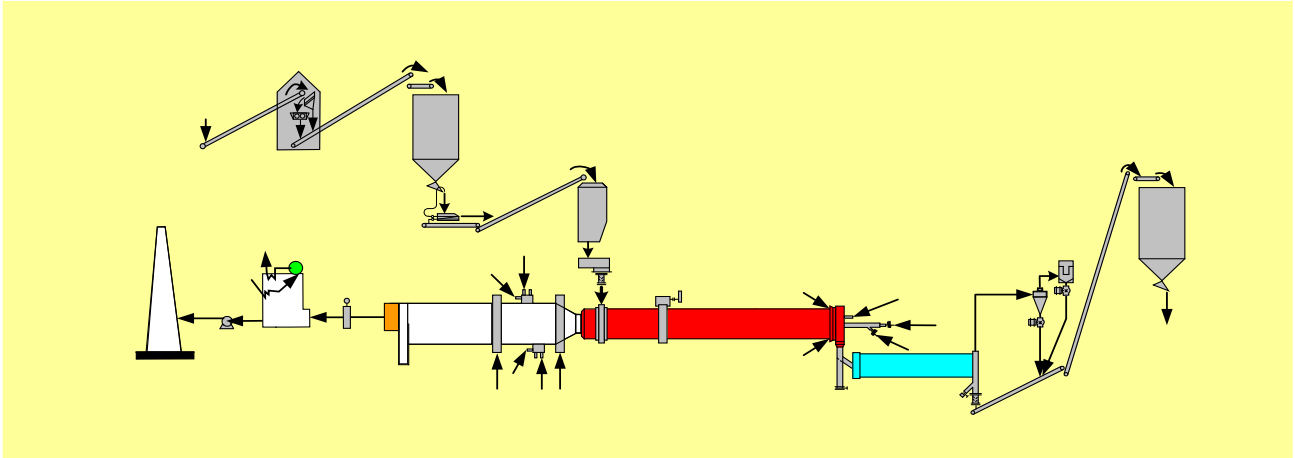
License-holder: Shell Global Solutions
Designing: «Salavatgazoneftekhimproject»
Institute of Petroleum Refining and Petrochemistry
(3D-modelling)

Coke calcining unit (280 th. tons/year)

“Lukoil-Volgograd Neftepererabotka (Volgograd)

- The term of guarantee for the refrigerator system increased in 5 times (no less than 10 years)

Designers of technology and equipment:
Institute of Petroleum Refining
and Petrochemistry



Hydrogen sulphide removal unit (3,8 mln tons/year)

Joint venture of Lukoil-CONOCO PHILLIPS
“Naryanmarneftegas» (South Khylchuyu deposit)

- Highly efficient removal in one stage
- Degree of hydrogen sulfide removal - 99%
- Oil withdrawal to Oil potential - 99%

Basic project, designing: Institute of Petroleum Refining and Petrochemistry

Package delivery, contract supervision:
“Project technology institute NKHP”

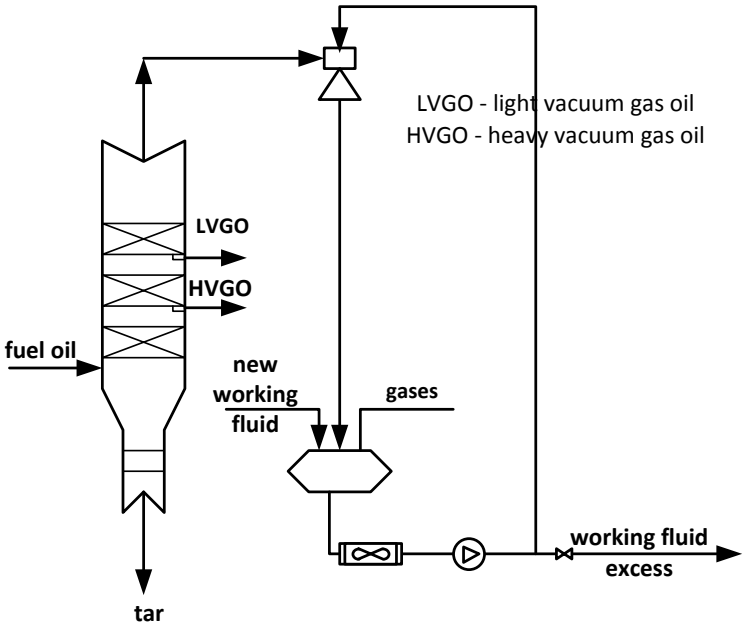
Automatized lubricant-blending unit (70 th. tons/year)

“Gazpromneft - lubricants» (Omsk)

Equipment purveyor: I.S.T. Molchtechnik GmbH

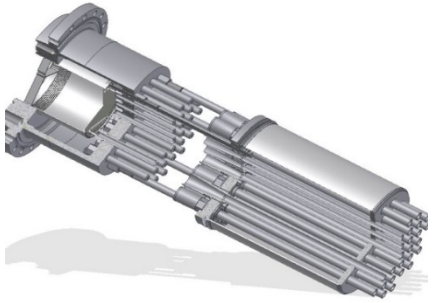
Designing: Institute of Petroleum Refining
and Petrochemistry

Hydro-ejector vacuum system



Comparison of vacuum systems

№	Parameters	Steam-ejector system	Hydro-ejector system	Advantages
1.	Mazut production, tonns/hour	255-270	264-282	▲up to 4,5 %
2.	Pressure at the top of the column, мм Hg	40-60	15-30	▼26-29 %
3.	Steam consumption on ejectors, tonns/year	4814	0	▼100 %
4.	Vacuum gasoil withdrawal, tionns/day	1221	1815	▲48 %
5.	Number of channels, tonns/hour	7,6-8,1	0,1	▼ 98,7 %
6.	Concentration of H_2S in channels, mg/liter	150	5	▼ 96,6 %
7.	Concentration of fractions, boiling away above the temperature 500°C, in tar, %	25	18	▼28 %



Jet liquid-gas ejector for the production of vacuum (working block)

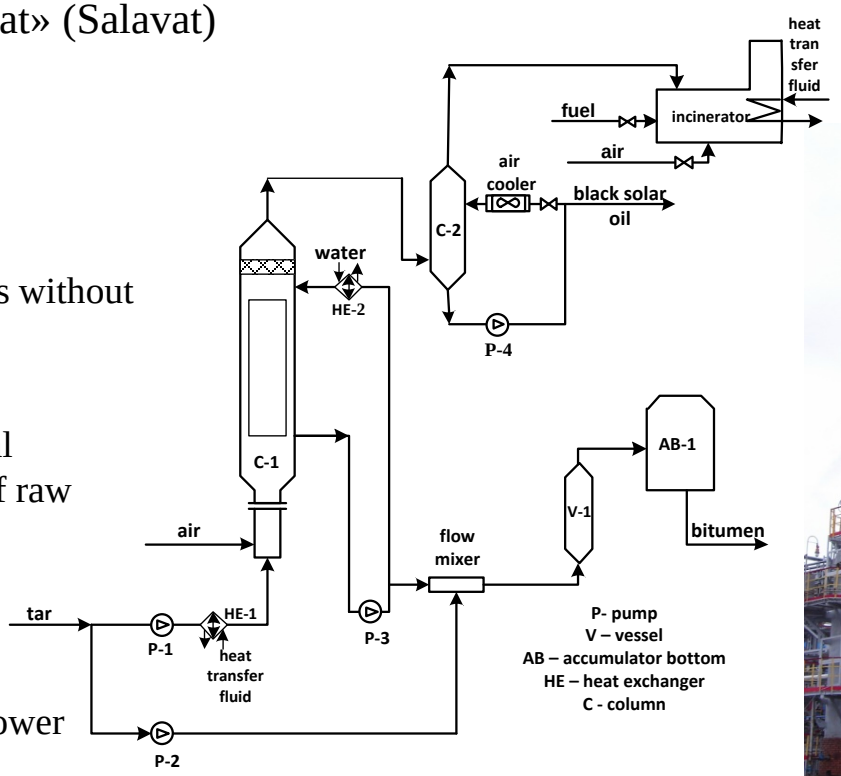
Implemented by “Mari Oil-Refining Plant” (Republic of Mari El)

Designer of technology: Institute of Petroleum Refining and Petrochemistry

Technology of bitumen production

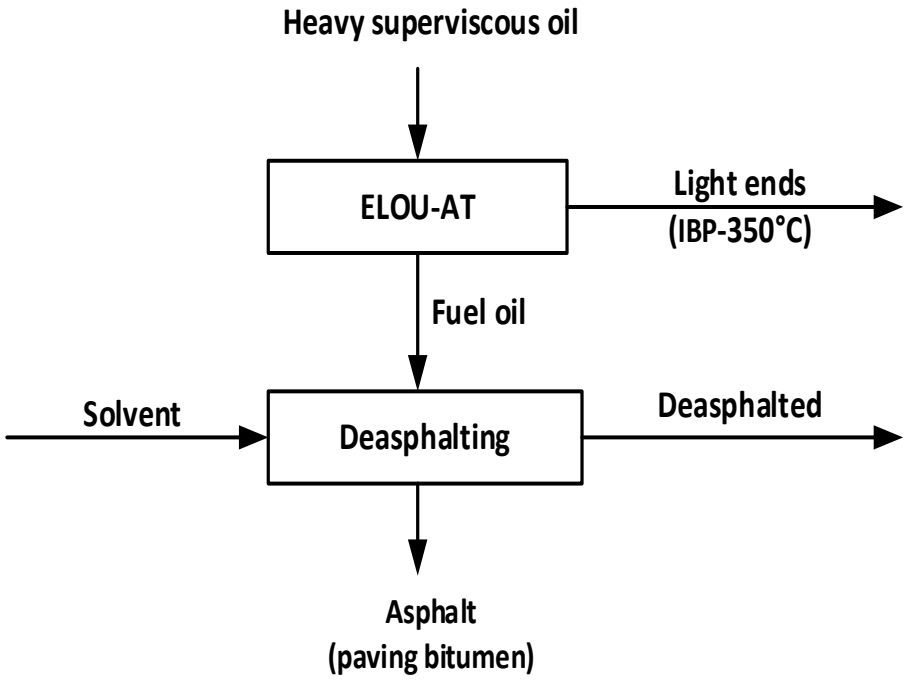
«Gazprom Neftekhim Salavat» (Salavat)

- Production of different bitumens without the change of reactor regime
- Minimal dependence of the final product quality on the quality of raw material
- Energy costs are 25% lower
- Atmospheric discharge is 15 lower



Designers of technology and equipment: Institute of Petroleum Refining and Petrochemistry

Technology of heavy extra-viscous oil refinery



- Possibility for implementation in block format
- Raw material for typical oil-refinery
- Highly-efficient low-cost technology

Designer of technology: Institute of Petroleum Refining and Petrochemistry

Raw material – heavy oil (**100**%)
Density – 936 кг/м^3
Coking capcity – 7,3%
Concentration of sulfur – 2,18%
Viscosity at 50°C – 135 сСт

Products:
1) ***Light distillate (33,6%)***
Density -860 kg/m^3
Concentration of sulfur – 0,79%
Viscosity at 20°C – 4,5 сСт
2) ***Atmospheric gasoil (4,0%)***
Density -901 кг/м^3
Concentration of sulfur – 1,48%
Viscosity at 20°C – 32 сСт
3) ***Asphalt-free oil (36,3%)***
Density -962 kg/m^3
Concentration of sulfur – 2,42%
Viscosity at 100°C – 77 сСт

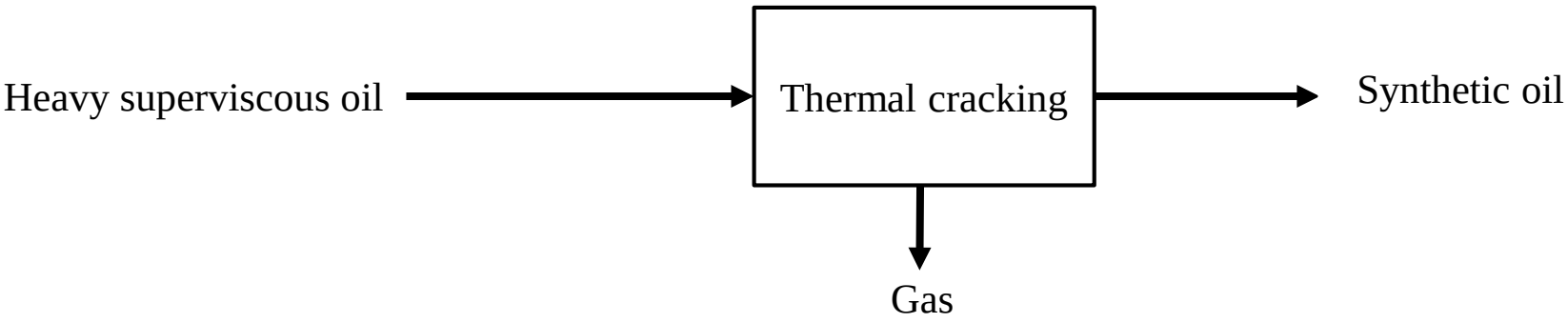
«Synthetic" oil – (73,9%)
Density -906 kg/m^3
Coking capacity – 2,25%
Concentration of sulfur – 1,73%
vanadium – 13 ppm
nickel – 7 ppm
Viscosity at 50°C – 17,6 сСт

4) ***Bitumen of mazut and asphalt mixture (26,1%)***
Density – 1020 kg/m^3
Softening temperature – 44,3°C
Penetration P_{25} – 103 дмм
Extensibility D_{25} – more than 100 sm
$Д_0$ – 6,9 sm
Brittle temperature – 26°C below zero

Technology of heavy extra-viscous oil refinery

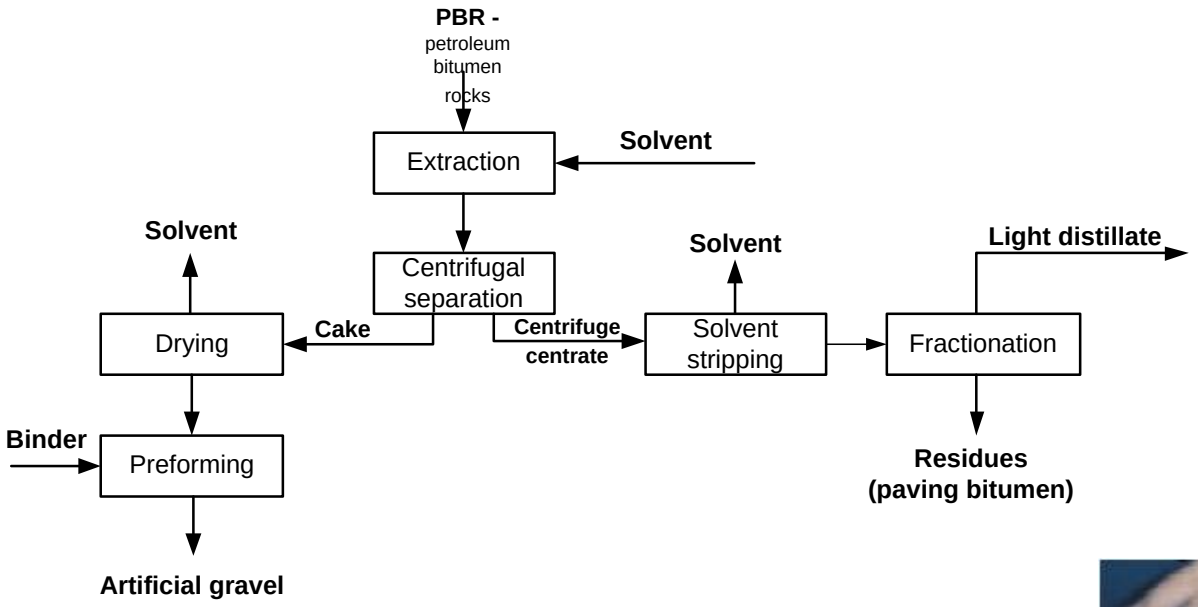
Figures	Gas output, weight %	Total liquid product output, weight %	Losses
Ashalchinsk oil	5,6	92,4	2,0
Camel oil	5,5	93,4	1,1
Russian oil	5,9	93,5	0,7
Yaregsk oil	5,3	93,9	0,8

- High-performance cost-effective technology
- Possibility for implementation in block format
- Raw material for typical oil-refinery



Designer of technology: Institute of Petroleum Refining and Petrochemistry

Technology of oil and bituminous rocks processing



- Waste-free production
- Highly-efficient low-cost technology
- Possibility for implementation in block format
- Feed for typical refinery

Case:
Raw material – oil and bituminous rock (100%)
Concentration of organic mass – 10,0%

Products:
1)Light fraction (0,6%) - «Synthetic» oil – refinery
2) Road bitumen (9,4%) – construction
3) Waste rock –
Highly-pure sand (90,0%) - construction

Designer of technology: Institute of Petroleum Refining and Petrochemistry

Proprietary technology

№	Technologies	Features (Advantages)
Commercially tested technologies		
1	Oil refining from hydrogen sulfide	Hydrogen sulfide stripping with organic agent. Reduction of waste water quantity by 75-80%. Without chemicals
2	Atmospheric-vacuum rectification of oil, gas condensates and oil products	Use of organic evaporator. “Dry” vacuum distillation (without water steam). Reduction of power consumption by 15%. Reduction of effluents by 60%.
3	Precise rectification of oil naphtha and gas condensates	High degree of hot stream heat recovery from 20-30 to 50-60%. Reduced furnace fuel consumption by 60 % and electric power by 0.255 kW/t of oil (with respect to CDU-VDU-6). High concentration of target components in obtained fractions up to 90-95 %. Generation of high-octane (86-87 points by the motor method) component for motor gasolines with benzene contents of below 1% vol. Without gas compression.
4	Atmospheric-vacuum oil rectification as per a 2-column circuit	Reduction of plant’s steel intensity by more than 2 fold as compared to a 4-column circuit. Reduction of water steam consumption, reduction of effluents’ volume.
5	Deep physical stabilization of gasolines and gas condensates	•eliminates the need for alkalization of gasolines, generation of harmful hard-to-decontaminate and recycled effluents; •the contents of hydrogen sulfide and low-boiling mercaptans is reduced in stable gas condensate delivered for refining, which improves the environment and reduces a fire hazard at the oil refinery; •eliminates compression of hydrocarbon gases for their production in liquefied form, raises their production up to 90% of potential; •methods of process mathematical simulation and calculation of thermal physical properties of feedstock components assure high reliability of selection of its conditions and apparatus design.

Proprietary technology

№	Technologies	Features (Advantages)
6	Oil rectification for achieving high gasoline extraction and high diesel fuel flash point	Supply of water steam as stripping agent in a diesel fuel stripping column is eliminated, due to which it is not filled with water.
7	Production of fuel for reactive motors of TS-1 grade from paraffin oil	Provides high fractionation efficiency between TS-1 and related gasoline and diesel fuel fractions. The advantage of TS-1 fuel from paraffin oils is low contents of aromatic hydrocarbons (up to 10 % wt.), total sulfur (up to 0.04% wt.), high density - 785 kg/m^3 and viscosity at 20^0C - 1.4 mm^2/s etc. TS - 1 fuel meet premium grade requirements
8	Vacuum rectification of fuel oil in lubricants' production	Enables to reduce power costs due to lower fuel, electric power and water consumption. Fuel oil distillation in a vacuum column is performed based on the improved technology using regular additives, valved and sieve with knockout drums rectification trays.
9	Deep vacuum fuel oil rectification for producing catalytic cracking feedstock	Enables to extract vacuum gas oil up to 540ºC meeting requirements for catalytic cracking feedstock.
10	Combined environmentally friendly diesel fuel production technology	Production of environmentally friendly diesel fuel with low aromatics contents.
11	Deep vacuum fuel oil rectification for producing catalytic cracking feedstock	Enables to extract vacuum gas oil up to 540ºC meeting requirements for catalytic cracking feedstock.
12	Combined environmentally friendly diesel fuel production technology	Production of environmentally friendly diesel fuel with low aromatics contents.

Proprietary technology

№	Technologies	Features (Advantages)
13	Contact oils and paraffins treatment	Advantages: -high speeds of adsorbed substance diffusion in adsorbent pores; -high specific surface of natural adsorbents; -availability and low cost of natural adsorbents; -no recovery stage; -low process power intensity.
14	Percolation treatment of oils and paraffins	Advantages: -possibility for producing high-quality paraffins for food and medical industry; -use of high-efficient synthetic adsorbents with the possibility for their recovery; -adjustment of process conditions using a wide range of volume velocities; -process continuity in case of connection of percolator apparatus in series.
15	Vacuuming systems (water- and steam ejector, combined)	Vacuum up to 10-20 mm Hg. Deep extraction of vacuum distillates.
16	Solvent deasphalting	Solvent recovery in supercritical conditions. Reduction of power consumption by 40%. Possibility for solvent composition variation. Adjustment of deasphaltizate output and quality.
17	Viscosity breaking of petroleum asphalt Versions: - by furnace option; - with a reaction chamber with upflow - with cracking residues vacuuming; - without using water steam at the fractionation unit	Maximum achievable viscosity reduction. High distillate output. Reactor operating in the ideal displacement mode. Organic turbulator in a furnace. Minimum acid effluents' volume.

Proprietary technology

№	Technologies	Features (Advantages)
18	Delayed coking	Unit’s run between repairs is longer by more than 2-3 fold. High liquid product output. Low coke output. High-efficient unit of atmospheric emissions entrapment. Closed coke unloading system. Reduction of the volume of atmospheric emissions by more than 95%.
19	Coke calcination	High-efficient highly durable coke refrigerator.
20	Comprehensive heavy pyrolysis tar refining	Obtained products: high-efficient petroleum pyrolysis pitch with low sulfur contents and mesogenic properties; soot feedstock with a high correlation index and feedstock for synthesis of Addifans superplasticizer – efficient additive to concrete mixtures. The process has high profitability (return on investment period is less than 1 year) and is low-waste production.
21	Production of oxidized, partially-oxidized, compounded and residual road bitumens	Bitumens meeting requirements of world leading producers, including Superpave methodology, are produced from high-sulfur heavy oils based on deep vacuum fuel oil distillation, fuel oil oxidation, deasphalting and compounding technologies. High bitumen resistance to ageing. Colloidal structure optimization. Durability of road pavements is over 15 years.

Proprietary technology

№	Technologies	Features (Advantages)
22	Production of bitumen-polymeric bonding materials	Products according to requirements of world leading producers, including Superpave methodology
23	Preparation of hard-to-extract high-viscosity oils for transportation and refining at the oil refinery	Thermal treatment of oils with significant viscosity reduction (up to 40-50 fold) and increase of light fractions output (up to 40-55%).
24	Refining of hard-to-extract high-viscosity oils in production areas	Combination of rectification and solvent deasphalting with production of feedstock for hydrocracking and high-quality road bitumens
25	Production of feedstock for black carbon from the mixture of gas oil fractions of the oil refinery	Thermal cracking with production of feedstock for black carbon with low coking capacity (below 3%) and correlation index of minimum 120.
26	Sulfur production (hydrogen sulfide treatment)	Hydrogen sulfide conversion degree – 98-99.9%. Sulfur degassing without chemicals. Residual hydrogen sulfide contents in sulfur below 10 ppm.
27	Industrial waste water treatment	Wastewater free operation with a closed cycle. Area is lower by 3-5 fold. Efficiency is higher by 25-35%. Power losses are lower by 15%.
28	Flue gas and gas emission treatment by high-efficient sorbents	Sorption capacity is 0.3-0.6 g/g. Purification depth is 90-98% depending on pollutant concentration. Operating life is minimum 5 years. Unlike well-known sorbents, it is particularly efficient for treatment of industrial emissions with low pollutant contents – below 5 g/m^3.

Proprietary technology

№	Technologies	Features (Advantages)
Pilot tested technologies		
1	Selective catalytic cracking gasoline hydroskimming	Production of products with sulfur contents of maximum 10 ppm with ON increase by 1 -2 p.
2	Production of low pour point diesel fuel of Euro-5 grade	The middle distillate fractions' pour point is reduced by 5 - 30 °C
3	The catalytic vacuum gas oil hydrocracking system with production of middle distillates	High level of conversion and generation of light products, optimum entrapment of mechanical impurities and demetallization
4	Hydrodesulfurization of fuel oils and marine fuels	Reduction of sulfur contents up to requirements of environmental standards – below 0.5% wt.
5	Production of compound ethers of dicarboxylic acids in supercritical conditions	One stage process; no catalysts; environmental friendliness; simple hardware design.
6	Production of fatty acid ethyl ester (biodiesel) in supercritical conditions	Biofuel has excellent lubricating properties; fuel spills are quickly decomposed by microorganisms; simplicity, low cost and biodiesel production speed; no acrid odour and low toxicity level.
7	Production of isoprene in supercritical conditions	No catalyst, no by-products, reduction of power costs. Isoprene output calculated per passed piperylene 51 % wt.

Proprietary technology

№	Technologies	Features (Advantages)
8	Recovery of heterogeneous catalysts in supercritical conditions	Extraction of coke sediments from catalyst pores without variations of morphological and textural characteristics. No effluents, emissions, solid waste. Low power consumption simple process design. Possibility of recovery of all heterogeneous catalysts, petroleum refining and petrochemistry Increase of catalyst life cycle.
9	Isobutane alkylation by olefins on ceolite catalysts with “in situ” recovery	Continuous alkylation process mode on heterogeneous catalyst combining in-series alternation of traditional and supercritical conditions with ”in situ” recovery. Increase of service life (by 2 fold) and catalyst efficiency
10	Production of dimethyl ether	Conversion is higher by 15 %
11	Catalyst based on SAPO-34 for MTO process (methanol to olefins)	Flexible adjustment of the ethylene/propylene ratio
12	Fischer-Tropsch synthesis catalyst (bifunctional)	Adjustment of the product fraction composition from gasoline fractions to synthetic oil
13	Catalysts for producing complex comprehensive ethers and alkyl naphthalenes for production of low pour point synthetic oils	High conversion and selectivity
14	Hydrogen production	Possibility of refining of any hydrocarbon feedstock from methane to diesel fraction with production of 99.98 % pure hydrogen

№	Technologies	Features (Advantages)
Advanced technologies		
1	Supercritical fluid primary treatment of heavy, superheavy oils and bituminous sands - production of synthetic oils - demetallization, dewatering and desalting	Reduction of capital costs and power consumption by 50-75%
2	Supercritical fluid oil separation into components	Reduction of capital costs and power consumption by 50-75%
3	APG refining in synthetic oil / synthetic fuel	Direct isoparaffins synthesis without a hydroskimming stage with up to 80% selectivity
4	Pyrometallurgical pyrite ore treatment	Production of “pure” iron. Production of non-ferrous and noble metal concentrates. No sulfur dioxide generation.
5	Production of high-sulfur products on the basis of elemental sulfur	Qualified elemental sulfur disposal with production of sulfur-containing complex compounds and polysulphides