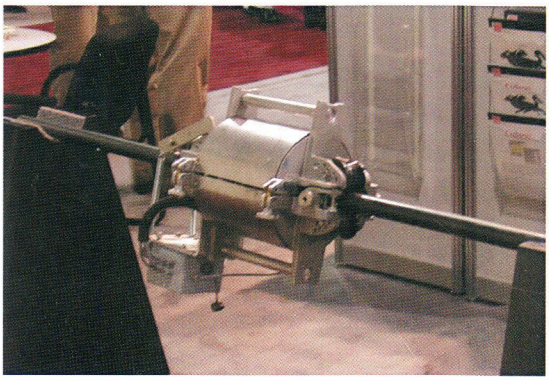
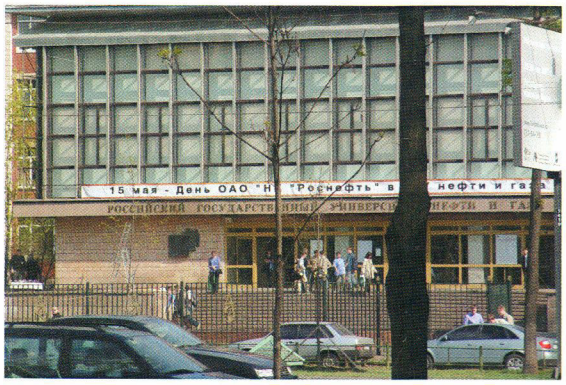
Nonprofit Partnership
"COILED TUBING TECHNOLOGIES' DEVELOPMENT CENTER" (CRKT)





Coiled tubing times

issue 4

The conference and exhibition on coiled tubing

SPRING MEETING IN HOUSTON

The conference and exhibition on coiled tubing, which was held on the 8th—9th April 2003 in Houston (USA), united under the roof of the Woodlands Waterway Marriot hotel the representatives of more than 50 companies — developers of the advanced technologies and those, who use them. The presence of a large number of professionals and two «live» coiled tubing plants provided the participants with the opportunity to share their experience and information about the fast-developing prospect branch — using the coiled tubing technology for drilling and repairing wells.

For the first time the conference was organized in 1990. SPE and ICoTA are the organizers.

The only Russian-language participants of the conference — the representatives of the FID Group of Companies — shared their impression about the exhibition with «Coiled Tubing Times».

Linevich Alexander Vladimirovich, Head of coiled tubing units bureau, FID Group of Companies

On my view the exhibition bore rather informational, than commercial character. At this exhibition the majority of the companies has presented the prospect equipment, which has not passed the whole complex of tests and is not ready for the commercial use.

Among the producers of coiled tubing units the company Varco with its subdivisions, the leader among the producers of the coiled tubing in the world, and the company Stewart & Stevenson were widely presented.

The company Hydra Rig, being the part of Varco, presented the coiled tubing unit, composed of: a four-axial tractor with a pump station mounted on it and a three-axial special semitrailer with: an operator cabin, a winding unit, injector (mounted at the rear end of the semitrailer on the turnover frame) with a spout guide, permanently fixed on it, two reels of winding sleeves. This unit can be put to the line between the plants M2001 and M40, produced by the FID Group of Companies. The distinctive features of this unit are the following:

- The four-axial truck tractor with a built-in rear trolley, only two rear axles are driving.
- The power delivery from the engine of the truck tractor and the pump station are mounted on the tractor frame.

Injector of company «Stewart & Stevenson» ◄

■ The space lifting operator's cab with additional working places, which has a conditioner and a heater. The control panels from whole non-rusting sheets with devices fastened on them and engraved inscriptions (false panels). It is also necessary to point out the convenient access to the cab and light aluminium stairs and hand-rail.

■ The winding unit is specially designed with the possibility of the fast change of the coil with a wound pipe and fast adjustment of installation unit for different diameters of a coiled tubing (CT).

■ On the CT in the region of the installation unit head the device for measuring the length of a pipe of special design is mounted (developed by the company CTES, the subdivision of Varco, being occupied only with control devices of the CT state and the software for devices of such kind), including two wheels, contacting with the CT from the bottom and from the top respectively. Data reading is made dynamically exactly from that wheel which rotates faster, that is the wheel, which slips or jammed, is excluded from the estimation.

■ On the winding unit the CT QT16Cr80 was wound (produced by the company Quality Tubing, a subdivision of Varco) of diameter 50,8 mm, of length approximately 5000 m from stainless steel of the new chemical composition and strength properties.

■ On the winding unit and the injector folding posts with safety mechanisms for those who work at large height are mounted.

■ At the rear end of the semitrailer the injector of the new series HR-560 with the drag force 36 tons is mounted on the turnover frame. In the design of this injector new-designed chains and the reducer part with one high-speed hydromotor are used.

At the exhibition the unit was presented which was similar by the composition to the unit of the company Stewart & Stevenson. However its design is much simpler, and the manufacture level is lower by order, than for the unit of Hydra Rig.

Our company has been taking part in similar events for already 4 years. At first the number of participants was small — 1—2 persons, now we visit similar events with the group up to 8 persons, including both engineers and supervisory managers. Analyzing the four-year experience of the participation in similar subject exhibitions and round tables, I can point out, that the information about the newest technologies became more accessible, — the organizers illustrate widely the themes not only at round tables and in the exhibitions pavilions, but also use the printing (such magazines like «JPT», «SPEDC», «Coiled Tubing Times» and the Internet. There is the possibility to exchange the experience. The presence of Russian companies at similar events is negligible. During all this time only at round table in Aberdeen (Scotland) we met the representatives of Gazprom and Sibneft. It is particularly astonishing, that at the fastest in the world tempos of growth of such a prospect equipment as the coiled tubing, the number of implemented newest technologies in the former Soviet territory is very small. In Russia the holding of similar informative and visual events also began. I hope, they will gather under their roofs a large number of professionals not only from CIS countries, but from Europe, Asia and Africa.

Hruzdzilovich Leonid Mikhailovich,
President of FID Group of Companies

Kablash Sergei Victorovich, Head of the coiled tubing complexes department FID Group of Companies

At this exhibition the whole spectrum of main producers of the coiled tubing equipment was presented, the producers of the accompanying and other equipment, used directly on coiled tubing units (producers of CT, blowout preventer equipment and different instruments), as well as a number of service companies, which use this equipment.

Quality Tubing – one of the subdivisions of the company Varco – presented CT for working under the conditions of high pressure of type QT1200. A special interest was caused by the tube QT16Cr80, produced from stainless steel. The material has the increased resistance to CO_2 and H_2S (what is actual for the conditions of Orenburg and Astrakhan). The CT from this material is at the stage of testing. According to preliminary estimations the CT cost from this material will be twice as higher that the cost of a usual steel tube, but at the same time the lifetime will exceed more than 2 times the lifetime of a tube from steel of group QT900.

CTES presented at the exhibition the hardware and software for planning and analyzing operations with the coiled tubing – Orion and Cerberus, as well as the program of data acquisition – the analog of the domestic SKR-40. They propose the device for controlling the diameter and ovality of the CT in the real time regime when working on a well, which works with programs Orion and Cerberus. The firm has also developed the device controlling the thickness of the tube wall.

The similar device, also measuring and controlling the thickness of the tube wall, is proposed by the Rosen. The company Rosen doesn't sell the device, but renders services for flow detection.

The firm AnTech presented at the exhibition the orientator of new type for drilling wells with coiled tubing. In contrast to the design known before, which turned BHA by order from the surface to the required angle, the orientator, presented at the exhibition by the AnTech, refers to the so-called «indicating» type. Such an orientator curves BHA by order from the surface in the required direction to a small angle (up to 1,5°). The possibility to drill easily rectangular areas of the borehole, lesser required power for orientation in comparison with the orientators of rotation type, and then the demands to the surface equipment (electric collector, transformer), can be attribute to the advantages of the orientator of such type. The drawback is a large radius of the borehole curvature, because bending of BHA takes place higher than the screw downhole motor. At the same time BHA COLT has a very small length (of order 8,2 m (4,6 m without downhole motor)), what allows to carry out assembling and lowering of BHA safer, because these works will be done without the locking operation. The number of preventers being used also decreases, because there is no necessity to carry out the intercept when assembling BHA.

CTES device to control geometry of CT

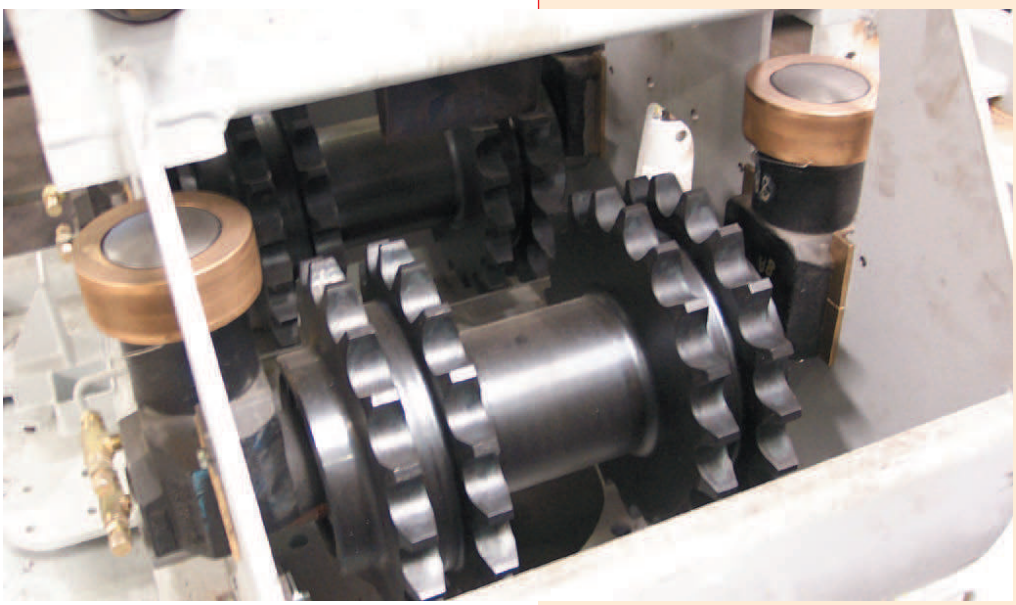
At the same time the demands to hoisting machines (mast, crane) decrease, because the required height of lifting the hook decreases significantly. Principally, such length of BHA allows to do with the simplest hoisting machines of the type crane-beam of carrying capacity about 500–700 kg. In addition to the best characteristics «under ground», it allows to decrease the steel intensity (and that means, also the cost) of surface structures, to do the work of the complex safer, to decrease the time, spent on assembling and lowering-lifting of BHA.

BHAs for drilling wells were also presented by Baker Hudges, Weatherford and Schlumberger.

BHA Viper produced by Schlumberger has the closest characteristics to BHA COLT of AnTech.

The Weatherford Company has the assembling with a hydraulic orientator of rotation type, being controlled from the surface through hydraulic capillary pipes running inside the tube. The length of BHA is about 15 m. About 45

Down sprocket of injector of the company Hydra Rig



CT characteristics after shear rams' work of the preventers of «Texas Oil Tools»

Coiled tubing equipment of the company «Varco»

Stand of the company «Precision Tube Technology», one of the leading manufacturers of coiled tubing

wells during 4 years have been drilled by this assembling. The electric orientator is not yet ready. BHA of the Weatherford is proposed only on the terms of leasing.

The Baker Hudges has already presented the known BHA CoilTrack, as well as the prospect assembling with the orienting mechanism of deviation type, with retractable shoes, which setting against the wellbore wall, deviate BHA to the desired side.

At the exhibition the devices for increasing the reach of the coiled tubing in the horizontal hole (intrawell tractors) were also presented. In addition to the known tractors (Welltrack, Smarttrack) the firm Western Well has presented the tractor of the crawling type (with 2 rotors, working in turn). The tractor is under testing and has already made almost 54 km in wells. The pushing force in 5,5 t will allow to use it for drilling wells.

I think, that the participation in the conferences and exhibitions of this kind is necessary in order to bring out our positions at the coiled tubing equipment market and acquaintance with new achievements in this field.

COILED TUBING TECHNOLOGY AND PROCESS OF TRAINING CERTIFIED SPECIALISTS

Ivanovsky V.N.,
Head of the chair of machines and equipment of the oil and gas industry of the Russian State University of Oil and Gas named after I.M. Gubkin

The chair of machines and equipment of the oil and gas industry – one of the oldest and leading chairs of the faculty of engineering mechanics of the Russian State University of Oil and Gas named after I.M. Gubkin – is now the basic one for training mechanical engineers in specialty 170200 – Machines and equipment of oil and gas mines. It coordinates the work of kindred chairs of higher educational institutions of the oil and gas profile of Russia.

The professor of the Moscow Mining Academy and the Moscow State University, later the full member of the Academy of Sciences of the USSR Leonid Samuilovich Leibenzon was the founder and its first head. He took the active part in organizing the Moscow Oil Institute named after I.M. Gubkin, and in April 1930 he was at the head of the chair of petroleum mechanics and hydraulics.

The first graduation of specialists was in 1932.

From the moment of the chair formation the lectures were delivered on two disciplines: primary one – «Oil field mechanics» and professional-wide one – «Hydraulics». In 1931 one more course was added to them «Refinery mechanics», and in 1933 – «Electricity in oil business».

Later the courses «Hydraulics», «Refinery mechanics» and «Electricity in oil business» were transferred to the newly formed chairs, and the efforts of the chair were directed to the preparation of mechanical engineers in specialty «Refinery machines and mechanisms».

For the successful solution of problems arising in the oil and gas industry at the chair were created consequently the scientific research and branch laboratories of *Dynamic stability of the technological equipment, Refinery equipment, drilling equipment, Gas-field equipment, Sector of polymer coatings*, as well as *the students' design office (SDO)*. All this led to the creation at the chair of a big scientific school, where the scientific trend got its further development, the basics of which were laid already in the works of the academician L.S. Leibenzon and the professor I.A. Charnogo. Now the chief of the school is the professor, PhD in engineering, honoured worker of science and engineering of the Russian Federation Y.V. Zaitsev, who within 20 years (1983–2002) was at the head of the chair of machines and equipment of the oil and gas industry of the Russian State University of Oil and Gas.

The developed methodologies of solving industrial tasks were widely used to increase the reliability and effectiveness of work of the refinery equipment. The scientific school, created at the chair, has been recognized by all organizations of the machine-building type, as well as by the enterprises of oil and gas companies. A number of works has been done under the contracts also for foreign customers.

Among the most famous developments of the chair there are electric drills, drilling bits with the hydromonitor washing of the borehole bottom, chisels with sealed oil-filled bearings, hydraulic rod pumping plants, multiple-string roller chain-drives for driving the units of drilling rigs, algorithms and programs of control the drive of mud pumps, impulse-wave, ejection and vibroejection instruments and devices for drilling and underground repair of wells, complexes for hydraulic breaking of the sheets, long-stroke well pumping units, assemblies for lowering and lifting continuous wind-up tubes, used for major repairs and drilling of wells, hydraulic diaphragm electric pump, screw engines and pumps, soft hardware complexes of selection and diagnostics of the refinery equipment, methods and programs of control the drilling process when using the technology «coiled tubing» and many others.

The development of the direction «coiled tubing» is «continuously wind-up tubes (CWT) and pumping rods (PR) and the equipment for work with them» is carried out at the chair from the beginning of the 70-ies of the XX-th century.

These works were carried out in cooperation with the Special design office on rodless pumps (SDO RP), with the Tatar Research Institute of Oil Machines, with the factory «Borets», Voronezh mechanical factory and with other developers and manufacturers of the refinery equipment. Already in the middle of the 70-ies of the XX-th century at the chair and in the students' design office the degree work projects on the assemblies for lowering and lifting continuous tubes and rods were developed, in the beginning of the 80-ies these two projects to the problems of deformation and durability of continuous tubes and rods were prepared and defended. Many elements and units of the equipment for the coiled tubing technology, developed at the same time, were used later when designing and manufacturing the development assemblies for the work with CWT and PR.

At the chair the works are permanently carried out in order to improve the equipment for working with continuous tubes and rods. The professor A.G. Molchanov carries out a large work in this direction. He is one of the authors of the book on the basics of designing and using the equipment with coiled tubing, as well as

one of the authors-designers of the original assembly for working with CWT. This assembly was called «Scorpio» (Fig. 1). Because of the original composition the assembly has all necessary equipment for carrying out the works on irrigation of sand and hydrant plugs (including the sealing agent of the well head and pump plant), which are placed on one and the same transport base of small mass and increased permeability. When working on the well the injector (conveyer of CWT) of the assembly rests upon a separate support and has no negative forced influence on the head of the processed well (Fig. 2).

In 1980–1990 the employees and students of the chair took part in the works for creating a series of assemblies with the CWT and conducting their oil field tests. These works were carried out together with the SDO RP on oil fields of the country.

In recent years the teachers, employees and students of the chair cooperate closely with the Open JSC Experimental Factory «Metallist», which has developed the production of coiled tubing units of the series MURS. The drag force of conveyers of these plants is 25 tons, the depth of lowering the CWT of diameter 38 mm achieves 3500 m. These plants have some design advantages over others similar types of equipment and are placed on standard automobile transport bases.

Having the significant experience in creating the equipment with continuous pump tubes and rods, the chair of machines and equipment uses it in the training of the certified specialist for oil and gas branches, as well as for the machine building companies. Only during the recent five years the chair turned out more than 20 specialist, who today work in different oil companies as mechanics and operators on the assemblies and plants, which use continuous stalks. In order to train such specialists a special literature and methodical developments, which are prepared at the chair, are used. Among these developments it is necessary to point out the monograph «Underground workover and drilling of wells by using coiled tubing» (the authors are Vainshtock S.M., Molchanov A.G., Chernobrovkin V.I.), the handbook «Equipment for oil and gas production» in two parts (the authors are Ivanovsky V.N., Darishchev V.I., Kashtanov V.S. and others), lecture summaries on special chapters of the course «Machines and equipment for oil and gas production and preparation», on the course «Underground workover of oil and gas wells». The mentioned courses are given for both the students-mechanics and for the students of the faculty of the petroleum and gas deposit development. Every year 1–3 students prepare and defend the degree works on the theme «Equipment for working with continuous tubes and rods».

The teachers and employees of the chair deliver lectures at the courses of professional development of the workers of the oil and gas industry, where the exchange of opinions on different issues of creating and using the equipment with CWT and PR takes place. In addition to the mentioned literature at these lectures video films are used, both of the foreign production, and made by the chair employees when manufacturing and using the equipment with continuous tubes and rods on the oil and gas fields.

The appearance of the subject magazine «Coiled Tubing Times» became a significant event for oil industry workers, gas industry workers and mechanicians, because the possibility of exchanging opinions and information, agreement of terms and prospects of this progressive type of equipment appeared. ▲

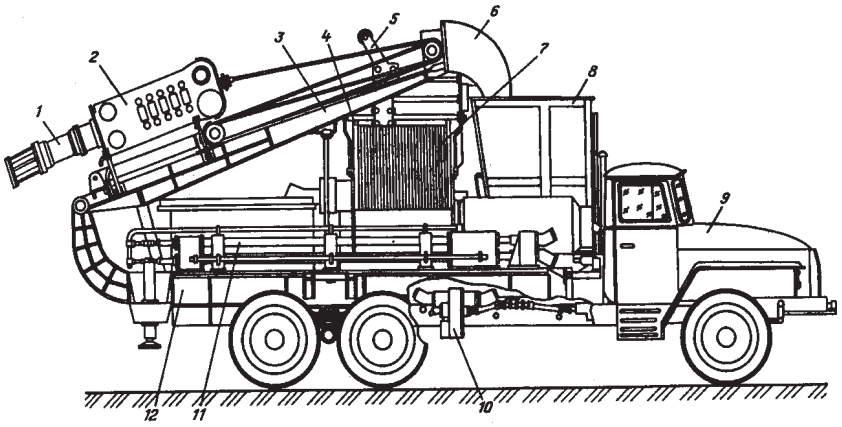


Fig. 1. Aggregate «Skorpion» in over-the-road position:
1 – stripper; 2 – transporter; 3 – assembling device; 4 – reel; 5 – CT levelwind; 6 – guiding arch; 7 – coiled tubing; 8 – operator's cabin in over-the-road position; 9 – chassis of truck; 10 – distributing reduction gear of the hydraulic drive pump; 11 – screw pumps for the process fluid supply; 12 – platform.

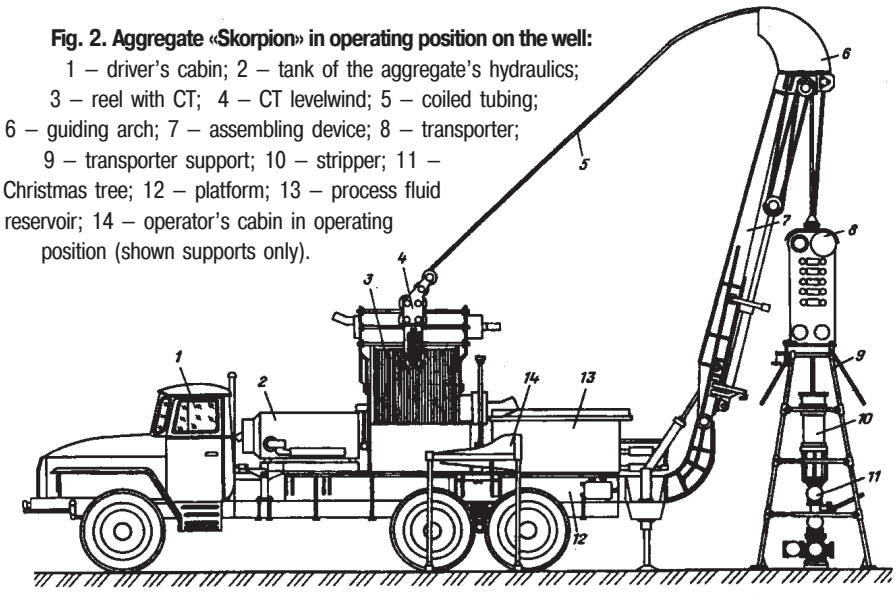


Fig. 2. Aggregate «Skorpion» in operating position on the well:
1 – driver's cabin; 2 – tank of the aggregate's hydraulics; 3 – reel with CT; 4 – CT levelwind; 5 – coiled tubing; 6 – guiding arch; 7 – assembling device; 8 – transporter; 9 – transporter support; 10 – stripper; 11 – Christmas tree; 12 – platform; 13 – process fluid reservoir; 14 – operator's cabin in operating position (shown supports only).

UNDERBALANCED DRILLING SYSTEM WITH COILED TUBING APPLIED

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(Report at the IV Congress of Oil-and-Gas Producers of Russia, May of 2003, city of Ufa, Bashkortostan)

The hydrocarbon raw stock in the Earth's interior is on a steady decrease, especially it is a pressing problem for Russia where the majority of oil and gas fields are in the late stage of development and characterized by the reservoir underpressure. To hold the former level of the hydrocarbons production rate, the drilling techniques are moreover required which will guarantee the utmost degree of preservation of collecting properties in a payout bed, ensure the reduction of costs and of gross drilling time. One of the most efficient and a state-of-the-art technologies – the underbalanced drilling with coil tubing applied – meets all these requirements. This technique includes a number of other benefits:

- Increase of the payout beds recovery factor;
- No need to shut down a drilling process for adding of drill pipe length, therefore a controlled differential pressure drawdown remains constant during the whole drilling process;
- Reduction of material and financial expenditure for well completion operations;
- Reduction of material consumption for drilling agents and process liquids;
- Enchancing of a penetration speed and a drilling bit performance owing to the hydrostatic well bottom pressure decline;
- Reduction of time and material consumption for elimination of drilling problems and emergency cases (lost circulation, absence of sticking caused by repressions and so on);
- Complete environmental safety of uncovered collectors and environment;
- Reduction of gross drilling time and well completion time.

«Bashneft» oil company initiated a project on development and mastering of the underbalanced drilling technique, with the coil tubing applied, for rat holes and horizontal bore holes. In accordance with the performance specification offered by «Bashneft», FID group of companies invented an M-4001 mobile coil tubing aggregate (fig. 1, fig. 6, pos.1) which became a component part of the underbalanced drilling system, hereinafter named as the System (fig. 2, 6).

The underbalanced drilling system with a coil tubing aggregate applied includes the following component parts as well:

- a closed-type circulation system, an automatically controlled throttle manufactured by «Burenie» Research & Production Association, city of Krasnodar (fig. 3, pos. 1, fig. 6, pos. 2 – a throttle automatic control system, pos. 3 – a control board of the throttle automatic control system, pos. 4 – a sludge remover, pos. 5 – a gas buster and a receiving tank,

Fig. 1. M4001 Mobile Coil Tubing Aggregate

Fig. 2. Underbalanced Drilling System with Coil Tubing Aggregate Applied

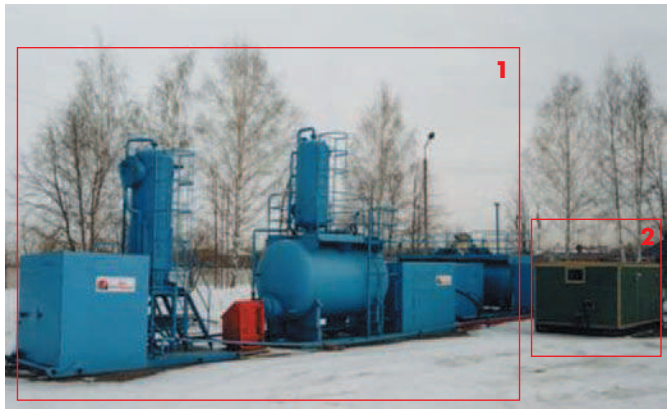


Fig. 3 Closed-type Circulation System and Pump Block

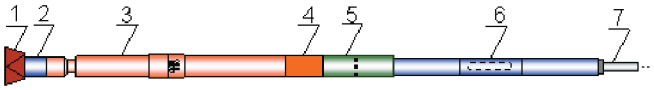


Fig. 4. Bottomhole Television System for Coil Tubing Drilling:
1 — a drilling bit; 2 — an above-bit television system block (in the television system manufactured by the Research Institute of Geophysical Investigations only); 3 — a screw motor; 4 — a catline sheave (an emergency breaker, a check valve, an equalizing sub); 5 — a hydraulic orientator; 6 — a television system, the coil tubing provided with electric cables

pos. 6 – a block for chemical treatment of the solution, pos. 7 – a compensating tank);

- a pump block manufactured by «Sinergia» close corporation, city of Perm, provided with a feed control device during the drilling process (Fig. 3, pos. 2, fig. 6, pos. 8 – a pump block, pos. 9 – a pump control unit);
- a system for processing characteristics control in the circulation system manufactured by «Geophysika» Research&Production Factory, city of Ufa;
- a bottomhole television system «Nadir» manufactured by «Geophysika» Research & Production Factory, city of Ufa, or a bottomhole television system manufactured by the Research Institute of Geophysical Investigations, (VNIIGIS), town of Oktyabrsky (Fig. 4);
- a nitrogen apparatus mounted on a car chassis (in case of need);
- a blowout preventer equipment manufactured by Voronezh Engineering Plant (Fig. 5);
- flare (in case of need, Fig. 6, pos. 10 – a line for a flare).

A production equipment arrangement is depictured in Fig. 6.

The underbalanced drilling with the coil tubing applied is performed in some stages (Fig. 7). At the first stage a holing is executed down to a payout bed,

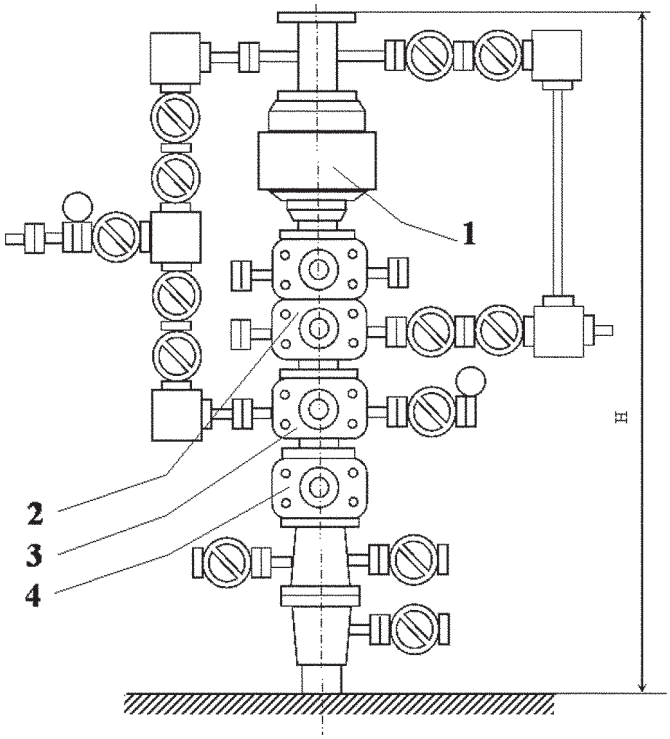
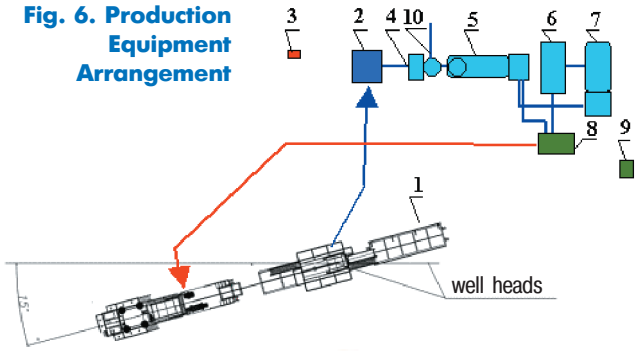


Fig. 5. BOP equipment:
1 — a general purpose rotary preventer; 2 — a twinned ram-type blowout preventer; 3 — a single-gate blowout preventer; 4 — a blind ram-type blowout preventer.

Fig. 6. Production Equipment Arrangement



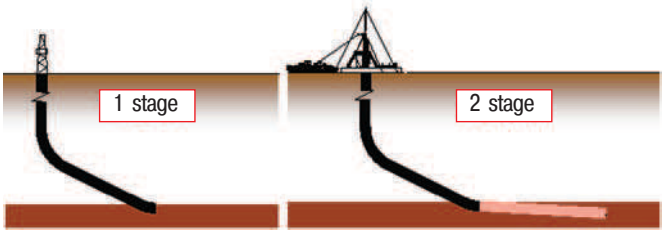


Fig. 7. Stages of Well Boring with the Coil Tubing Applied

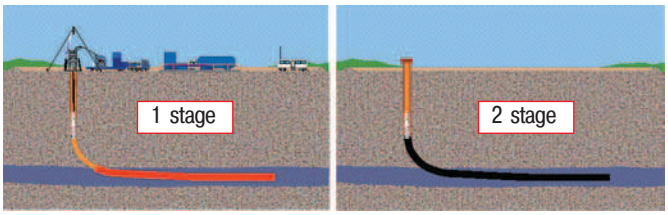


Fig. 8. Stages of Well Completion with the Coil Tubing Applied

the ordinary drilling rig is being used, or a bore hole of an old well is conditioned. At the second stage a tailing-in and a hole making within the limits of the payout bed is accomplished by means of the described system using the underbalanced drilling technique.

When the well boring stage is over a retrievable cutting packer is being lowered into the well through the coil tubing (Fig. 8), it is positioned there and thus seals the under-packer space, just precluding the possibility of a contamination in the critical area of formation at the time when the System undergoes dismounting and a production equipment is assembled.

During the well boring process the information from all systems is being transmitted to an operator's compartment, being interpreted and represented in an understandable form. The program for hydraulic parameters calculation enables to perform a revision, corrective actions and and to obtain indication of parameters in accordance with the current environment (Fig. 9). All logged parameters are stored in the computers.

Logged parameters are subdivided into following groups:

1. M4001 Coil Tubing Aggregate parameters:
   - injector force;
   - pressure in a discharge manifold and inlet manifold;
   - circulating fluid temperature;
   - tripped tube length;
   - quantity of tube trips;
   - as well as parameters characterizing the M4001 equipment operation;
2. Close-type circulation system parameters (Fig. 9):
   - pressure, density, a circulation rate, an electric conductivity,
   - temperature at the

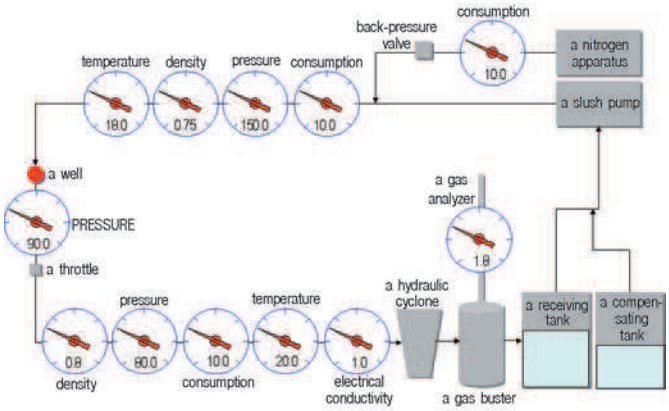


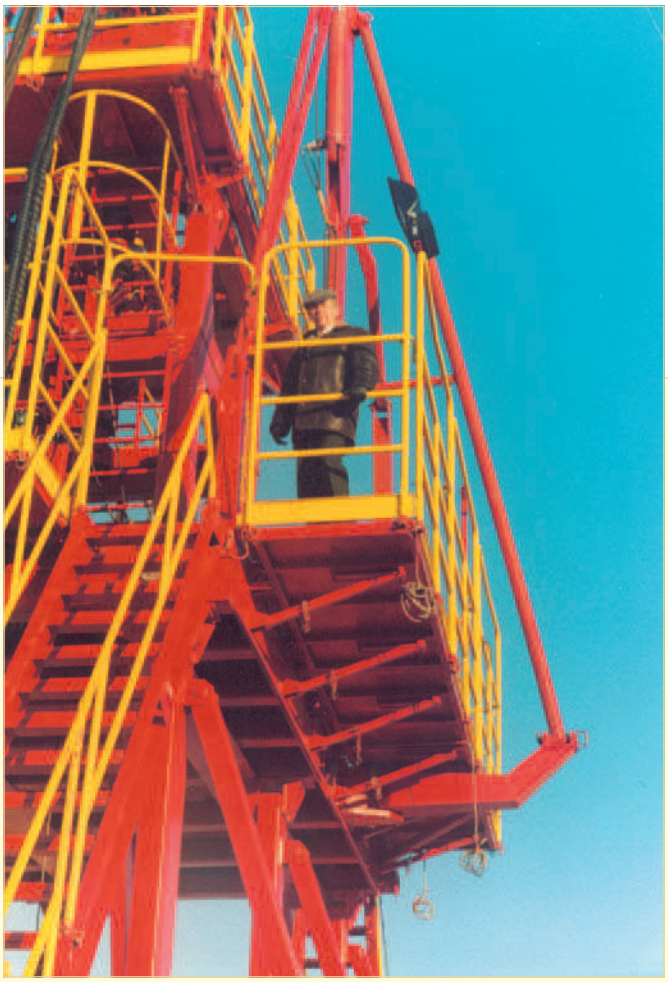
Fig. 9. Circulation System Checking Routine

pressure line and at an upstream line;

- fluid level, an interface level, pressure in a receiving tank;
- fluid level in a compensating tank;
- hydrocarbon gases concentration at a gas buster outlet;
- gas flow at the nitrogen-plant outlet;

3. Bottom hole television system parameters:

- azimuth, an inclination angle, TV-system body position with respect to the apsidal surface;
- natural gamma activity of rocks;
- tube pressure and annulus pressure at the television system;
- thrust load on the bore bit;



- bore bit operating speed.

A throttle automatic control system is also provided with its own storage mapper and a data recording unit.

A drilling process is controlled by three experts: an operator of the coil tubing aggregate (responsible for round-trip operations and the advance of tool), a telemetrist (responsible for a navigation in a payout bed) and a drilling mud engineer (responsible for keeping the performance objectives of the circulating fluid and project differential pressure drawdown).

At the beginning of this year the underbalanced drilling system with the coil tubing aggregate applied which was developed at the proving ground of Ufa UBR (city of Ufa, Bashkortostan) passed successfully preliminary tests and currently it is being prepared for field testing.

Nowadays a combined control and monitoring system of the above complex is being worked out (Fig. 11). It will enable to effort an opportunity for the most efficient drilling-in of payout beds.

The above underbalanced drilling complex for a drilling-in of payout beds serves as an instrument for a multihole horizontal well construction as far as it is considered to be the most advanced mining technique.

The application of the coil tubing in the drilling process is not panacea. The coil tubing proves itself as a high-powered and expensive apparatus that has definite shortcomings, operating limitations and demands a high professional handling.

Gennady SHURIGIN,
Vice-President, FID Group of companies

The application of M4001 — technological, workover and stimulation operations on oil, gas and gas condensate wells without killing. A working out and manufacturing of the KM4001 coiled tubing unit, which is a part of the underbalanced drilling system, by «Bashneft» took eight months.

The essential moment was the close cooperation of FID group of companies staff and broad specialists of «Bashneft» as well as the research engineers of «Bashnipiheft» during the process of the coordination of the underbalanced drilling system performance specification.

I believe that in future this job will give solid grounds for the coiled tubing drilling techniques advance in Russia. ▲

COILED TUBING TECHNOLOGIES

IN «URENGOIGAZPROM» – STRATEGY, NEW TECHNOLOGICAL DECISIONS AND MAIN TRENDS OF FURTHER IMPROVEMENT

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«Urengoigazprom» develops the Urengoi gas-oil-condensate field (UGOCD) for more than 25 years. At the present time the deposit is at the conclusive stage of the development, in addition the well operation is complicated by a number of factors: drop of the formation pressure; destroy of the productive formations and removing mechanical admixtures; lifting the level of the gas-water contact (GWC) and supplying wells with water, etc. Therefore recently at UGOCD increased the role of organizations, being occupied with the major and current repairs of wells.

The success of repairing wells depends in many respects on the effectiveness of used technologies, for which increase at UGOCD, beginning from 1999, the implementation of coiled tubing units began.

During the period from 1999 to 2002 the repair of more than 400 wells has been carried out by using the coiled tubing.

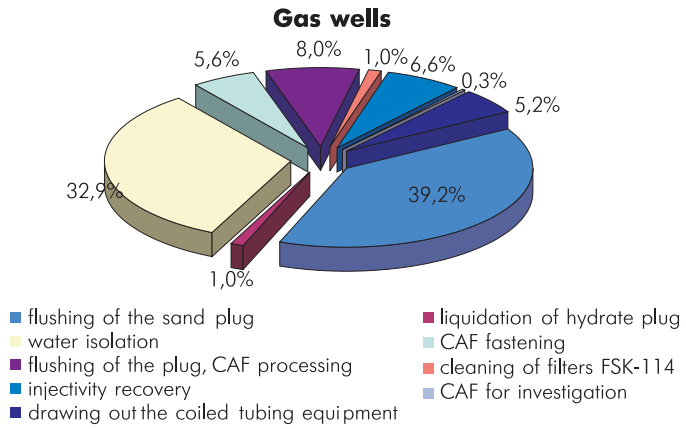
The following technologies have been developed: liquidation of hydrate and paraffin-hydrate plugs; sand plug flushing; isolation of the formation water influx by pumping the water-isolation materials; fastening of the critical area of formation (CAF) with liquid soda glass; carrying out acid processing; development of wells; flushing wells with the horizontal end; cutting of pump-compressor pipes; restoration of the injectivity of injection wells, etc. In addition, there is the experience of liquidating accidents with a coiled tubing (CT).

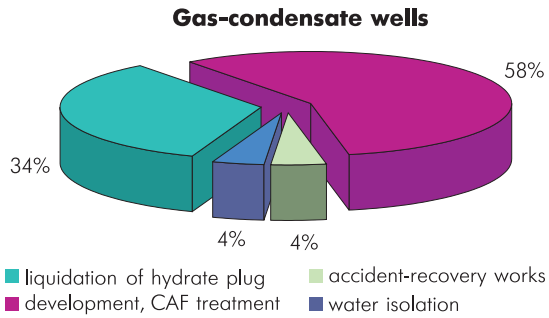
In the diagrams of the ratio of quantity of repair types are given, which were conducted on gas, gas-condensate and oil wells of the Urengoi deposit. Let's examine the main types of technologies of carrying out works.

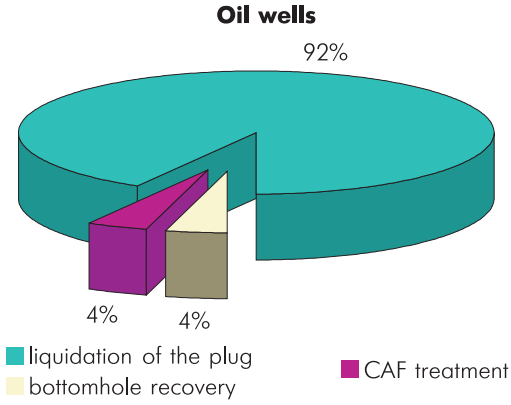
Liquidation of hydrate and paraffin plugs

The change of the operation modes of wells, coming of formation water into the well production, as well as the presence of paraffins in the produced oil brings to the formation of hydrate and paraffin-hydrate deposits in the borehole. Bridge plugs being formed as a result of that bring to the stop of wells.

The technology of liquidation of this complication consists in the plug thaw by simultaneous lowering of CT with the circulation of a hot heat carrier. As a heat carrier stable gas condensate or degassed oil are used for thawing oil wells, which have the increased specific heat. To thaw







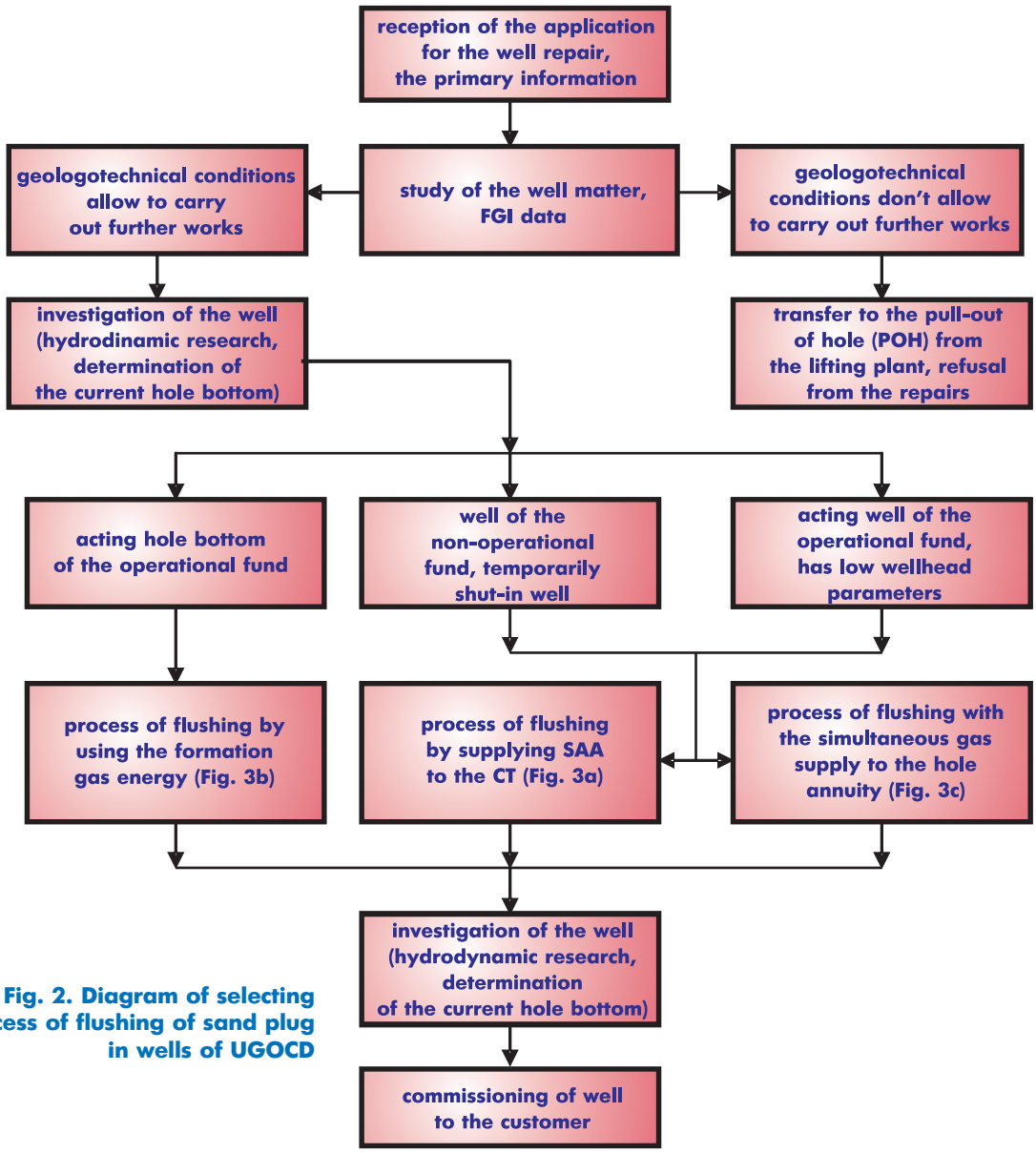


Fig. 2. Diagram of selecting the process of flushing of sand plug in wells of UGOCD

gas and gas-condensate wells the water-methanol solution is used, which is at the same time the inhibitor of the hydrate formation. The advantage of using coiled tubing units consists in the following:

- decrease by 2–3 times of the repair duration and consumption of chemical reagents;
- ecological safety of the process in connection with the closed circulation cycle;
- there is no need to kill the well, to work under the conditions of depression on the productive formation;
- safety of conducting works under the conditions of high gas factor.

Flushing sand plugs, buildup of borehole bottom

The technology of sand plug flushing is based on the process of fluidization – transformation of the grain material layer (formation sand) to «pseudoliquid», the so-called «boiling layer», and its lifting by the upflow of the liquid-gas mixture.

The technology of carrying out the repairs consists in making the following works in series:

- determination of the current state of the well (investigation with the sample splitting in different regimes, breaking of the current borehole bottom);
- lowering of CT till the sand plug top;
- sand plug flushing by lowering the CT and supplying the flushing liquid with the simultaneous blowing-out to flare discharge, for lifting the formation sand from the borehole and freeing of CAF from the flushing liquid;
- removal of CT;
- investigation of the well after making the repairs.

As flushing liquids two-phase foam systems are used, which are prepared on the basis of technical water by adding foam formers – 0,5–2 % of surface active agent (SAA) (OP-10, neonol). Under the conditions of low temperatures the 30–40 % of water-methanol solution is used instead of water.

As a result of works, carried out on not more than 200 wells, three process flowsheets of flushing sand plugs have been developed, which are different in the method of receiving the two-phase foam in a well. The selection of this or that flowsheet depends on the conditions of carrying out the works (the design of the well and underground equipment; temporarily shut-in

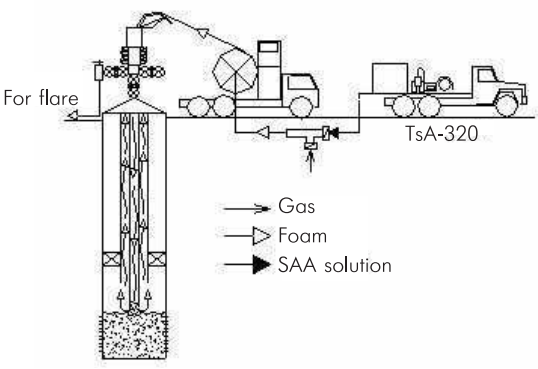


Fig. 3a. Flowsheet of flushing the sand plug in the temporarily shut-in well

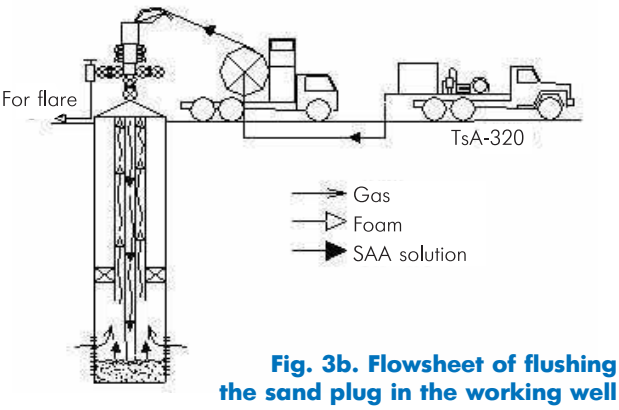


Fig. 3b. Flowsheet of flushing the sand plug in the working well

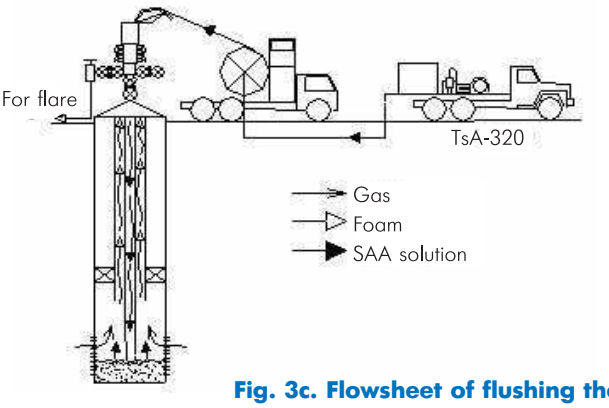


Fig. 3c. Flowsheet of flushing the sand plug in the temporarily shut-in well by attracting a booster plant

well or development well; the current state of the well; possibility to supply gas from the donor well). In Fig. 2 the scheme of selecting the process of flushing the sand plug is given, and in Fig. 3a, 3b, 3c the process flowsheets of flushing are given.

Isolation of the formation water inflow

At the present time the water-isolation works by using coiled tubing units have been carried out on 96 gas and gas-condensate wells of UGOCD. For carrying out works the available formulas of isolation compositions have been adapted and new ones have been developed. The methods of selecting the repair process, consisting of several staged have been developed. In Fig. 4 these methods are presented schematically.

Diagnostics. At this stage the preliminary well selection is made, whose geologo-technical state allow to carry out the water isolation by means of the coiled tubing plant. It includes:

- complex study of geo-technical conditions of carrying out works by taking into account specific features (designs of wells and the underground equipment; the perforation interval; GWK level; presence of the high-permeability interval, etc.);
- data of recent field and geophysical investigations (FGI), hydrochemical analyses of formation water samples is estimated, the character and the source of watering are preliminary determined;
- the current study of the well is carried out (hydrodynamic research, breaking of the hole bottom).

Preparation of the well for carrying out isolation works (if necessary). This stage consists in the pass-through recovery in tubing, false bottom recovery and cleaning of the critical area of formation. After that, if necessary, in order to make details of the reasons of water inflow additional FGI are carried out.

Choice of the technology of carrying out the works. According to the results of investigations at this stage all possible technological solutions are developed, and the choice of the method of carrying out the isolation works is made.

After carrying out the isolation works the well development, working-off and investigations are performed, according to the results of which the effectiveness of the works made are determined.

Well development and intensification

One of the problems, presented at the concluding stage of development of UGOCD is the development of wells, after the extensive repair. Thus, in order to bring a well to the working operation mode 3–7 acid treatments are made, after every one the repeated well development is carried out and the working-off for flare within 48–72 hours is carried out.

As have been already pointed out, the long operation of the deposit has brought to the drop of the reservoir energy, and the methods and process of the well development used before, don't allow now to use them effectively. The low pressure in collectors of multiple well platforms doesn't allow to decrease the liquid level in the well to the required value and cause the influx. As a result of it, in order to carry out the development and to bring gas, gas-condensate wells to the operation mode a lot of time was spent, in some cases on gas-condensate wells the works lasted up to 2–3 months and more, what led to the significant rise in price of repair works.

This problem was solved when the gas-pumping units were purchased, the use of which in a complex with coiled tubing units allowed to make effectively the works on giving rise to the influx. This problem is solved with special effect in the wells equipped with bottom-hole packers, where there is no possibility of circulation between tubing and the hole clearance.

Totally with using coiled tubing units the recovery of the well productivity has been made on 72 gas, gas-condensate and oil wells.

In this connection the foreign experience indicates, that CAF directed acid treatments through special nozzles with side hydro-monitor holes (the most prospective (hydrochlorid-acid,

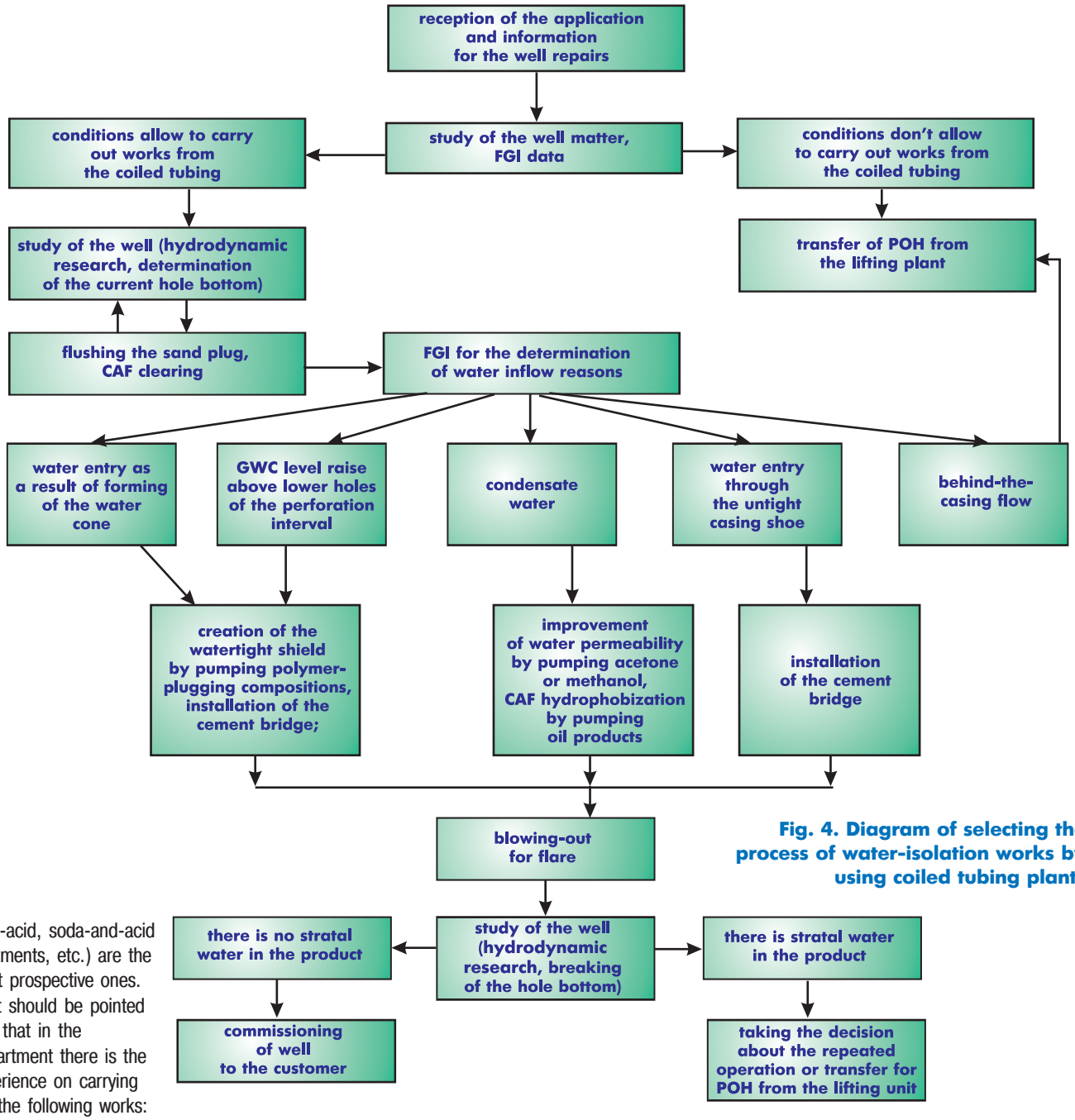


Fig. 4. Diagram of selecting the process of water-isolation works by using coiled tubing plants

mud-acid, soda-and-acid treatments, etc.) are the most prospective ones.

It should be pointed out, that in the Department there is the experience on carrying out the following works:

- flushing of horizontal boreholes;
- liquidation of stickling and clipping of CT;
- two operations are made on cutting of caught-on tubing;
- one operation for drawing out the radioactive source;
- the process of drawing out valve-shutoffs has been developed and implemented with success.

In prospect it is planned to expand the list of works, carried out by using coiled tubing plants:

- interval acid treatments;
- drawing out restrictions (scratch wire, geophysical devices, etc.) from wells;
- investigation of wells, logging works, perforation;
- drilling cement bridges;
- liquidation of wells;
- installation of drillable bridge packers.

The prospects of the further use of coiled tubing plants, as before, are restrained by the absence of the underground equipment and tools; inflatable packers for isolation works and for acid treatments and drillable packer-plugs; special grab iron; screw downhole motors; hydraulic stabilizers, etc. It makes impossible the use of the coiled tubing equipment for carrying out complex operations, expanding the technological possibilities of pants.

Conclusions

The scientific and technical potential, available in the UIRS, allows to solve with success many problems on the well repairs by using coiled tubing units at the UGOCD. UIRS has 15 coiled tubing technologies of making the well repairs. The received experience and methodological approach when choosing the repair technology allowed to increase the work effectiveness: the growth intensity of the gas well number, working with the restriction on debit, reduced approximately in 2 times. ▲

— What is your opinion about the importance of the edition of the specialized magazine about coiled tubing in Russia («Coiled Tubing Times»)?

— Any publication which promotes the use of coiled tubing in a responsible way should be welcomed. A local publication for the Russian market may be especially useful for distributing information about coiled tubing products and their use in the field. There will be a rapid expansion of coiled tubing applications in Russia in the coming years, so relevant information will become more important.

— What are the prospects of coiled tubing development in the world and in Russia?

— The use of coiled tubing continues to accelerate around the world and at a very rapid rate in Russia particularly. This is mainly because coiled tubing has not been widely used in Russia until a few years ago. The oil & Gas operators in Russia are now beginning to see the economic impact of using coiled tubing instead of other traditional, less cost effective methods of well workovers. Coiled tubing drilling (CTD) is also poised to make an impact on the Russian scene. Today, the value of the coiled tubing market for all products and services exceeds $2 billion and is continuing to grow at the rate of about 11 % annually globally, but at a much higher rate in Russia.

— Have you ever been to Russia? Have you ever tried to study Russian language?

— Yes, I have been to Moscow and Siberia many times. In 2001 I was fortunate to participate in an Energy Ministry meeting to discuss the future of coiled tubing In Russia. My speech was titled «Russia, the Next Frontier for Coiled Tubing».

The answers on the questions are comments of Ron Clarke and not official comments from ICoTA. ▲

REDUCING THE COST OF COILED TUBING CLEANOUTS BY CONDUCTING THEM WITHOUT NITROGEN

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SPE 81744

Abstract

One of the most common applications of coiled tubing is the removal of sand or other debris from wells. The typical operation involves circulating fluids down the coiled tubing and up the well. The fluids are designed to carry the sand from the bottom of the well to surface, without killing or over pressurizing the well.

Because most sand producing wells are under pressurized, gas is typically required to keep the hydrostatic weight of the return fluid column under that which the reservoir can support. This gas is typically nitrogen. Difficulties arise in many locations around the world where the supply of nitrogen is problematic, or at least very expensive. A cleanout method that does not require nitrogen removes the need for a timely, reliable and cheap source of nitrogen as well as the need for cryogenic pumps and tanks.

This paper details the use of concentric coiled tubing and a down hole jet pump to conduct cleanouts in the balanced or underbalanced condition without the use of nitrogen. This technique has been the subject of previous papers, demonstrating its applicability in difficult, deviated well profiles. This paper describes the enhancements made to the system to make it suitable to simple wells, focusing on low-cost, lower-tech operations as opposed to difficult applications. The first case histories are included.

Introduction

Much attention, of late, has been focused on how to clean difficult wells, several papers having been written on highly deviated wells and large bore wells [1, 2, 4, 6, 8, 10]. Little attention is paid to the simpler vertical wells, near vertical wells, or wells with small internal diameters.

The reason for so little attention being focused on these wells is that technically, they are very easy. Often, no gels are required, simple water mixed with nitrogen, pumped through coiled tubing at relatively low rates will do the job nicely. However, the most common or obvious method may not be the most commercially attractive method. For example, there are instances where logistically, pumping nitrogen can be very difficult and expensive. The technique described in this paper provides for an alternative method under these conditions.

Conventional Cleanouts of Vertical Wells

This first part of the paper identifies why nitrogen is required to clean depleted vertical wells, and what factors determine just how fast nitrogen has to be pumped for how long. Figure 1 shows the simple case of a sand particle falling though a fluid, the fluid itself simultaneously rising in the well bore. The net velocity of the particle is the upward velocity of the fluid minus the falling rate of the particle in the fluid.

Figure 1 represents the simplest case where a liquid fills the well. Typical fall rates of particles in water are of the order of a few inches per second.

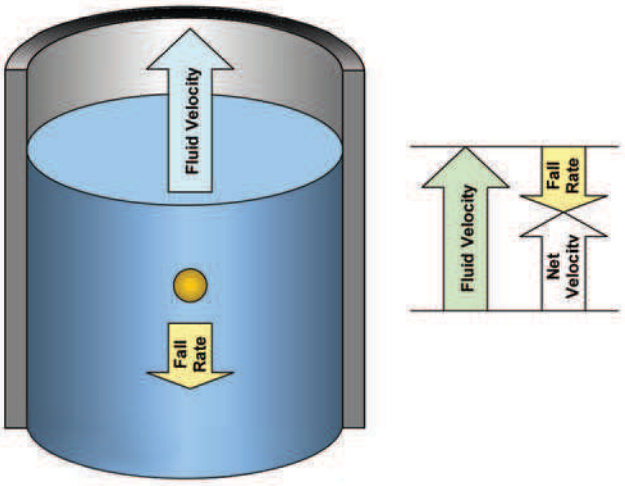

Figure 1.
Particle Falling in a Rising Fluid ▶

Generally, an upward liquid velocity of 10 in/sec will provide for a good cleanout.

In reality, it is usually not possible to have the wellbore full of a liquid steadily moving up. The full column of liquid would exert a pressure over that which the reservoir below can hold, so lost returns would result, leaving little of no fluid returning to surface. To combat this, nitrogen is added to the liquid to ensure that the hydrostatic pressure of the well contents (strictly plus their friction pressure) does not exceed the reservoir pressure.

The well scenario now involves gas traveling up the well, with liquid being suspended in the gas and the solids being suspended in the liquid. The net particle velocity remains the same, which is liqid velocity minus fall rate. The nitrogen moves up the well the fastest, followed by the liquid followed by the solids. Figure 2 shows this pictorially.

If the well conditions are unfavorable, the nitrogen may be moving very much faster than the liquid resulting in large nitrogen volumes being required to complete a cleanout.

Conditions that lead to large volumes of nitrogen being consumed are:

1. Highly depleted reservoir.
2. Large volume of solids to be removed.
3. Large well diameters (result is a high gas slip velocity – foam may be a good choice).
4. Deep wells.
5. Small diameter completions (result in high annular return friction pressures making an even lighter fluid column necessary).

Note that the particle tends to remain in the liquid (as shown in Figure 2) only when there is a significant volume of liquid in the mixture. This system breaks down when there is only a small amount of liquid present. It is not the purpose of this paper to go into great detail as to all flow regimes involved during cleanouts. The point is that that the gas moves up the well the fastest and very significant flow rates of nitrogen are required in some circumstances.

Example Well Cleanout Design

A simple design for an example vertical well cleanout is given in Table 1.

The job design for this well is very straightforward and if liquid nitrogen is readily available, one typical offshore vacuum insulated tank is sufficient. However, consider the economic advantages of not requiring any nitrogen at all.

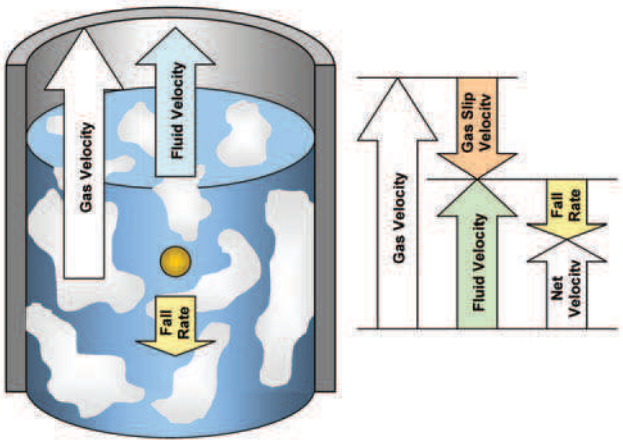

Figure 2.
Gas and liquid moving up the Well with a particle falling through the Water

Table 1

Example Well Parameters

Tubing size	3½
Casing Size	7”
Tubing Depth	6,000ft
Casing Depth	6,500ft
Bottom Hole Pressure (BMP)	l,500psi
Water Circulation	Ibpm
Nitrogen circulation	500 scf/min
Estimated Circulation time	4hours
Estimated Nitrogen Usage (including losses)	2,000gal

The following equipment is then not required:

1. Cryogenic nitrogen pump/ converter
2. Cryogenic nitrogen tank
3. Cryogenic hoses
4. High pressure iron and valves

Plus no nitrogen equipment operators are required. This obviously reduces the rental and transportation costs of equipment and personnel. In an offshore environment, less deck space is required, fewer beds and fewer equipment lifts. Also, since a full tank of nitrogen typically weights 12 tonnes, in many cases the heaviest lift of all can be avoided. Where any of these factors have an impact, using a jet pump on concentric coiled tubing without nitrogen may provide for a cost-effective solution.

Alternative Method

Down Hole Jet Pump

As stated, the most common way of dealing with a depleted well is to use nitrogen to reduce the hydrostatic head of the return fluid column. If a lightweight fluid is not used, some other method is required to drive the return fluid column back to surface. In other words, a down hole pump is required.

The most obvious choice of down hole pump is a jet pump. The reasons for this are first that this pump is very tolerant of sand or other solids; it has no moving parts and therefore is very rugged. The second reason is that the pump simply needs hydraulic horsepower at surface. No electrical power is needed as with electrical submersible pumps (ESP’s), and no recipricating or rotary motion is required making the coiled tubing operation simple.

Jet Pump Method of Operation

A jet pump is a venturi tube. It consists of a high-pressure nozzle, a suction port and a diffuser. High-pressure fluid is accelerated through a nozzle. The acceleration of the fluid leads to it dropping in pressure as dictated by conservation of energy equations. Ports that are open to the well bore at the point of this high velocity fluid allow wellbore fluid to enter the high velocity stream.

The combined flow is then slowed along a diffuser. As the velocity decreases, the pressure of the combined fluid increases. If the system were 100 % efficient, the pressure would return back to the original pressure at the nozzle. However, due to inefficiencies and mixing with additional wellbore fluids, the regained pressure is typically of the order of half the original nozzle pressure. Still, in a correctly designed system, this

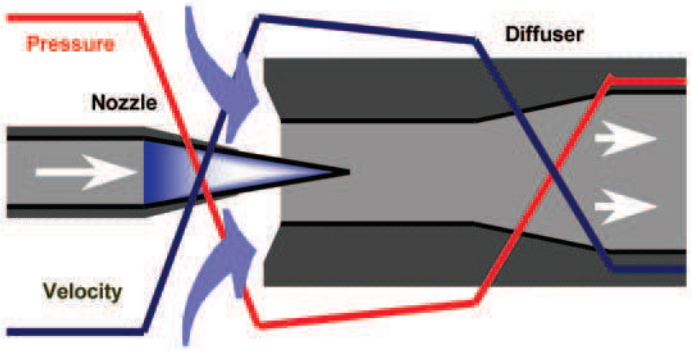

Figure 3. Jet Pump Schematic

diffuser pressure is enough to drive the column of return fluids back to surface. In effect, the wellbore fluids are «sucked» into the jet pump and then returned to surface along with the fluid jetted down to power the jet pump. Figure 3 shows the operating principle of a jet pump.

Concentric Coiled Tubing

The easiest and most common method of running a jet pump on coiled tubing is to run it on concentric coiled tubing. That is one coiled tubing string inside another. The fluid to the jet pump is typically pumped down the inside string, the returns being taken up inside the outer string. This permits the jet pump to be run up and down the interval to be cleaned in one clean, continuous operation. Figure 4 shows the flow paths.

Modifications required to adapt the Technology to Simple, Cheap Applications

Coiled Tubing Size

Most of what has been described so far in this paper is no different to the established concentric coiled tubing/jet pump applications described in other papers [3, 5, 7, 9]. Historically, the method has employed large, heavy- coiled tubing strings running typically large diameter tools. For example, a typical equipment spread has used a $2^3/_8$" outer string and a $1^1/_4$" inner string. This puts the pipe weight at about 4.21 b/ft empty and 5.51 b/ft when full of water. This makes say an 8,000 ft string 15.3 tonnes empty, which renders it inappropriate for many locations, especially offshore locations with limited crane capacity.

Clearly a smaller coiled tubing is beneficial for cost-effective, simple cleanouts. Using a smaller coiled tubing saves weight and permits the use of a smaller, lighter coil unit. However, the smaller coiled tubing provides for a less efficient operation as flow rates become more limited. A compromise is required. The smallest concentric string used to date has been a $1^1/_2$" outer string by $^3/_4$" inner string. The weight of this coiled tubing is 2.21 b/ft empty and 2.71 b/ft full of water. This is nearly half the weight of the $2^3/_8$" by $1^1/_4$" string typically used for more complex horizontal wells.

Achieving Higher Flow Rates through Small Coiled Tubing

The use of Friction Reducers

Downsizing coiled tubing greatly reduces the flow area. Figure 5 compares $2^3/_8$" by $1^1/_2$" coil with $1^1/_2$" by $^3/_4$" coil. The figure is actual size.

The pressure drop per foot through $^3/_4$" pipe is about 20 times higher than through a $1^1/_4$" string at the same flow rate! Put another way, the maximum flow rate through the coiled tubing at a given pressure differential is reduced by a factor of about 5. This will render cleanout operations non-commercial in many cases as the job time would be too long. The key to using small diameter coiled tubing is the use of good friction reducers to achieve reasonable flow rates.

Friction reducers have been used for many years with coiled tubing with good success. The choice of friction reducer for small pipe applications is very important. A series of laboratary tests were conducted to see how effective friction reducers are in this very small coiled tubing size. The results showed that friction reducers worked well in the highly turbulent conditions associated with this small pipe.

The chosen friction reducers was shown to reduce friction by about 70 % inside the $^3/_4$" pipe. This dramatically improves the situation but still results in an overall reduction in maximum achievable flow rate by a factor of 2.6.

Tests were also conducted on the effectiveness of friction reducers in the return annular space. Using clean water, a 40 % reduction in friction could be achieved. However, in reality this return fluid will not be clean. It will be mixed in with some hydrocarbons from the well. Laboratary tests conducted with water contaminated with 10 % oil showed an effective reduction in friction of only 10 % when the oil was present.

From a design point of view, this means that the velocities have to be kept lower in the coil-by-coil annulus as friction effects are more significant for the return fluid.

The use of Higher Pressure Pumps

To increase the power fluid flow rate further, higher pump pressures are required. The good news here is that small pipe is well suited to high pressures.

There are two factors that dictate how high a pressure can be used inside coiled tubing. The first is the yield pressure of the coiled tubing, the second is the resulting fatigue life generated by moving the pipe at high pressure. The following table compares $^3/_4$", 0.087" wall coil with $1^1/_4$", 0.095" wall coil. The material is 80,000 psi yield strength.

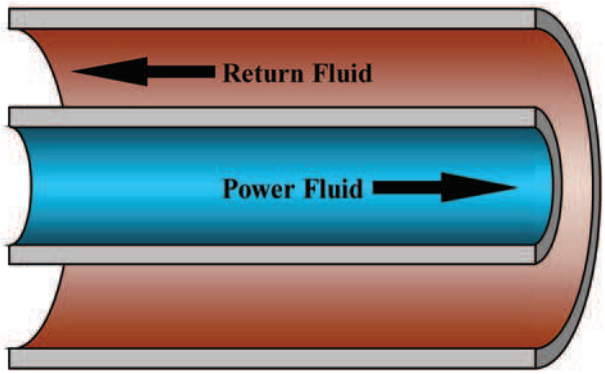

Figure 4. Concentric Coiled tubing Configuration

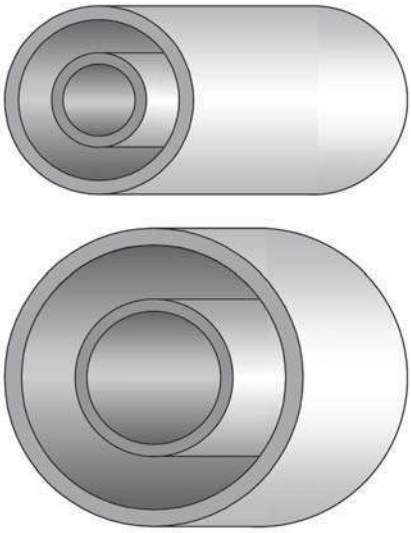

Figure 5.
Relative Sizes of Concentric Coiled tubing Systems

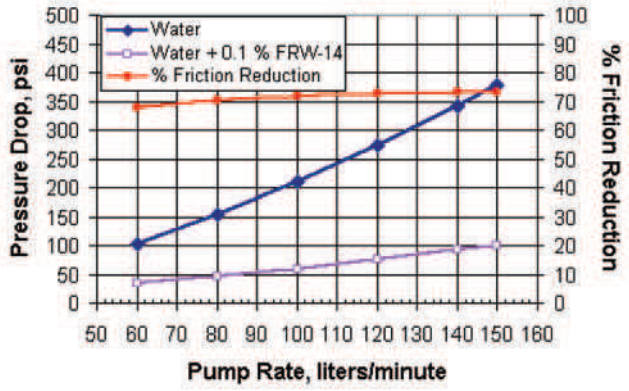

Figure 6.
Measured Friction Reducer Effectiveness inside $^{3}/_{4}$" Pipe

As can be clearly seen in Table 2, the fatigue/ballooning resistance of the smaller pipe is far superior when working at high pressures. Key to operating a jet pump on small concentric coiled tubing is utilizing high pump pressure. Working up to 10,000 psi on the surface pump is well within the coiled tubing limits and with care, even higher pressures can be workable.

Typically a standard coiled tubing unit is not worked above 5,000 psi. Doubling the pressure simplistically increases the pump rate achievable by approximately 45 % (actually a function of other factors too such as hydrostatic pressure). So combining friction reducers and higher pump pressures, it is possible to pump at about 55 % of the rate it is possible to pump at through a larger $2^{3}/_{8}$" by $1^{1}/_{4}$" concentric string under standard conditions. This rate permits economically sound operations.

Jet Pump Size

The original jet pump developed for concentric coiled tubing was $4^{3}/_{4}$" in diameter. This tool is simply too large for many wells. A smaller tool had to be developed that would fit through $3^{1}/_{2}$" completions.

Reducing the size of any down hole tool is always complicated. Generally the same functionality has to be compressed into a much smaller space, at the same time keeping flow areas large enough, particularly those that see sand. In the case of a jet pump used to clean up sand, this is further complicated by the fact that the external flow paths also have to be designed. The jet pump must dislodge sand from the well so that it can be sucked into the jet pump itself.

The tool's external jets must first dislodge the sand and then efficiently direct the sand to the jet pump suction and hold it there long enough for it to be sucked in. Tests were done using full-scale tools inside of transparent flow loops to ensure the external nozzle design was sound.

Example Well Cleanout Design

Earlier in this paper, an example well was given to illustrate a typical nitrified fluid cleanout. This same well can be cleaned using the $2^{1}/_{2}$" jet pump on $1^{1}/_{2}$" by $^{3}/_{4}$" concentric coiled tubing. The job parameters are given in Table 3. A 7,000 ft string of concentric coiled tubing is assumed.

As can be seen, the total job time has increased by a couple of hours. However, rig up time will be reduced due to the omission of nitrogen equipment. Note the pump pressure of 10,000 psi. Standard oilfield pumps are capable of pumping at these pressures so long as they are dressed with the correct pistons.

Case Histories

The $2^{1}/_{2}$" jet pump on $1^{1}/_{2}$" by $^{3}/_{4}$" concentric coiled tubing was first used to clean out sand from wellbores in October 2001 in Indonesia. The wells to be cleaned suffered production declines, believed to be caused by accumulated sand in the well bore.

Nitrogen costs are high in this particular location due to the remote and cleanouts using a jet pump on coiled tubing were attractive. This paper lists the results of the first four jobs completed.

Conclusion

1. A miniaturized version of an established jet pump/concentric coiled tubing system can be used to remove sand from wells.
2. A jet pump system can be a cost effective versus conventional nitrified fluid clean outs.
3. Friction reducers work well in smaller diameter pipes at high flow rates. They work less well in annular spaces and less well again if oil is present.
4. Pumping at 10,000psi or higher on small pipe in motion

Table 2

Coil Size Pressure Limitations

Coiled Tubing	Internal Yield Pressure	80% Internal Yield Pressure	Internal Pressure giving 200 cycles safe working life
1 %"	II,400 psi	9,100 psi	3,500 psi
3/4"	17,200 psi	13,700 psi	10,500 psi

Table 3

Example Well Cleaned with a Jet Pump

Tubing size	3'/2"
Casing Size	7"
Tubing Depth	6,000ft
Casing Depth	6,500ft
Bottom Hole Pressure (BHP)	I,500psi
Water Circulation	0.42bpm
Estimated Circulation time	6hours
Surface Pump Pressure	10,000psi
Jet Pump configuration	#2 nozzle #3 throat

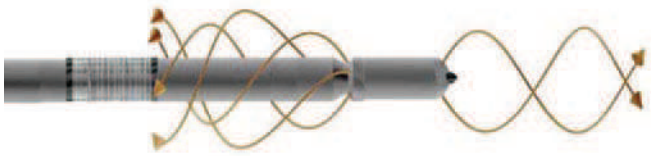

Figure 6. Designed External Jet Swirl Patternfor $2^{1}/_{2}$" Jet Pump

does not result in excessive pipe fatigue.

Acknowledgments

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Table 4

Summary of first four jobs using the Reduced Size Jet Pump System Conclusion

Well No.	Sand Removed (lb)	Notes
1	3,360	Metal debris sucked onto the jet pump's intake screen. Obstruction prevented tool access to TD. Liner damage was suspected.
2	4,400	Cleaned to TD. Previous attempts to reach TD with jointed pipe had failed.
3	3,360	Cleaned to TD. Previous attempts to reach TD with jointed pipe had failed.
4	500	Obstruction in the well prevented significant jet pump access.

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UNDER NO CIRCUMSTANCES LOSE TOUCH WITH A CUSTOMER!

In any company executing a supply of complex equipment facilities a special attention is always paid to the problem of relations with a customer after the equipment was shipped. Today we are going to tell by what principles the Service and Reliability Department of «Fidmash» close corporation is guided in its work.

B.Y. Emelyanov,
Deputy Director of «Parametr» Unitary Enterprise
V.V. Golubev,
Head of the Service and Reliability Department, JSC «Fidmash»

In any company engaged in a supply of complex equipment facilities a special attention is always paid to the problem of relations with a customer after the equipment was shipped. Today we are going to tell about the main principles guided in the Service and Reliability Department of JSC «Fidmash».

The coiled tubing equipment manufactured by Russian-Belarusian FID Group of Companies is the first serious alternative to the analogous products of American origin. Nowadays Russian oil-and-gas companies run more than thirty coil tubing aggregates manufactured by FID enterprises and their number is planned to be increased. Coiled tubing aggregates are the state-of-the-art technical facilities different from the equipment used previously for oil and gas wells repair work. Owing to this fact another approach to their maintenance and operation is required. For the efficient servicing of coiled tubing aggregates supplied by our enterprise there was established a structure responsible for the efficient after-sales servicing of the equipment facilities supplied, that is the Service and Reliability Department (SRD).

Organizational Structure of the Service and Reliability Department

The Service and Reliability Department is an self-dependent organization subdivision belonging to the Management and Quality Department of JSC «FIDMASH».

The Service and Reliability Department is a team of young and competent specialists having a big experience in their business. The SRD is headed by Vladimir V. Golubev who is subordinated directly to Igor V. Dvornik, Director of the Management and Quality Department. The staff of the Service and Reliability Department includes Alexandr N. Gorohovich and Anrey I. Gil, both of them are adjusters and testing engineers. All the members of the Department are higher-educated mechanical engineers (M.E.), their skill level enables to make self-dependent decisions with respect to the equipment repair and debugging. In the process of work the Department personnel gained great experience in carrying out the coil tubing equipment servicing and repair.

The authorities of the Department are aimed to give the opportunity to every member of the after-sales service to work at improving and developing themselves, to perfect their creative ability and to raise their skills level. To improve quality of

Gorohovich A.N.

In whole the high-quality servicing as it is understood in modern world practice is presented a set of measures that at minimal service costs ensure the following:

- *A maximal reduction of losses which may originate due to technical reasons in the machine running process;*
- *A maximal implementation of a machine capability with respect to its reliability.*

work the various training forms and methods including «a bench marking» method are used. By this is meant the method of the comparison of the major characteristics of activity with those of competitors.

On written demands of enterprises the experts of the Service and Reliability Department drive out immediately to the site for a troubleshooting and failure cause analyzing. All types of breakdowns are recorded and the proposals on troubleshooting are passed to the engineering department for a debugging to be performed. The experts of the Service and Reliability Department keep on working constantly with the manufacturer in order to upgrade the production of CT aggregates. The performance of every aggregate being run is registered individually. All malfunctions are recorded and give a full picture of the working of system, a schedule for defects elimination is drawn up.

A close connection with other divisions and departments enables to respond to any customer's inquiry and claim immediately. It makes the time of response to a customer's claim much more shorter than the time our competitors spend dealing with a customer.

Main Goals of the Service and Reliability Department

The equipment performance reliability and the expert knowledge of the staff – these are two main factors defining nowadays the moving forces and stability of the coil tubing technique development irrespective of environment and even of a financial condition. Therefore two key guidelines are outlined for our after-sales service; these are the ensuring of an undisturbed operation of the equipment and the improving of skills level of the personnel who run this equipment.

Main Goals of Service and Reliability Department Staff:

- Planning, organizing and executing of the chef-montage of the all-type equipment manufactured by the enterprise, training of personnel to run the present equipment;
- After-sales service and maintenance after the guarantee period concerning equipment supplied by the enterprise;
- Registration and analysis of the exploited equipment;
- Working-out of recommendations, consulting customers;
- Implementation of the policy and the goals in respect of the quality within the limits of own powers;
- Efficient application of factory standards of the quality management system.

By our Department forces the starting-up and adjustment as well as the equipment chef-montage are executed including the training of the customer's personnel who run the aggregates. The personnel training is carried out at the site of the equipment run out in accordance with a special program worked out by our experts. The training course duration takes 15–17 days. However this period of time, as the exploitation experience showed, was mostly insufficient. One of the reason was the lack of the customer's personnel backgrounds for the training course and the start-and-adjustment job; our experts had to wait for weeks owing to the fact that a well was not ready for service, and sometimes there was nobody to be trained. For the most part the workers were trained, with rare exception of the engineers of the Head Mechanic Department.

The Service and Reliability Department is provided with up-to-date technical facilities enabling to perform testing and diagnostics of the maintainable equipment systems. At present the work on the equipment retrofit is executed with the purpose of improving and facilitating the aggregate hydraulics testing. Regarding this the system of test points for hydraulics working characteristics indications to be recorded is being currently worked out. The working characteristic will be recorded automatically, that will allow verifying defect causes more accurately and faster.

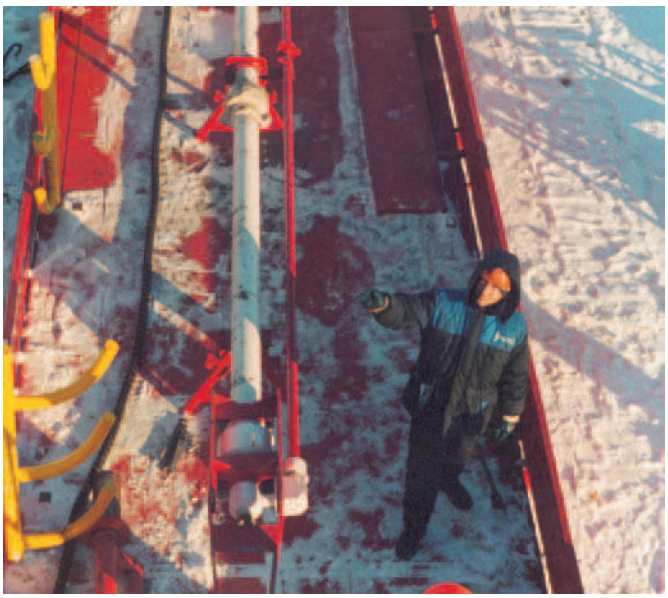
In the modern world practice there were formed the following strategic guidelines ensuring a goal achievement of a high-quality servicing:

- *A significant attention should be paid to preventive measures aimed at the highest possible reduction of a machine failure;*
- *An anticipatory repair of all machine aggregates should be performed in due time while this repair is still labour-consuming, uncomplicated and will not require large resource consumption and a long-term shutdown;*
- *It is expedient to perform all the activity concerning a technichal maintenance at the time when a machine shutdown is planned and at off-hours.*
- *It is expedient to shorten every scheduled repair period and its waiting period.*

Partnership

The concept when every staff's effort is bent to maintain relations with a consumer in any circumstances was assumed as a basis of our engineering policy at the time when the company did not possess a single quality control system. Today our concept of work became broader owing to the order introduced by ISO 9000 standards and to the experience gained.

The Service and Reliability Department established partnership with customers, these are relations based on confidence and mutual understanding. We are always in the position to render consulting services on improving of the operating efficiency and



General recommendations and suggestions

- *Carry out a due retraining and probation of the maintenance personnel if they don't have experience more than one year;*
- *Follow the operating manuals for the equipment and its assemblies and component parts;*
- *Perform a due and high-quality MP-1 (maintenance works period) and MP-2 , pay special attention to the quality of MP; in many enterprises it performed carelessly or is limited within the imperfect MP of chassis only;*
- *Use the control and registration system abilities in corpore; (some enterprises use less than 1/3 of the control and registration system volume and there are some who exploit the equipment whose control and registration system is faulty. It is inadmissible;*
- *Perform an oil inspection at every MP-2, or at least next nearest, dump the oil sludge and a condensated fluid out from the tank in proper time, scour magnetic chucks, while performing the oil substitution, follow the recommendations of the operating manuals. During the oil substitution special attention should be paid to the obligatory flushing-out of the hydraulic system, for this purpose a low-cost industrial oil (12A or I-20A, GOST 20799-75 — GOST is «all ex-Soviet Union State Standard») may serve as a washer fluid. This is the oil purity on which the operation of the whole hydraulics of the aggregate, a lifetime and reliability of hydrojets depend;*
- *Perform a due maintenance and testing of a preventer. Some enterprises perform neither a preventer servicing nor its pressure testing after its assemblage onto the well is done;*
- *A proper attention should be paid to a pneumatic hydro accumulators charging (do not charge them more than recommended in the operating manual);*
- *In case you deal with the aggregates of previous series please inspect brake valves in the injector hydraulics while performing every MP-1;*
- *Perform a pumping of a pressure-operated weight-indicating device and check adjustment before every trip operation. While performing the adjustment and pumping please follow the recommendations of the operating manual. Do not forget about pumping/squeezing a wellhead pressure and a working pressure medium separating device;*
- *Check the adjustment of a chain clamping and a feed beam tray.*

equipment repair. Many problems related to the operating efficiency are solved as a result of negotiations by phone. A customer is always given a chance to affect the quality and the efficiency of the fulfillment of warranty policy. The accuracy and timeliness of the information obtained play an important part in improving the after-sale service quality. The timely information obtaining depends much on an organization which exploits the equipment. In order to reach higher efficiency of interrelations a questionnaire is sent to enterprises every year, all notes and requests notified in it are to be reviewed and taken into consideration while manufacturing the next aggregate. We would like to have permanent contacts with the client even when the warranty period is expired.

To exploit our equipment more efficiently after the warranty period is over, every customer is offered to conclude an after-sales service agreement. With all of that the way of action, the frequency and a job volume are selected personally depending on features of every organization. In addition to the job done in conformity with an after-sales service agreement the Service and Reliability Department executes one-shot job aimed at the updating of the equipment which has been already operating.

While updating the equipment we take into account all customer's requests which meet the requirements of Regulations and Performance Specifications. If solving of problems on the updating is needed, the design department is to take part in. In order to obtain the information on solution of the problems on the updating which was made already as well as the information on design debugging, please do not hesitate to contact our Department.

The efficiency and reliability of the equipment operation depend not only on the quality of manufacturing, assemblage and planned updating. A great deal is determined by the equipment service quality, whose basis is provided with:

- A regular and complete servicing of the equipment;
- A qualification level of each team member;
- A professional level of the persons performing the service;

Our company offers to conclude an after-sale service agreement with you. In case of the concluding such an agreement we shall perform the free-of-charge diagnostics of your equipment.

In conclusion we'd like to say some words to technical and engineering staff who run our machinery directly.

Working life of the machinery in many respects depends on its correct run; this is a well-known postulate which is beyond of any doubt. Our aggregates are not provided with systems known as an «fool-proof system», but they are provided with a control and registration system KRS-1. Take this opportunity, it will discipline maintenance personnel, and in the end the aggregate will operate for a long time and without breakdowns.

The aggregate is mounted on a chassis of high passability, but not on a cross-country chassis; in view of this a condition of road where a driving of the aggregate is planned should be prior inspected.

The adjuster is destined for the equipment assemblage and dismantling only (a preventor, injector, BHA, a site) regarding a well, in case it is used for the purposes different from the forgoing ones it should be considered as the break of the safety measures regulations.

Do not ignore daily inspections of machinery; it will do much in preventing troubleshooting, avoiding breakdowns and long-term shutdowns of the equipment.

The maintenance is to be performed in a strict conformity with an operating manual, to be especially earnest in case of a hydraulic oil substitution.

A preventer and injector mounting on a well and their breaking-out are to be performed in a strict conformity with an operating manual.

To obtain more details do not hesitate to contact the Service and Reliability Department of the JSC «FIDMASH», our staff members are always glad to render any assistance you need.

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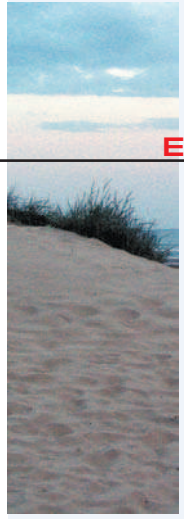


THE OIL IN THE SEA

In the present issue we proceed with the series of publications on the ecology of off-shore oil-and-gas compex. Today we lay open to public the information on what does really occur to the oil after its ingress into the sea-water.

Mineral oil is among other natural substrates and its ingress to the sea reaches 600 thousand tons a year owing to its seepage from the sea-bed only [Etkin et al., 1999. One should add to this more than 10–12 million tons of aliphatic hydrocarbons and other ones which are yearly produced by sea organisms [Gurvich, 1993]. As opposed to natural oil sources oil spillages usually occur during a short period of time and form local zones of anomalous high concentration of hydrocarbons posing hazard to the life of sea organisms.

The mineral oil behavior in the sea depends above all on its composition and properties. In respect to the chemistry the crude oil constitutes a complex mixture of thousands of the liquid hydrocarbons (80–90 %) with a touch of other organic compounds (naphthenic acids, asphaltenes, pitches, mercaptans and others as well as the water (up to 10 %), dissolved gases (up to 4 %), mineral salts and trace elements. As the analysis of 500 samples of different types of oil showed, the «typical» oil contains upon the average: 57 % of aliphatic hydrocarbons, 29 % of aromatic hydrocarbons, 14 % of asphaltenes and other compounds [Swan et al., 1994).

The first moment when the crude oil contacts the marine environment it is lost as a source substrate and undergoes different and dynamic processes of migration, scattering and transformation. It's showed schematically at fig. 1 and fig. 2 The quickest process is the evaporation of light oil fraction: from 30 to 60 % of oil vanishes from the sea surface during the first 24 hours after an oil spillage has occurred. At the same time the processes of the mineral oil spreading and the oil film drift on the sea surface (generally under the action of the wind and currents) take place, resulting in the oil dissolution and emulsification in the sea-water due to a top layer agitation by the wind. As usual the solubility of mineral oil hydrocarbons is exponentially reduced while their molecular weight is increasing. Therefore the aromatic compounds (especially such as benzene, toluene and others) pass rapidly in an aqueous phase in contrast to many aliphatic hydrocarbons.

The emulsified oil is accumulated in sea organisms (particularly in molluscs owing to their filtration-type nourishment) and at the same time it is used as a food substance for oil-oxidizing bacteria which are capable to decompose hydrocarbons dispersed in the water column. As a result of these multifactors and interrelated processes the oil spilled in the sea is divided to aggregative fractions (forms of state), including surface films, dissolved and suspended forms, emulsions, solid and tough ingredients deposited on the seabed as well as compounds accumulated in sea organisms. The dominating migration forms during the first

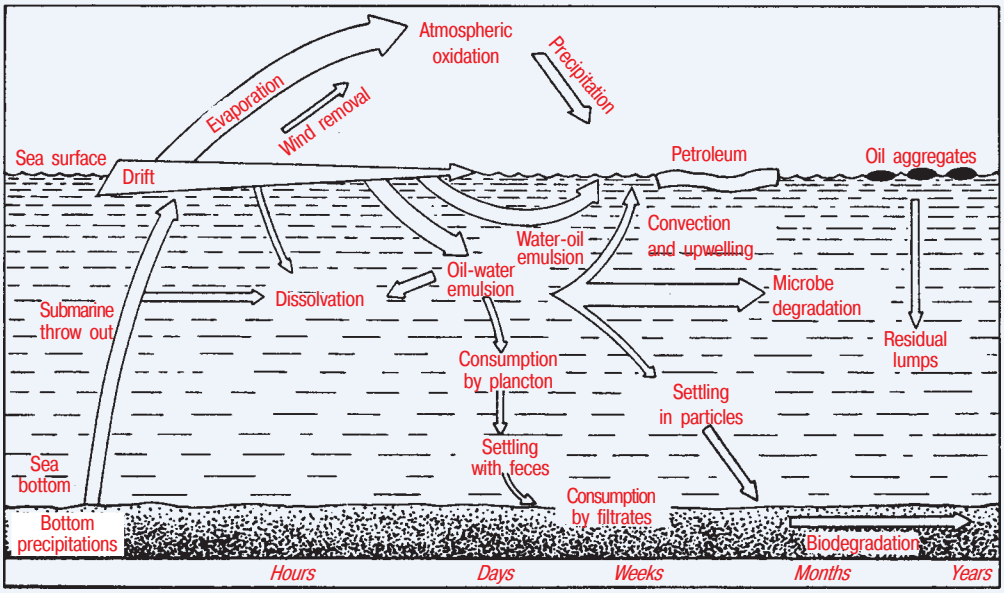


Fig. 1. Scheme of distribution and migration of oil in the sea

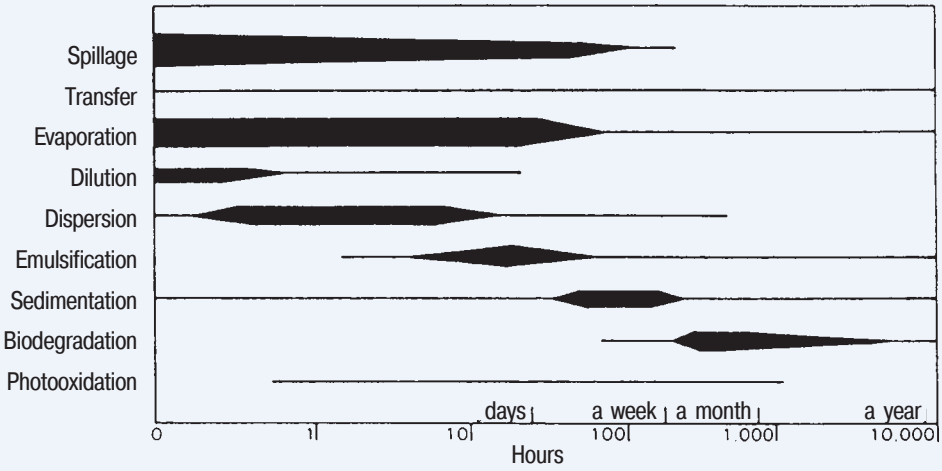


Fig. 2. Sequence, duration and relative process scale of oil transfer and transforming in the marine environment: the line length shows the process duration, the line width shows the relative process intensity

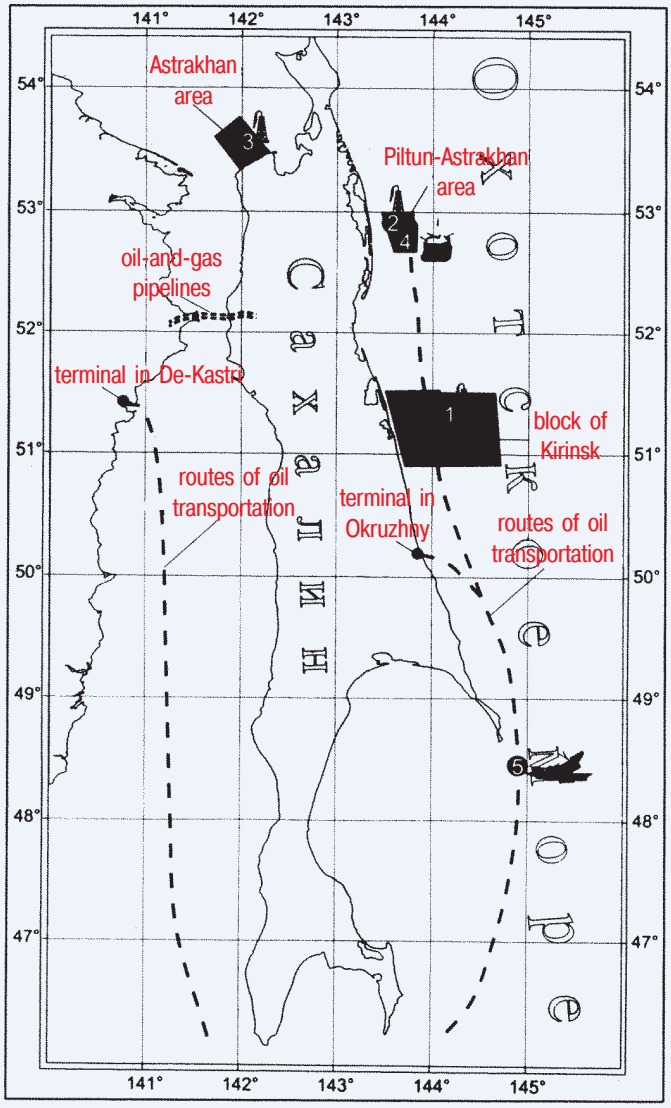
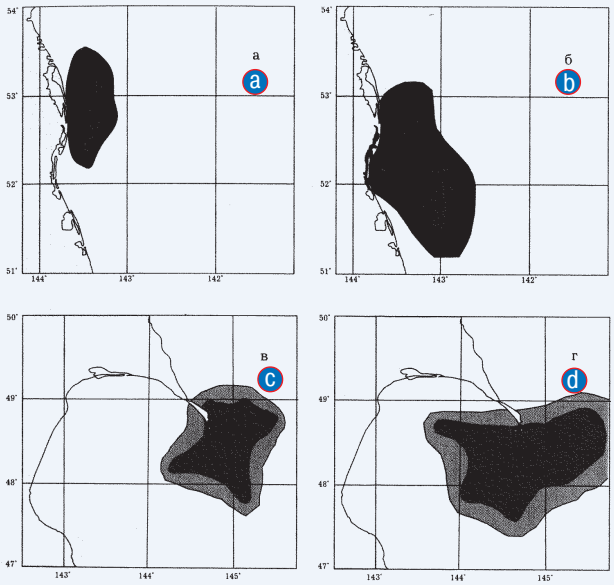


Fig. 3.
The would-be oil spillage sources in the shelf of Sakhalin:
1, 2, 3 — drilling of the test wells; 4 — exploitation of the field complex «Vitiaz»; 5 — the transport tanker breakdowns

Fig. 4.
Zone of oil spillage expansion according to the results of modeling in the regions of north-east shelf of Sakhalin (a, b) and at the cape «Terpenie» after three days of spillage: the spillage volume is 12720 t in the north-east shelf and 71550 t at the cape "Terpenie":
a, c — in the summer time; b, d — in the autumn time



24 hours after the oil spillage occurred are oil films and emulsions. No more than 1% of the crude oil turns to the solution, while the concentration of dissolved hydrocarbons beneath the oil film does not usually exceed 0,5 mg/l and keeps safe during some hours only. When oil spillages are intense (more than 1000 t) beneath the oil film at the depth up to 10 m there can be presented the emulsified oil whose concentration equals up to 5–10 mg/l, nevertheless the lifetime of these fractions lasts no longer than some hours [Baker et al., 1991; Patin,1997].

Oil spillages are among the most intricate and dynamic phenomena of the impurity distribution in the sea. Every such a spillage is unique in its own way and nonrepeatable owing to a practically perpetual combinations of specific natural and anthropogenic factors in the given place and in the given period of time. The most complicated situation arises in ice conditions when the evaporating rate and a hydrocarbon decay rate fall drastically while the oil is accumulated beneath the ice cover, in gaps and air holes, being held out there till the ice starts thawing.

For the quantitative description of such spillages to be made numerous techniques and scores of mathematical models are developed. Naturally, all of them are rather conditional and approximate inasmuch as the mode of behavior of oil fields in the sea depends on the variety of most different and never known in advance factors, beginning with the oil type, circumstances, a place and time of a breakdown and ending with the hydrometeorological and oceanographic conditions in the area of a possible event. It is known, for example, that the drift of an oil patch during the first day after the spillage occurred is determined basically owing to the direction and the velocity of the wind dominating at the given moment [Swan et al., 1994] while the oil spread on the sea-surface depending on the time tends to the logarithmic dependence [Matishov et al., 1999]. To forecast and especially to describe quantitatively such situations when every of them is unique and nonrepeatable in its own way is practically impossible.

Moreover nowadays the whole array of information on the oil behavior, ecological effect and consequences of oil spillages in the sea has been compiled that enables to make preliminary qualitative assessments and the approximate forecast of similar events, taking into consideration the statistical probability of hydrometeorological and other conditions in an area.

Currently this trend is actively growing in Russia, particularly owing to the start of development of offshore oil-and-gas fields in Arctic Zone and on Sakhalin.

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Coiled tubing times

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