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A report

“Experience and problems of development of Orenburg oil-gas-condensate field, prospects of gas-chemistry development at Orenburg gas-chemical complex”

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Fuel-energy industry is a key one for both, world production in general and separate national economy. It maintains activity of all other industries; its condition influences on character and dynamics of development of separate countries and large-scale geo-economic subjects.

Gazprom, JSC is one of the most important participants of energy markets which are able to stabilize markets and ensure global energy safety.

Gazprom is not limited by reputation of reliable and stable exporter of energy resources but its specificity is in the fact that it is a producing and transporting company which possesses rich resources base and manifold gas-transporting infrastructure.

Its activity is directed to conservation of minerals and raw materials base, improvement of production and gas-transporting facilities, storage, processing and supplies routes diversification of gas, condensate and oil as well as power generation.

Gazprom sees its mission in maximally effective and balanced gas supplying of Russian consumers, ensuring of high reliability during implementation of long-term gas export contracts and energy safety of World markets.

Strategically, the Company aims to become a leader among global energy companies by new markets development, diversification of activities, ensuring of supplying reliability.

The main object of the Company is keeping of parity between stock addition and production up to 2010 and ensuring of extended reproduction of resources in future trends.

Gas resources of Gazprom are evaluated as about 33.1 trillion m$^3$ or in other terms 17% of the World recourses.

20% of the World production fall at Gazprom; by 2010, production volume will reach no less, than 570 bcm a year.

Priority directions of Gazprom’s activity is development of resources at Yamal Peninsula, Arctic shelf, Eastern Siberia and Far East.

Gazprom is an owner of the largest gas transporting system. Its length is 157 thousand km. Gazprom exports gas to 32 countries and is keeping on strengthen its market positions.

Gazprom’s first-rate gas-transport projects are:
- gas pipeline “Blue Stream” from Russia to Turkey, which was put into full capacity in 2005;
- gas pipeline “North Stream”, which will allow increasing of gas supplying reliability to the European market;
- gas pipeline “South Stream”.

“South Stream” is able to increase reliability and flexibility of gas supplying to Europe. As far as European Union recognizes importance of diversification of export routs from Russia, realization of this project becomes of a great urgency. “South Stream” will connect Russia and Europe by seabed of Black Sea; total length of the Black Sea section will get about 900 km., maximum depth – over 2000 m., project capacity – about 30 bcm/year.

Recently, a liquefied natural gas sector (LNG) is actively developing. Gazprom extends its market position step by step. In 2005 Gazprom started supplying LNG to the USA, in 2006 – to Great Britain, Japan and South Korea. In February 2009, the first Russian plant of LNG output, with 9.6 millions tons/year capacity was put into operation at Sakhalin.

The Company keeps on developing and increasing of oil business efficiency. Development strategy of this type of activity provides for annual oil extraction gain up to 100 millions tons by 2020.

In sphere of gas-processing and gas-chemistry, Gazprom aims diversification, increase of extraction extend and efficient use of valuable components of natural gas and associated petroleum gas (APG) for their further processing into high liquid products with high added value.

Now, Gazprom exercises reconstruction and improvement of gas-processing facilities of Gazprom dobycha Orenburg, LLC, Gazprom dobycha Astrakhan, LLC and other; it also plans creation of new production and gas-chemical facilities while complex development of recourses at Eastern Siberia and Far East.

Strategy of gas-chemistry development takes into account not only Gazprom’s interests but, also, Russia’s in general, due to decrease of volumes of combusted APG and development of processing facilities and, as a result, support of economic development of Russian regions.

Following to the worldwide tendency, i.e. connection of Gazprom’s profile activity and power industry will allow getting of sufficient synthetic effect of gas- and electric-power sectors.

Gazprom’s level of market capitalization is third among the World largest power companies. It gives way only to PetroChina, China and ExxonMobil, the USA.

Long-term relationships have been established with countries of the Central-Asian Region: Turkmenistan, Uzbekistan, Kazakhstan, Kirghizia and Tadjikistan in order to implement some joint investment projects, connected with reconstruction and development of their gas complexes.

In frame of strategy “global presence” of the Company at the World gas and oil markets, Gazprom aims at participation in projects on exploration, production, transportation and distribution of hydrocarbons in other countries (Libya, India, Vietnam, Venezuela and other).

At the same time, the most pressing problems in sphere of gas industry are:
- to increase efficiency of fields development and to ensure safe fields development;
- to invent technologies for development of poor-cracking stock and nonconventional gas recourses in low-pressure collectors, gas-hydrate accumulations and methane of coal fields;
- to ensure safe gas-products supply through development of technologies that aim to secure reliable functioning of unified gas supply system and include methods and means for diagnostics and repair as well as storage systems and systems for delivery of compressed and liquefied gas;
- to enhance products and services competitiveness at Russian and international markets through introduction of advanced technologies and advanced technical means for intensive processing of raw hydrocarbons thus aiming to produce and launch into the market new products and services;
- to utilize in the most effective way fuel-and-energy resources and to stimulate gas and energy conservation;
- to enhance environmental and industrial safety, information and antiterroristic security of production facilities.

The key factors that will ensure Gazprom’s leadership in the Global market and guarantee its shareholders confidence in the future are the largest gas deposits, ever-stronger presence at international market and further development of Russian market, strong position as a producer of such basic energy resources as gas, oil and electricity.

As for production is concerned, Gazprom, JSC includes seven producing companies; one of the leading among them is Gazprom dobycha Orenburg, LLC.

First gas was produced at Orenburg gas-condensate-oil field in November 1966. The field comprises 2 trillions m$^3$ of natural gas and 120 millions tons of condensate; its uniqueness is in high content of non-hydrocarbon components in gas: H2S-up to 3%, carbon-dioxide gas – over 1%, helium – up to 0,06%, mercaptans sulfur – over 500mg/m$^3$. Valuable gas components are raw materials for processing. Previously, Russia didn’t have similar experience in development and exploitation of the fields with high content of H2S. Due to complicated gas composition, it was necessary not only to equip the field but, also, to create a gas-chemical complex; it was composed of gas-processing and helium plants.

Orenburg gas-chemical complex is the largest in Europe. It was founded in 1970-es; now, it consists of four main structural divisions: gas-production division, gas-processing plant, helium plant and directorate on connective products pipelines exploitation.

Gas-production division was created in order to develop Orenburg field. Gas, oil and condensate are collected and treated before transportation to the gas-processing plant at 11 units of gas complex treatment, consisting of 37 gas and 3 oil technological lines. At all such units, gas is treated by mechanical separation.

Hydrocarbon products, treated at the above units, are transported to the gas-processing plant by the connective pipelines system with applying of 3 booster pump stations.

The following types of hydrocarbon raw materials (minerals) are yielded in process of deposits development:
- natural gas;
- gaseous unstable condensate;
- raw unstable oil.

Raw materials, treated at the field, are transported to the Orenburg gas-processing plant. It was started up in 1974 for processing Orenburg field gas with high content of sulfur and condensate. Design capacity of the plant, with respect to gas processing, was 45 bcm/year, to condensate with oil – 6,26 million tons/year. Now, Orenburg gas-processing plant consists of 3 trains. Gas processing capacity is 37,5 bcm a year.

The I train consists of the following facilities:
- gas processing – 15bcm a year;
- unstable condensate mixed with oil processing – 4,26 million tons a year;
- sulfur production – 377,8 thousand tons a year.

The II train consists of:
- gas processing – 10 bcm a year;
- unstable condensate mixed with oil processing – 0.8 million tons a year;
- sulfur production – 592 thousand tons a year.

**The III train** consists of:
- gas processing – 12.5 bcm a year;
- unstable condensate mixed with oil processing – 1.2 million tons a year;
- sulfur production – 560 thousand tons a year.

Natural gas, treated at the gas-processing plant from H2S, carbon dioxide and dewatered is a raw material for the helium plant; its design capacity with respect to dry gas is 18 bcm a year.

Helium plant was designed to treat gas from mercaptans sulfur and simultaneous deep dewatering and gas processing, and in order to get target products, such as: helium, ethane fraction and liquefied gases. Helium plant also consists of 3 trains:

- **I train** – 6 bcm a year (2 helium units);
- **II train** – 9 bcm a year (3 helium units);
- **III train** – 3 bcm a year (1 helium unit).

**The main commercial products** of gas-chemical complex are: dry gas, stable condensate, ethane fraction, liquefied hydrocarbon gases, pentane-hexane fraction, helium, sulfur (liquid, lump, granulated) and odorant.

Production volumes, within the whole period of field development, are:
- Helium – 136 million m³;
- Ethane – 6 million tons;
- Sulfur – 32 million tons;
- Odorant - 76 thousand tons.

Directorate on exploitation of connective pipelines was created in order to transport raw materials from complex gas treatment units to the Complex’s facilities and from two plants to customers. Total pipelines length is over 4 thousand km.

The Orenburg field is a mixed structure object. The level of oil and gas content of the field reaches 500 meters in the central part of the field. Carbonaceous rocks presented by dolomite limestone and dolomites are working as oil and gas collectors. Thick mass varying from hundred meters to 1000 m and more is a rock cap, presented by salt series with sulfate alternations.

The Orenburg OGCF consists of the Osnovnaya gas-condensate, Philippovskaya oil-gas-condensate, Central carbonous and Asselskaya gas-oil and Artinsko-sakmarskaya oil deposits. (fig1).
The Osnovnaya gas-condensate deposit, that concentrates about 92% of free gas primary reserves, is smoothly under laid by oil rims.

Oil rims of the Osnovnaya gas-condensate deposit have sporadic extension, forming independent objects for development in the east and west.

The pilot operation of the Osnovnaya gas-condensate deposit has been started in October 1971 from the central part of the field and 0.3 billion m$^3$ have been produced from 8 wells. During the pilot operation the range of operating production rates has been changing from 0.5 to 1.5 mln m$^3$/day.

Commercial development of the oil-gas-condensate field started in 1974 by putting the Osnovnaya gas-condensate deposit into operation, starting from the central part, in 1978 the west and the east areas of the field have been into operation.

The increasing gas production from the Osnovnaya deposit lasted from 1974 to 1979. In 1979 the field reached the constant stage of production at rate of gas extraction above 48 billion m$^3$ per year, the gas production rate was kept at the level 48,0 - 48,7 billion m$^3$ up to 1984 and at the same time every year about 45 wells were put into operation.

Before putting the OOGKF into commercial operation, when the geological structure had not been studied thoroughly, the field was related to the massive type of deposits. It was suggested that the Orenburg field was a massive reservoir, connected hydro-dynamically over the whole massive pool, under laid by oil rims everywhere.

But analysis of the field development at the primary stage had shown that the geological structure was more complicated. To upgrade the system of the field development it was decided to keep to the pattern of operation of the OOGCF by separate objects and distinguish three production zones in the productive strata.

On the basis of the field development analysis, results of field studies, core analyses and geophysical information the characteristic of those zones had been given.

Fig. 1 Structural-geological model of the OOGCF
Studies of the deposit development horizontally and by cross-section had been carried out during the whole period of the Osnovnaya deposit operation, but a number of reasons made the solution of that problem ill-defined and those were connected with peculiarities of geological structure and opening of producing deposits.

First of all the degree of hydrodynamic disconnection of the operation objects was not known. A number of investigators marked presence of local zones of opened vertical fracturing, especially in the central part of the field, and its influence in mass transfer processes was evident.

An essential factor rendering difficult the studies of the Osnovnaya deposit development was peculiarities of productive deposits opening by wells. In the initial period about 400 wells had been drilled with an open (not cased by the production casing) hole, which opened the whole level of gas content. At the same time to reduce risk of flooding the wells were completed by drilling in 40–50 m higher WOC mark. Such wells provided high productivity owing to the idealized character and high degree of opening.

Later when water was found in production of the central area wells, a turn to the closed (cased by production casing) design with selective perforation was carried out, which had to provide new well operation without water according to designers’ opinion.

The turn to the closed design resulted in sharp reduction of well productivity. Later productivity had been increased partially by additional selective perforation of non-opened gas saturated intervals. In such a case it was allowed to open simultaneously in one well deposits of the first and second, first and third objects of operation. In such a way gauging of production from development objects was impossible from the moment of their separation. Owing to impossibility to separate production and high hydrodynamic connectivity the second and the third objects had been combined in the designing documentation.

Several factors determined the order of the field drilling over, the main were the following:

- occurrence of the field areas with different hydrocarbon content, on that basic it was more reasonable and effective to put into operation the eastern part of the field firstly (considering high efficiency of sulfur production);
- production of gas with high sour content required more reliable protection of field equipment;
- primarily, it was suggested to supply untreated gas with low sour content (relatively to that of the eastern part) to the electrical power station;
- different rate of production over the field areas, the most favorable were the central and the west parts of the field;
- the distance between the gas processing plant and the central part of the field was the shortest, and consequently the time and money expenses for its development and put into operation were minimal.

On the basis of aforementioned the field drilling over had started from the central roof part and the drilling over area had been expanding gradually to the west and east. Filtration inhomogeneity of productive deposits, diversity of putting into operation and different degree of flooding of CPGU areas determined irregularity of development and different rates of formation pressure reduction horizontally and to the cross-section of the OOGCF main deposit.

Precise estimation of the average formation pressure is a hard problem enough, because distribution of formation pressure over the field void volume had distinct irregular
character and distributed in time horizontally and to the cross-section depending on various factors:

- diversity of putting into operation of separate parts of the deposit;
- redistribution of specific drainage zones under the grid concentration and wells drop out of the operation;
- well shift to the upper productive horizons;
- well flooding;
- changing of drainage conditions for separate wells in the result of conducted geological and operational arrangements;
- insufficient period of time for post reduction of the formation pressure during studies of void space determined by structure.

Practically from the very start of the development the wells operation of the Main deposit was complicated by presence of formation water in production. From the start of development formation water was found in production of 357 wells, a part of them has been liquidated by now.

For the last 5 years up to 10-15 wells go to water annually. Under formation pressure reduction drowned wells operation is complicated by degradation of water recovery to the surface conditions and that lead to productivity reduction and wells further self killing.

Hydraulic system underlying the OOGCF reacts actively to gas production from the deposit and a vast cone of depression is formed. The deepest part of the cone relates to the central the wettest zone of the OOGCF and coincides with the longitudinal meridian direction of the deposit structure.

According to the estimation the volume of formation water got into the deposit makes 1-2% of the primary gas saturated void volume of the OOGCF the main deposit collectors. At the wet areas the bulk volume of water, got into the deposit (or its greater part), fills the system of fractures and a small part of void space around well bores of drowned wells. Insignificant designed volumes of formation water intrusion into the deposit from the hydraulic system do not compensate pressure reduction in wet zones of the deposit.

Results of well testing confirmed irregularity of the field development not horizontally, as it was mentioned before, but to the cross-section as well. The lower levels of the Main deposit are characterized by the greatest degree of working out. Current formation pressure in the III operational object (fig.1) does not exceed 6.0 MPa. Tests in the well have shown presence of non-broken oil rim.
According to the results of the cartography of formation pressure distribution of flooding areas of the Main deposit and oil fields (oil rim) it is possible to suppose the influence of the last ones on the flooding degree of intensity. In such a way in general flooding conditions the mode of the main deposit development is a gas one, with manifestations of water drive at separate areas. Figure 2 shows influence of the water drive system (well flooding) on changes of the formation pressure dynamics of one of the wells of the complex gas preparation unit.

To maintain production rates at the level 3.7-4.0% from the residual resources about 20 wells had been put into operation in gas production rates decline conditions. Since 1995 drilling of new wells had been reduced. In the period 1995-2003 64 wells had been drilled and put into operation. Decline of production rates, reduction of new wells drilling, ageing of operating well stock resulted in annual gas production rates reduction for 6-8% in the period 1998-2004. In those conditions the production rate from the current geological resources reduced to 2.8% by 2004. All in all during the field operation from the Main deposit had been produced 1.15 trillion m$^3$ of gas and 46 million t of condensate.

Activation of well drilling in 2004-2008, when 76 wells had been put into operation, provided slowdown of gas production. At the same time the gas production rate from residual resources made about 3%.

To stimulate inflow a complex of arrangements had been recommended, including treatment of separate intervals with blocking compounds, controlled-angle fluid jet method, application of bottom hole drilling assemblies for object separation according to a single lift pattern.

Maintenance of gas production capabilities from the Main deposit had been facilitated by commissioning of two booster compressor stations in 1984 and 1987.

Maintenance of the field production capabilities and provision of resources uniform drainage in protected environmental zones presence conditions has been realized since 1991.
by the program for well construction with horizontal wellbore 500-600 m and recovery of the “old” well stock by side tracking.

Construction and recovery of wells is performed as a rule on the I-st object of development (fig.1), which is characterized by low collector properties, and where 40% of gas residual resources is accumulated. At the same time horizontal wells production rates exceed that of vertical ones 3-5 times.

Use of horizontal and recovered wells at the current stage of the field after development is aimed at achievement of hydrocarbon stock component production maximum factors and is economically feasible. So in 2007 horizontal and recovered wells provided production of 2.3 billion m$^3$ of gas.

In environmental limitation conditions determined by aggressive components in formation production and low values of current formation pressures, since 2006 the complex development of new and recovered wells has been performed using coil tubing, nitrogen and separation units, that has provided significant reduction of development period, not violating environmental restrictions. All the operations for wells development are carried out under the environmental laboratory control.

Construction of multilateral wells at the field is planned in 2009, that gives an opportunity of involvement of deposit maximal gas saturated volume into the development and an increase of production rates 1,5-2 times in comparison to mono bore horizontal wells.

<table>
<thead>
<tr>
<th>Incremental growth of reserves</th>
<th>Deviation</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas, bcm</td>
<td>100</td>
<td>+5</td>
</tr>
<tr>
<td>Condensate, ml n t</td>
<td>7</td>
<td>+5</td>
</tr>
<tr>
<td>Oil, ml n t</td>
<td>4</td>
<td>-1</td>
</tr>
</tbody>
</table>

![Fig. 3 Full scale 3D geological-hydro-dynamical model of the OOGCF](image)

Since 2005 in the central part of the field, studied only by operational drilling have been conducted CMP-3D surveys. Those operations in complex with the results of exploration drilling of marginal zones, operational drilling of the last years and development analyses, made basis for creation of full scale, 3D geological hydrodynamic model of the Orenburg field. (fig. 3).

The target of the 3D seismic works at the Orenburg OGCF is the adjustment of the field geological model, predicting of improved collector properties zones, maps making of litho-stratigraphical screens to optimize production well location. Thereby are solved
problems of the field geological structure detailed study, predicting of structural-formation
and reservoir properties of productive deposits, preparation of recommendations for well
location. According to results of contour mapping and geo-statistical analysis of the wave
field dynamic characteristic using data on collector properties in wells are made maps of
collector roofs and effective thickness maps for the main productive formations. On the
basis of the seismic attributes detailed analyses zones of suggested facture development
dislocations are separated. The result of the carried out investigations is a field digital model
within the limits of the studied by 3D seismic works polygon.

In 2008 the institute VolgoUralNIPIgaz has finished revised estimation of the
Orenburg field resources, the incremental growth made about
100 million ton of reference fuel.

According to its complex component composition the
Orenburg oil gas condensate field
belongs to the fields with helium content, average concentration of
the last is 0.055% by volume.

Gas component composition varies greatly horizontally. Changes are mainly
connected with non-carbon components content, such as H_2S, CO_2, N_2. For example
hydrogen sulfide concentration in the west and central part of the field makes 1.5-2%
(mole), increasing to the east up to 5% (fig. 4). An attempt to find out clear trend of
hydrogen sulfide concentration variation with altitude of the pay zone on the basis of well
surveys results was a failure, because many wells open the significant part of the productive
deposit. That is why that trend has been determined only analytically.

An insignificant tendency of H_2S concentration increase in production is observed
with loss of pressure, and further investigation of these processes is required in the
Orenburg field development.

In declining production conditions for mineral resources rehabilitation of the
Orenburg complex are required exploration and involving of new fields into the
development, using advanced methods of geophysical works, prospecting drilling and
construction.

The territory of the Orenburg region is a unique region from geological point of
view, it has no analogs in Russia and in the world. It is located in the member zone of three
global geotectonic elements. In the whole there are sufficient reserves in the south of the
Orenburg region to maintain and strengthen the raw materials source of the Orenburg GCC.

The existing potential hydrocarbon stock base of the Orenburg gas chemical complex
is 300 million t of reference fuel, including 280 billion m^3 of natural gas.

«Gasprom Dobycha Orenburg» has been conducting geological exploration works
(GEW) at its option since 1993. During that period the Company carried out two programs
of GEW. The first one, accomplished in 2002, was characterized by irregularity of drilling
and geophysical works performance. In the course of the second program realization the
Company achieved stabilization of footage drilled, geophysical works and first of all an
increase, of seismic surveys. Three dimensional seismic 3D-CDP method is widely
introduced.

The company uses a standard procedure for GEW performance – it is several types of
the field geophysical works, mainly seismic (regional, prospecting-detailed, three
dimensional), further on prospecting, prospect-evaluation and exploration drilling. Seismic
survey as the basic method for structures preparation is enlarged in different scopes by barymetry, seismic locator of lateral survey (focal points of emission) and other methods of the field geophysics.

In the period 1993-2008 on the license areas of the company 30 wildcats and stratigraphic wells of total footage 150 thousand m have been drilled.

In the period of intensive GEW (2004-2008) the company drilled 67 thousand m of rock, length of reflection profiles made 3200 linear km, scope of 3D seismic survey – 2090 km².

During these five years two new fields have been discovered, two new oil deposits have been found out at the north-west flank of the Orenburg field.

Since 1985 due to declining production of the major pool annual production has fallen from 48 to 18 billion cubic meters, annual decline being equal to 1.5 or 2 billion cubic meters.

Declining production is characterized by progressive drowning, decrease in formation pressure up to level insufficient to displace fluid from well bore, lack of surplus pressure necessary for gas low-temperature separation, alternations in designed operation mode of the field (high temperature of gas after low-temperature separators, disagreement of gas quality with project specifications), different composition of formation fluid, worse conditions for hydrocarbon raw materials treatment (pic.5)

At present moment new conditions require serious alternations and sometimes even radical changes of low-temperature separation technology which has been applied for raw hydrocarbons treatment since the very beginning. Without these changes it will be impossible to meet quality requirements that are set by technical specifications for raw hydrocarbon materials delivered to Gas –processing Plant from Orenburg oil-gas –condensate field.

The above –mentioned problems have influenced operating mode of complex gas treatment units, connective gas–condensate pipelines and on operating mode of Gas –processing Plant as extraction and processing are tightly connected with each other:

- Desulphurization processes suffered due to inlet pressure drop at the gas processing and helium plants
- Greater ingress of highly mineralized water due to drowning caused troubles with gas condensate stabilization units
• Operation of electrical desalting plants as well as of gas condensate stabilization units at Gas Processing Plant deteriorated due to greater amount of oil in unstable condensate.

• Increased concentration of impurities made difficulties for sewage disposal plants operation and resulted in higher load on power equipment and facilities.

The greatest quality challenge that one is facing while supplying raw materials to Gas-processing plant is necessity to satisfy requirements of Technical specifications for concentration of emulsified, free water and for concentration of chlorides in unstable condensate and oil.

![Graph: Tar Concentration in OOGCF condensate](image1)

**Fig. 6. Tar Concentration in OOGCF condensate**

To overcome difficulties mentioned above there were worked out short-term (until 2010) and long-term (until 2030) programs of Orenburg Gas-Chemical Complex Development. The basic principles of these programs are development of raw materials base and processing intensification and as a result greater output of such valuable petrochemical products as ethane, liquefied gas and other.

A number of measures will help to so live these strategically important problems.

To maintain the same level of production the third gas booster station was put into operation. Since 2006 the first and the second booster stations have been operated in two stages of compression. At the first station up-grading of internal parts of three-phase separators helped to improve quality of liquid hydrocarbons supplied for Gas-processing plant.

In the middle of 80-es, problems concerning liquid hydrocarbons treatment arose due to revealing in condensate of the central part of the field associated oil, tars, pyrobitumen, which were natural emulsifiers and promoted formation of trice emulsions (pic.6). Beginning with the middle of 90-es, problem of liquid hydrocarbons quality aggravated.

First, volumes water, which was carried out from oil and gas wells sufficiently increased; at the same time, oil recover volumes increased and condensate volumes production decreased.

Secondly, insufficiency of technological possibilities of complex gas treatment units and booster pump stations to ensure required quality of

![Graph: Oil content dynamics in liquid hydrocarbons of OOGCF](image2)

**Fig. 7. Oil content dynamics in liquid hydrocarbons of OOGCF, for further processing**
oil-condensate mixtures due to emulsions formation sharply appeared.

Thirdly, supplying of raw materials, coming for processing, from Orenburg region and Kazakhstan suppliers increased; this stuff had higher content of heavy and sour components.

Extent of operation influence of each facility into quality of liquid hydrocarbons is shown by results of integral analysis of functional conditions of technological transporting trains (TTT) “a well-complex gas preparation units – a booster pump station - gas-processing plant”. Factors for each section of TTT, which complicate condensate and oil treatment, were detected.

Such approach allows detecting potential quality level of liquid raw materials treatment at each separate object and developing effective technical decisions in order to decrease complications risk. Analysis conception of TTT operation allows keeping an eye on reasons of raw materials quality loss during treatment, which is caused by any of complicated factors.

Results of complex analysis made at the train “a well-complex gas preparation unit- a booster pump station-gas-processing plant” were as follows:

- demulsifier “Hercules” tested and recommended for industrial use; it was found out, that 20…40 g/t of liquid along with thermal emulsion stimulation ensure necessary level of oil and condensate dehydration;
- injection units of oil-soluble demulsifier into technological lines of gas, condensate and oil treatment designed and set on the sites of complex treatment units; they consisted of 2 sections: tanks for solution preparing and metering pumps;
- improved scheme of Kopanskoe field raw materials treatment developed and introduced; it provided for application of existing equipment and consisted of:
  - introduction of two-stage liquid treatment scheme;
  - extraction of “gas-gas” heat exchanger from technological scheme;
  - condensate warming before last separator;
  - structural changes of separators of technological line;
  - putting into operation of injection unit for demulsifier.

As a result, content of free, emulsified water and chloride salts was sufficiently decreased; it allowed reaching of normative quality characteristics for unstable condensate.

Booster pump station is the last technological unit before gas-processing plant; it plays important part in formation of liquid hydrocarbons quality. Within 2000-2007, a preparation unit for liquid hydrocarbons was worked out, mounted and put into operation; it allowed improving preparation technology at Booster Station No1. Upgrading work consisted of:

- building and putting into operation warming system for coming products;
- development, building and putting into operation demulsifier injection unit;

reconstruction of three-stage separators, mounting additional internal devices of FMC Technologies: evenflow inlet device, mist eliminator, perforated distribution baffle, plate pack coalescer.

Optimization of preparation process allowed creation of additional possibilities for stability of normative indexes of products quality that were supplied to gas-processing plant within 2001-2008, and minimizing quality violation.

It should be noted that at present stage of development of Osnovnaia deposit and taking into account development projects of Asselskaia gas-oil deposit, Filippovskaia oil-gas-condensate deposit, Srednekamennougolnaia gas-oil deposit and perspective increase of oil extraction, all made arrangements are not enough. They need corrections and, sometimes,
fundamental changes, otherwise, it will be impossible to meet requirements of Technical Conditions for quality of hydrocarbon raw materials.

Gazprom dobycha Orenburg, LLC proceeds with optimization of treatment process and modernization of existing processing equipment. In this year selection and testing of more effective demulsifiers, which operate at lower temperatures and have minimal reaction time, produced by “Baker-Petrolight”.

It has been noted, that in process of development of exhausted field, formation pressure is becoming sufficiently lower and portion of low-pressure gas is increasing. A closed scheme of recycling of low-pressure gases, without being flared, is applied at productive and processing facilities of our Company.

The term “low-pressure gas” is used in two cases:

1. Gas and gas condensate fields, which industrial use, with deep compression and further trunk transportation, is not profitable or low-profitable.

2. Gases, which working pressure is lower then pressure of main technological process; they are utilized in accordance with specially developed and introduced technical arrangements.

To utilize low pressure gases, inclusive of oil-well gases, at its field facilities the company introduced effective systems with jet pumps and compressor units.

Having undergone conditioning low pressure oil-well gases and condensate flash gases that appear during treatment of oil and gas wells production are mixed with main gas flow and then go first to gas booster stations and then to Orenburg gas-processing plant.

At Orenburg gas-processing plant such technological processes as condensate stabilization and natural gas sweetening and dewatering generate low pressure gas (amine expansion gas, gas of condensate weathering and stabilization, end gases e.t.c) with sulfur content equal to 3000 mg/m³. According to the initial project low pressure gas was used as power gas for the plant itself and for Kargalinskaya heat and power plant.

At Orenburg gas-processing plant low pressure gas was divided between by two systems:

- power gas net of the plant (end gases, gas of amine expansion);
- compression facilities of the condensate stabilization unit operated by third stage of the Orenburg gas-processing plant (gas of condensate stabilization and weathering).

Treatment and utilization of low pressure gases in accordance with initial project brought about a number of problems.

Ecological problems - application of sour gas with high sulfur content as power gas at the gas-processing plant and Kargalinskaya heat and power plant resulted in environmental pollution in the district near Orenburg gas-processing plant.

Technical problems – in accordance with the project developed by YuzhNIIgipro gaz-institute it was impossible to treat power gas and end gas received from two stages of the gas-processing plant with existing equipment since the compressor required 0.65MPa of min. inlet pressure while pressure of power gas in the gas-processing plant collector fluctuated between 0.5 – 0.55MPa. Moreover transportation of low pressure gases from first to second stage of the gas-processing plant resulted in pressure difference of 0.15Mpa which hindered effective operation of the compressors.

Through utilization of low pressure gases the company aims to solve two problems:

- to improve ecological situation in the vicinity of Orenburg gas-processing plant;
to extract additional amount of marketable products since the company has production facilities for extraction of ethane and broad fraction of light hydrocarbons, while low pressure gases are notable for high content of hydrocarbon C
2
and higher.

As a result it was decided to modernize system of low pressure gases collection and processing by replacing obsolescent piston compressors with centrifugal ones. Centrifugal compressors made it possible to direct low pressure gas first for desulfurization and then together with main gas flow towards the helium plant for extraction of ethane and broad fraction of light hydrocarbons. At the same time low pressure gas (as power gas for Orenburg gas-processing plant and Kargalinskaya heat and power plant) was replaced with tank gas with sour sulfur content equal to 36mg/nm³ and hydrogen sulfide content equal to 20mg/nm³.

To modernize system of low pressure gases collection and processing it was necessary to do the following:

- to start a low pressure gases collector equipped with automatic system to fuel a tank gas collector;
- to start a compressor plant with special sections for compression of low pressure gases and gases of zeolite regeneration.

In 2005 when the first stage of modernization of system for low pressure gases collection and processing was accomplished the following results were observed:

- reduction of sulfur dioxide emission at Orenburg gas-processing plant for 1100 t/year;
- reduction of sulfur dioxide emission at Kargalinskaya heat and power plant for 850 t/year;
- rise in production of propane-butane fraction for 40 000 t/year, of ethane fraction for 32 000 t/year.

Due to anticipated difficulties during the final stage of the main field development our company is compelled to research utilization problems of low pressure gas reserves. We believe that the most promising solutions are:

- construction of small-capacity facilities to process and sweeten certain parts of produced gas (with lower pressure than the main gas flow) immediately at the field which can be viewed upon as an alternative to multi-stage compression. In this case sweet gas will be delivered to local consumer (to those who are located within 100km distance) without preliminary compression.

- Construction of electro-steam units to burn wet gas with further sulfur dioxide removal of exit gas;

Some steps have been already taken. One of the acceptable variants is a plant for selective biological cleaning of gas flow to remove H
2
S and light mercaptans which are converted into elemental sulfur immediately in the field.

The above mentioned plant will remove 99.99% of sulfur. After that sweet gas can be delivered to consumers.

In contrast to gas sulfur produced now biologically obtained sulfur can be used as fertilizer.

This technological process has its advantages as well as disadvantages.

Its advantages are a wide range of applicable technological pressures, absence of high temperatures, compactness.

Its disadvantages are

- low efficiency for removal of heavy mercaptans;
- methanol and corrosion inhibitors which are added to raw gas and are poisonous for bacteria

As for the second solution we suggest usage of a 240MW power plant (wet-gas-powered one with combined cycle with further removal of sulfur dioxide from combustion gas). This plant has high efficiency ratio but at present moment it is planned only to meet the requirements of the company itself.

In order to improve quality of natural gas sweetening at the desulphurization units of Orenburg gas-processing plant NOVAMIN, a new highly effective absorbent invented by VNIIGAZ-institute, was introduced.

According to the project aqueous solution of diethanolamine was prescribed for natural gas sweetening. Initially amine sweetening was planned to process natural gas of Orenburg field with hydrogen sulfide concentration equal to 2% of volume and CO2 concentration equal to 1% of volume.

Now desulphurization units of Orenburg gas-processing plant process natural gas of eastern parts of Orenburg gas field and of Karachaganak oil and gas field. Concentration of sour components in natural gas from these fields is three times higher than it was planned by the initial project (hydrogen sulfide+carbon dioxide – up to 13% of volume, hydrogen sulfide - up to 6% of volume, carbon dioxide - more than 6% of volume).

Processing of greater amount of natural gas from eastern parts of Orenburg gas field and from Karachaganak oil and gas field caused poorer quality of sweet gas and deterioration of desulphurization units performance. Moreover it was necessary to ensure 300 mg/m$^3$ of carbon dioxide concentration in gas supplied from Orenburg gas-processing plant to Helium Plant.

When gas from Karachaganak field was accepted for processing the challenge was to preserve designed output of the desulphurization units since sweetening with diethanolamine did not ensure sweetening of Karachaganak gas at designed output level. On the other hand it was necessary to ensure quality of tank gas supplied to the Helium plant and into pipelines so as to meet the requirements of the operating standards and norms.

Thus Orenburg gas-processing plant encountered a number of technical problems that required modification of technology and intensification of gas sweetening.

For higher efficiency of gas sweetening a number of laboratory and pilot experiments were conducted to test new absorbents. The result of the experiments was a number of new processes of sweetening that first underwent piloting and then were tried out on industrial scale at Orenburg gas-processing plant. Those processes were:

1. Sweetening with strong solution of diethanolamine
2. Selective sweetening of Karachaganak gas with methyldiethanolamine to remove hydrogen sulfide
3. Sweetening with aqueous solution of diethanolamine/ methyldiethanolamine mixture
4. Simultaneous sweetening with absorbents of physical-chemical property (Ukarsol, Ekosorb) to remove sour components
5. Sweetening with amine absorbent with added physical component NOVAMIN

Experiments and tests proved NOVAMIN (a new absorbent of physical-chemical property invented by VNIIGAZ-institute) to be the most effective one. It has been used by Orenburg gas-processing plant since 2001. If compared with diethanolamine and methyldiethanolamine NOVAMIN is characterized with less corrosion activity and at the
same time it reduces deposition on surfaces of heat exchangers and columns of desulphurization units.

Volume concentration of hydrogen sulfide in raw gas from Orenburg gas field was equal to 1.6-2.0\%, volume concentration of CO\textsubscript{2} – 0.6-0.8\%. Gas output was 240-270 thousands m\textsuperscript{3}/hr (one half a line), relative absorbent reflux was 1.0-1.1 mg/m\textsuperscript{3}, temperature of upper flow of regenerated amine was 50\(^\circ\)C.

The results of tests with Novamin showed that under equal conditions concentration of hydrogen sulfide in regenerated NOVAMIN was lower than in aqueous solution of diethanolamine/methyldiethanolamine mixture. In case of NOVAMIN final quality of sweet gas was better: hydrogen sulfide concentration was equal to 6.3-12 mg/m\textsuperscript{3}. At the same conditions mixture of diethanolamine/methyldiethanolamine ensured only 10-17 mg/m\textsuperscript{3} of concentration. Volume concentration of carbon dioxide was less than 300 mg/m\textsuperscript{3}.

Table 1.
Mean Values of Gas Sweetening with NOVAMIN at Desulphurization Units of Orenburg Gas-Processing Plant.

<table>
<thead>
<tr>
<th>No</th>
<th>Value</th>
<th>Piloting in 1998-1999</th>
<th>Production experiments in 2001 r.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2Y70</td>
<td>1Y70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOVAMIN</td>
<td>NOVAMIN</td>
</tr>
<tr>
<td>1</td>
<td>Raw gas flow rate, thousand m\textsuperscript{3}/hr</td>
<td>470-520</td>
<td>514</td>
</tr>
<tr>
<td>2</td>
<td>Concentration, %:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H\textsubscript{2}S</td>
<td>~ 1,6</td>
<td>1,37-2,77</td>
</tr>
<tr>
<td></td>
<td>CO\textsubscript{2}</td>
<td>~ 0,5</td>
<td>1,7-1,9</td>
</tr>
<tr>
<td>3</td>
<td>Relative reflux, l/ m\textsuperscript{3} of gas</td>
<td>0,8-1,1</td>
<td>0,9-1,1</td>
</tr>
<tr>
<td>4</td>
<td>Temperature at desorber bottom, ({}^\circ)C</td>
<td>126-127</td>
<td>121-124</td>
</tr>
<tr>
<td>5</td>
<td>Concentration of H\textsubscript{2}S in regenerated amine, g/l</td>
<td>0,6-1,7</td>
<td>0,4-0,8</td>
</tr>
<tr>
<td>6</td>
<td>Steam flow consumption, ton/hr</td>
<td>36-47</td>
<td>28-33</td>
</tr>
<tr>
<td>7</td>
<td>Concentration of methyl alcohol ethers in absorbent, %</td>
<td>-</td>
<td>7-13</td>
</tr>
<tr>
<td>8</td>
<td>Concentration (in sweet gas):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H\textsubscript{2}S, mg/m\textsuperscript{3}</td>
<td>10-17</td>
<td>6,3-9,8</td>
</tr>
<tr>
<td></td>
<td>CO\textsubscript{2}, vol.</td>
<td>0,002-0,015</td>
<td>0,005</td>
</tr>
</tbody>
</table>

The following facts were registered: lower steam flow consumption during regeneration of saturated NOVAMIN if compared with diethanolamine/methyldiethanolamine, steam saving due to better performance of amine-amine recuperative heat exchangers, improved regeneration, while corrosion rate of carbon steel was half or two times as less.

Since in Karachaganak raw gas concentration of sour components was higher than that in Orenburg gas it was impossible to convey Karachaganak gas to desulphurization units of the second stage of Orenburg gas-processing plant.

This problem was solved when a cross-flow PETON packing replaced conventional contact devices in absorbers and desorbers of desulphurization units (fig. 8).
Introduction of the PETON packing made it possible not only to process 2-2.5 BCM a year of Karachganak gas at the desulphurization units of the plant’s second stage and at the same time to guarantee quality of sweet gas in accordance with acting norms and standards. Moreover it allowed simultaneous removal of carbon dioxide from Orenburg and Karachaganak gas down to concentration of 300 mg/m$^3$ or lower. Later desulphurization units of the plant’s first stage were equipped with cross-flow PETON packings as well.

Solutions of sweetening-concerned problems helped to increase product output (ethane, broad fraction of light hydrocarbons) and to improve ecological situation near Orenburg gas-processing plant.

At present moment a number of measures are being taken to guarantee both quality of tank gas as per acting norms and standards and level of output. They are:

- modernization of desulphurization units at the third stage in order to process more gas of Karachaganak field;
- modernization of system for collecting and processing of low pressure gases and zeolite regeneration gases through installation of additional compressors;
- modernization of amine sweetening sections in operating desulphurization units;
- installation of plate-type heat exchangers;
- installation of flow analyzers to detect hydrogen sulfide and carbon dioxide in regenerated amine and tank gas so that make it possible to carry out on-line quality control.

The above mentioned measures will optimize desulphurization and guarantee gas production in accordance with acting norms and standards.
In order to achieve set targets in sphere of raw materials base extension for petrochemical industry Gazprom dobycha Orenburg, LLC:

1. carried out some local projects, which allowed increasing of commercial products output, ethane and light ends by over 200 thousand tons. For increasing ethane faction and light ends output, the Company introduced some arrangements, without sufficient capital investments, by improvement of existing technology.

1.1. Maximum involving into processing all hydrocarbons-containing gas flows.

![Diagram](image)

**Fig. 9. Processing of deethanization gas**

First, deethanization gas, which is processed at low-temperature oil absorption units of Orenburg gas-processing plant. Value of processing of this gas at helium plant is in high ethane content – up to 25% - which has not been extracted and up to 70% of C3-C5. In 2008, processing of deethanization gas allowed getting additional 35.2 thousand tons of ethane and 43.4 thousand tons of light ends. At that, there is a potential possibility to increase this volume twice and over. Technology improvement ensured additional decrease of specific power inputs by 18% as far as ethane has lower heat capacity and condensation heat at working pressures in compare with methane. (pic.9). Second, use of interflows of methane fraction as regeneration gases and zeolites cooling in adsorption processes allowed getting additional 17.4 thousand tons of ethane and 35 thousand tons of light ends in 2008. This technology decreases “coke formation” on zeolites, due to decrease of content of thiols, ethane and heavier hydrocarbons (C2+) in regeneration and cooling gases; it also excludes variation of component composition.

New method of zeolite regeneration and cooling ensures simultaneous: high quality of output products, process stability, and extension of zeolite service life in 1.5 times, adsorbent consumption from 0.06-0.08 up to 0.03-0.04 g/m3 of sweet gas and power consumption decrease (pic.10).
Description of the pic.10.: Scheme of the unit of natural gas dehydration and treating. 1,2,3-adsorbers, 6-low-temperature condensation and rectification unit, 7 – booster station; 11-compressor, 12 – regulating device of flow proportion of methane fraction and nitrogen-methane fraction; 14 – section of treatment on zeolite of regeneration gas from compressor oil’s vapor; 17 – furnace for regeneration gas heating; 4,5,9,13,15,16,18,19 – gases flows.
1.1. Increasing of commercial ethane and light ends output was a result of introduction of process of low-temperature hydrocarbon C2+ absorption from natural gas and after optimization of rectification process (pic.11). According to this technology pentane-hexane fraction is used as absorbent at the initial stage of natural gas low-temperature condensation and further absorption of hydrocarbons C2+ from gas at ///. This technical decision allows increasing yield of ethane fraction by 2.23 tons/h., and light ends, not treated from sulfur-containing compounds by 3.2 tons/h. at each helium producing unit.

### Chart No 2

#### Output volumes of ethane and light ends before and after improvement

<table>
<thead>
<tr>
<th>Production name</th>
<th>Unit measure</th>
<th>Before improvement</th>
<th>After improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETHANE</td>
<td>Tons/hour</td>
<td>10.37</td>
<td>12.60</td>
</tr>
<tr>
<td>LIGHT ENDS</td>
<td>Tons/hour</td>
<td>22.29</td>
<td>25.49</td>
</tr>
</tbody>
</table>

1.2. Improvement of processing equipment: contact devices, rectification columns, heat-exchangers (use of plate-type heat exchangers), canned pumps; all this ensured increase of unit capacity as for light ends rectification and liquefied hydrocarbon gases yield twice, at that, it allowed economy of energy resource - electric power - by 1700 thousand kW*hour/year, of recirculated water by 2100 m3/hour, increasing of ethane output by 4 thousand/hour at one helium producing section.

2. Implementation of reconstruction project of the unit for ethane and light ends extraction from natural gas is fulfilling. Ethane output at each modernized unit will
increase in 2.3-2.7 times, light ends – by 20%, considering the same capacity and volumes of processing raw materials and simultaneous decrease of power inputs. Institutes LenNIIhimmash, VNIIgas, VolgoUralNIPIgaz have developed working project for helium sections reconstruction. This project provides for application of new equipment and control devices and preserving of existing building structure, communications (distribution pipelines), buildings and facilities; such approach allowed decreasing capital expenditures for reconstruction by 30%. Application of a modern turbine expander with adiabatic efficiency no less than 0.85, adiabatic expansion of gas in the whole available pressure range exclude application of external cooling source – propane refrigeration cycle with isotherm boiling -36C. Efficiency of new, modern gas processing methods, energy-saving measures and construction decisions lies in the following:

- increase of output products volume due to increase of ethane extraction ratio up to 90% and over for each possible gas composition, supplied for processing;
- decrease of power inputs by 23%;
- high-rate safety and stable operation of helium plant;
- increase of reliability of systems operation.

Sufficient attention is paid to diversification. A project of output of sulfur-organic products is realizing; these products are disulfide oil, floto-reagents, corrosion inhibitors, thiofen. At that, by-products of gas treating – dialkilsulfides mixture, which are not unclaimed now, will be used as raw materials. 

Now, disulfide oil is output in pilot batches. First test stage, fulfilled at one of Russian petrochemical plants, showed that it may be used as coke formation inhibitor in pyrolysis of light hydrocarbon raw materials.

Now, parameters of technological process of thiofen output are laboratory developed; disulfide oil is used as raw materials.

Specialists of our Company along with research organizations are developing some perspective projects in sphere of improvement of processing technology.

1. Amendment of odorant output processing in order to ensure quality, which corresponds to existing European requirements (specifications), designer is VNIIGAS institute. Orenburg field’s raw materials are characterized by high content of mercaptans; their extraction is compulsory in course of processing of hydrocarbon stuff before selling to consumers. Alkali demercatanization with natural mercaptans mixture output (NMM) is used for treating of gas from mercaptans sulfur at Orenburg gas-processing plant. NMM is a mixture of ethyl-, methyl-, propyl-, butylmercaptans. Gazprom dobycha Orenburg, LLC is a Russian monopolist on output of this product; now, it is applied only for natural gas odorization, used as city fuel.

Odorant, produced at gas-processing plant is characterized as follows:

- mass fraction of mercaptans sulfur – no less, than 37%;
- cloud point temperature – no high, than15C;
- final boiling point 80% - no more, than 95C.

Volatile individual mercaptans: ethyl-, methyl-, isopropylmercaptans are usually used worldwide for odorization of fuel gas. In compare with mercaptans mixture, effectiveness of odorization by the above indicated mercaptans is higher and their consumption is lower.

In order to realize a project of individual mercaptans output, VNIIGAZ proposed two-stage NMM odorant rectification, which is produced at odorant drying unit. End product will be odorant with improved qualitative characteristics (ethyl-mercaptans content
is 80-95% mass, chilling temperature – no higher, than -45C, boiling temperature – no more, than 100C).

This technological unit includes two rectifying columns of packing type, shell-and-tube water chillers, vapor reboilers, pumping equipment, instrumentations systems. Capacity of the unit of odorant rectification after improvement will become 5000-8000 tons/year; capacity limit is 50-100%.

2. Creating of unit of fine helium concentrate cleaning. Designer - scientific production association “Geliumash”.

It is recognized that industrial and technological development of advanced countries is proportionate to helium consumption by their research-and-production complex, as helium is a key strategic component in majority of science intensive technologies, including energy, nuclear energy, thermonuclear and space.

Helium of different purity is required for industrial use and getting of scientific and technical solutions. Now, Orenburg helium plant produces two helium grades with helium content – 99.99 and 99.995%. Content of some additives, like nitrogen and hydrogen, as well as micro additive methane, oxygen, neon and argon limits its application. For getting more pure helium, a new technology has been developed, which will allow producing high purity helium with overall additives content at 0.1 ppm level. Energy resources economy will be 80% relative to existing units of fine cleaning of helium concentrate, it is defining rate of technology effectiveness.

3. Improvement of technology of getting of liquefied hydrocarbon gases in order to bring their quality to international standards requirements.

In view of export outlook of liquefied hydrocarbon gases (LHG), produced at Gazprom dobycha Orenburg, LLC, to Turkey, Poland and other countries, Gazprom, JSC set a target before our company to ensure quality of liquefied hydrocarbon gases (LHG), produced at gas-processing and helium plants, corresponding to requirements of European Standard EN589 “Fuel for internal-combustion engines. Liquefied petroleum gas. Requirements and methods of tests”.

Now, LHG, produced in Orenburg, do not meet this Standard in the index “content of total sulfur” (norm under EV589-no more than 50 ppm., actual content in products – up to 180 ppm.; major fraction of total sulfur in mixture of technical propane-butane, produced at gas-processing plant is disulfides, at helium plant-COS (hydrogen oxysulfide)).

Technical decisions and recommendations, developed by VNIIUS, JSC, took into account future toughening of requirements of European Standard, concerning content of total sulfur up to 10 ppm. In this connection, the institute proposed the following options:

- for gas-processing plant – reconstruction of existing unit of mixture of technical propane-butane cleaning; preliminary implementation term is 2012;
- for helium plant – decrease of total sulfur content in light ends by replacement of NaX zeolite in existing adsorbers A-1-4 into more effective adsorber. Zeolite Selexsorb COS is known to be used worldwide for treatment of liquefied hydrocarbon gases from COS. But, we should note, that light ends, supplied for treatment from sulphides, has trace mercaptans; that is why, combined (double-layer) zeolite loading is advisable for adsorbers. The second layer is NaX zeolite, which is widely used at the plant. Results of experimental-industrial testing confirm stable cleaning of liquefied hydrocarbon gases from sulphides up to 50 ppm. In order to reach stable results, which meet renewed requirements of EN 589, concerning total sulfur in treated raw materials (10 ppm), experimental-industrial testing of liquefied hydrocarbon gases treatment at helium plant are planned to be continued.
Main direction of Gazprom dobycha Orenburg, LLC’ activity is decrease of man-coursed influence of its facilities on environment and ensuring of ecological safety, due to improvement of environment safety control.

Initially, field’s facilities construction and operation of Orenburg gas-chemical complex depended on solution of different kinds of environmental problems, which arose during production, treatment, transportation and processing of hydrocarbon raw materials with high H2S and mercaptans content. These problems were redoubled due to location of the field in densely populated area. In affected zone over 30 settlements are located, including Orenburg’s southern outskirts and the Ural’s bottomland.

In general, technical and technological solutions, that were accepted and implemented concerning construction, ensured industrial and ecological safety up to beginning of the 90-es, while project operating conditions (pressure, temperature, flow rates, sour components content) were maintained in the system of gas production, collection, treatment and transportation.

Tendency of decreasing production led to resulted expansion of raw materials and mineral source due to strike and bringing into development of new fields with H2S content no more, than 3%.

In 1995 their share in total processing volume increased twice in compare with 1985. In this connection, working conditions of production and transportation changed. Sour components content increased from 1.9-2.1%; it reduced strength properties of facilities and pipelines. In order to keep ecological safety on the same level, acceptance of preventive measures, which corresponded new operation conditions, became necessary. Task to decrease man-coursed effect was solving due to:

1) introduction of advanced ecology oriented technologies;
2) resources, materials and energy conservation;
3) waste recovery and secondary resources use.

To improve environmental situation a number of technological processes of gas production, processing and transportation were upgraded, i.e. modernization of a unit for production of liquefied hydrocarbon gases that utilizes MEROX process to remove sulfides from propane-butane fraction; new environmentally friendly technologies for field treatment of gas and gas-condensate, closed system of low pressure gases conditining, system of non-destructive examination and screening to determine equipment and underground pipelines operating condition, closed well completion that helped to reduce emissions from stationary sources.

In addition to that more than 500 motor vehicles were converted to run on natural and liquefied gas thus reducing emission of air pollutants from vehicles.

A plant to process 400 tons a year of oil-slime without burning has been put into operation. Other modern technologies for industrial waste recycling are being developed and introduced.

All waste water undergoes compulsory treatment. Residential, industrial and storm waste water is treated by the biological treatment plants.

The company improves continually system of waste water collecting and treatment. In 2006 modernization of waste water treatment unit began at Orenburg gas-processing plant. It aims to implement system of zero-discharge water supply which will reduce annual fresh water consumption for 3 mln m³ and stop discharge of waste water on irrigated fields.

Unrecyclable waste undergoes decontamination with special equipment. The company has its own landfills at its disposal. All acting norms and standards for waste generation, decontamination and landfilling are strictly observed.
Measures are taken to monitor and prevent harmful influence of pollutants emissions generated by the company’s facilities.

Fig. 12. Location of computer-aided monitoring stations

Рис. 13. Values of ИЗА-3 index in 2008 (in comparison with 2007)

The company performs daily samplings of free air in 17 settlements. Development and
introduction of computer-aided system for environmental monitoring is near completion, computer-aided stations work in 21 settlements in the vicinity of the company’s production facilities (fig.12). Towards 2010 such stations will be located in 24 settlements. To assess level and ratio of anthropogenic impact three subdivisions of Gazprom dobycha Orenburg, LLC employ certified laboratories of environmental protection equipped with up-to-date analytical and measuring equipment.

Environmental situation in the proximity to the company’s production facilities is assessed with stationary stations and computer-aided stations of a system for ecological monitoring. Results of computerized and laboratory tests for hydrogen sulfide and carbon dioxide show stable mean values of concentration ratio for the above mentioned gases. Values of ИЗА-3 atmospheric pollution index are below normal values in the settlements located near the production facilities. Environmental situation can be appraised as calm and level (fig.13).

Application of state-of-art technologies and up-grading of existing production processes have reduced pollutants emission volumes.

Large-scale of production determines large-scale of required investments into environmental protection and industrial safety which exceed 9 billion a year, inclusive of expenses on repair, diagnostics, modernization etc.

Environmental safety rating of Orenburg gas-chemical complex has become higher due to a number of measures. Sedjwick, a world-known insurance company from Great Britain, has estimated highly environmental safety of Orenburg gas-chemical complex facilities.

Efficiency of a company’s performance depends much on management. Reforms that are being carried out by Gazprom, JSC and its subsidiaries aim to improve economic performance of the corporation, to introduce new advanced technologies, to ensure safety and reliability of production facilities and thus require introduction of new advanced managerial methods. At present moment in Russia and abroad separate companies as well as whole industries start to apply systems of management based on international standards. As Gazprom dobycha Orenburg is a supplier of more than 500 companies, adoption of new principles of management to ensure quality of products became urgent. In 2003 Gazprom dobycha Orenburg, one of the first among Gazprom’s subsidiaries, began to incorporate international requirements into existing system of management. In 2005 system of quality management adopted by the company was certified for compliance with ISO 9001 international standard. Inspection certification was done by Det Norske Veritas System of Certification. In addition to ever-stricter requirements for quality and competitiveness of products special requirements are set for environmental protection, industrial safety and health protection of employees and people who live near production facilities within in the densely populated area. It must be noted that production facilities of Gazprom dobycha Orenburg are classified as dangerous since in raw materials produced and processed by the company there is hydrogen sulfide, carbon dioxide and other hazardous substances while technological processes are not only fire- and explosive-hazardous but characterized by high corrosion activity and toxicity. In 2008 combined system of management that controls both of these important and interconnected activities of the company passed certification tests for compliance with international standards. Three certificates of conformity issued by Det Norske Veritas (Norway), one of the most well-known and respected System of Certification, state that Gazprom dobycha Orenburg employs integrated system of quality, ecology, health and industrial safety management which satisfy the requirements of international standards ISO 9001, ISO 14000 and OHSAS 18001. Our Integrated System of
Management that encompasses all activities of the company and its operating and administrative subdivisions with 8000 employees as well as its products establishes uniform managerial rules which guarantee quality of the products, environmental protection, labor protection and industrial safety. Introduction and certification of systems of management which conform to international standards give great advantages. Such key rules of the system as compulsory documentation, systematic analysis and revision of key production and managerial processes, periodic audit and internal checks help:

- to improve efficiency of the company’s performance
- to reduce risks
- to improve organizational structure and order and as a result to get more transparent system of management and manageability of the company;
- to enhance coordination between internal administrative levels, functions and divisions and to balance interests of internal and external parties better;
- to deepen personal interest of employees in the company's activities;
- to make the company more reliable and trustworthy

**Gazprom dobycha Orenburg, LLC has always been socially oriented company** and as such it has constructed one third of all city housing, 18 schools, 36 kindergartens and many other sites of culture, health care and sports.

Gazprom dobycha Orenburg, LLC has launched a number of social programs. Health care, recreation during vacation and child care are of primary importance. System of sanatorium-and-preventive treatment functions successfully. Preventive treatment is provided by the Black Sea sanatoriums Oren-Krym and Duna and by local health centers Ozon and Samorodovo.

For 40 years of the company’s history our employees have accumulated vast experience of development of the field that contains not only valuable but aggressive constituents as well.

Scientific and technical knowledge as well as experience gained by our employees will support implementation of the long-term program of the company’s development.

From the very beginning Gazprom dobycha Orenburg, LLC preferred innovation strategy of development and for forty years it has been taking active part in promotion of innovations, in development and introduction of advanced technologies and promising projects. It will allow Gazprom dobycha Orenburg, LLC to be one of the leading subsidiaries of Gazprom for years to come.