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# EQUIPMENT AND TECHNOLOGIES FOR OIL AND GAS COMPLEX

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## Information on the articles

### APPLICATION OF MODERN GEOPHYSICAL METHODS TO PERFECT OIL FIELDS DEVELOPMENT, LOCATED IN THE AZERBAIJAN SECTOR OF THE CASPIAN SEA

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Development of oil and gas fields in the sea requires the solution of many diverse and interconnected problems (organizational, technical, economic, environmental, legal, technologic and others), the special place among them at the present stage of development is occupied by geophysical surveys.

There are several types of seismic measurements (2D, 3D) used in oil exploration. These methods allowed discovering and developing huge hydrocarbon reserves of the Caspian Sea, as well as worldwide. 4D seismic survey, some new technique that is being applied while developing oil fields, is effectively used to track the movements of fluids in the underground tank. The modern 4D seismic survey method is not significantly different from the 2D and 3D methods. The main difference lies in introduction of some additional parameter – "time", i. e. three-component observations are repeated every definite period of time.

While interpreting seismic survey data, 4D method will be useful for defining the boundaries of oil-water contact, as well as for identifying the areas saturated with water and oil. This will allow determining the direction of offshore fields' further development.

**Key words:** seismic survey studies; measurement by applying 2D, 3D and 4D methods; interpretation; oilwater contact; development of oil and gas offshore fields.

### ANALYSIS OF THE STRESSED STATE OF CENTRIFUGAL-VOLUMETRIC-REINFORCED HELICAL CUTTING STRUCTURES OF A DRILL-BIT OF DRIVEN ROWS OF ROLLING-CUTTER DRILLING BITS

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The analysis of the stressed state of centrifugal-volumetric-reinforced helical cutting structures of driven rows of rolling-cutter drilling bits is performed. The basic load factors acting on drill-bit cutting structures as well as the direction of their effects are identified. Calculations served the basis for fixing the dependence of the stress distribution across the width of the working surface of helical asymmetric centrifugal-volumetric-reinforced cutting structures of a drill-bit. The stressed deformed state of two adjacent teeth of drill-bit cutting structures, being in simultaneous contact with the well bottom is studied.

The analysis of the stressed state of centrifugal-volumetric-reinforced helical asymmetric cutting structures of driven rows of drilling-bits, carried out in the present paper, allowed concluding that the work of the tool is accompanied by an uneven distribution of load between two adjacent teeth of drill-bit cutting structures, simultaneously working at the well bottom. The stressed deformed state of the teeth of centrifugal-volumetric-reinforced cutting structures of drill-bits is characterized by some strongly pronounced dependence, i.e. maximum stresses occur in the apical zone on the side that is opposite to the tooth inclination angle towards the surface of the well bottom, followed by further gradual decrease to the tooth base.

**Key words:** rolling cutter drilling bit; helical cutting structures of drill-bits; centrifugal-volumetric-reinforced cutting structures of drill-bits; finite element method.

### THE SYSTEM OF FREQUENCY EMITTANCE CONTROL OF THE HYDROIMPULSE GENERATOR

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Wells' hydrodynamic generators of elastic waves are used for providing vibro-seismic influence on an oil-bearing formation. The efficiency of these devices operation depends on the accuracy of correspondence of pressure pulses frequency, produced by the vibrator, with the oil formation dominant frequency. The system of automatic control of pressure pump flow-rate at the wellhead that allows controlling frequency of a hydro-pulse generator radiation is proposed. Presence of long hydraulic line, where perturbations transfer is delayed thus causing the loss of stability, is taken into account. Influence of the system transmission coefficient and the time constant of the flow-rate regulator on the control system stability is evaluated, the limits of these parameters' change are fixed.

**Key words:** oil recovery enhancement; borehole oscillator; frequency of vibro-seismic influence; control system stability.

## RESEARCH OF WORK OF UNITS DESIGNED FOR TREATMENT OF OIL-CONTAINING AND INDUSTRIAL WASTE WATERS

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The present paper considers design and operational principle of units that provide gathering petroleum products from water surfaces and neutralizing accidental releases of petroleum products during their transportation along the bottom of natural water areas with the help of underwater pipelines as well as plants for treatment of oil-containing waste-waters that are released by industrial enterprises (refineries, power plants). The paper also presents information relating to equipment and technologies applied for advanced treatment of oil-containing waste-water that include electric flotators with non-uniform electric field, with automatic control of current's density, with two chambers.

**Key words:** cleaning of waters from petroleum products; water surface; subsea pipeline failure; treatment of oil-containing waste-waters that are released by industrial enterprises; electric flotators.

## ENERGY INDICATORS OF REGENERATION PROCESS OF AMINO ACID SATURATED SOLUTIONS DURING AMINO ACID TREATMENT

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Experimental data on regeneration of 20 % potassium lysinate solution are presented in the paper. Energy regeneration indicators of solutions of amino acids salts and monoethanolamine solution, used in industry, are compared. It is shown that energy consumption on regeneration of 20 % potassium lysinate solution is lower than in case of sodium glycinate and is no more than 10 % higher in case monoethanolamine. The data on solutions' thermal capacity are provided, energy of activation is calculated. General possibility of this absorbent use for carbon dioxide absorption in industrial processes is shown.

**Key words:** carbon dioxide; potassium lysinate; desorption; heat capacity.

## FOAMY OIL: CHARACTERISTICS AND FORMATION MECHANISMS

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In case of pressure decrease lower than saturation pressure at heavy oil fields, developed under natural recovery drive, gas, rather often, doesn't form a free gas phase, but stays in an oil phase as tiny dispersed bubbles. Compressibility of such systems is higher than oil compressibility, that's why there occurs a formation pressure maintenance as it does in case of solution gas drive, but unlike it fluid flow mode in a formation is a single phase one.

This paper analyzes world experience of foamy oil study, identifies the most valuable characteristics of the phenomenon, which influence oil fields development as well as describes scientists' contemporary points of view on the factors that cause formation of such systems. Influence of foamy characteristics on such parameters of oil as formation volume factor (FVF), density, gas-oil ratio (GOR) and viscosity is discussed.

**Key words:** foamy oil; pseudo bubble point; emulsion; solution gas drive; increased oil recovery factor.

## DEVELOPMENT OF AUTOMATED ULTRASONIC BOREHOLE COMPLEX AND SONOCHEMICAL TECHNOLOGY TO IMPROVE PRODUCTIVITY OF WELLS

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The paper discusses the problem of development of automated ultrasonic borehole complex and sono-chemical technology to be used for raising wells' productivity.

The pilot tests of the down-hole module, carried out at the fields of the Western Siberia and Samara Region (Russia) prove high efficiency of the developed equipment and technology.

The developed equipment and technology can be proposed to oil producing companies as one of the promising methods of enhancing oil recovery factor.

**Key words:** oil; ultrasound; bottom-hole area; oil recovery factor; automated ultrasonic down-hole complex; sono-chemical technology; oil flow-rate; water cut; pilot-scale tests.

## SOME TECHNIQUES OF REDUCING HYDROCARBON LOSSES WHILE OIL GATHERING AND PROCESSING

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Provision of the required volumes of oil in conditions, when oil resources limitation, high cost and time-consuming of its production determine the importance of rational and integrated use of raw hydrocarbons, including reduction of hydrocarbons technological losses, is considered in the present paper. Technological losses of hydrocarbons mean their dead weight losses, associated with implementation of technical projects of fields' development, due to technological specific features of the production cycle as well as physical and chemical characteristics of oil extracted out of subsoil assets. The loss of hydrocarbons can not be completely prevented, but they can be greatly reduced by the rational organization of work, technological process optimization and equipment upgrading. The most widespread methods and equipment used to reduce the losses of hydrocarbons while oil gathering and processing, caused by oil evaporation, dropping oil entrainment by oil (associated) gas flows as well as dropping oil entrainment by drainage water flows of oil oilfields are discussed.

**Key words:** hydrocarbons; technological losses; reduction; gathering and processing of oil.

#### **SOME TECHNIQUE OF WELLS' COMPLETION BY HORIZONTAL WELLBORES WITH DETERMINATION OF OPTIMUM LENGTH OF HORIZONTAL FILTRATION INTERVAL**

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The paper presents technical description of some technique used for wells' completion by horizontal wellbore with determination of the optimal length of horizontal interval. The objective of the technique is efficiency increase and drilling and operational reliability of a horizontal well, reduction of filtration interval and probability of complications. Technical result is achieved by drilling of a productive formation for the optimal length of the well's horizontal filtration interval. The main feature of the technique is the fact that a productive formation is drilled for the optimum length with expansion or without expansion of a filtration interval. In this case the length of the well's horizontal interval as well as probability of complications and expenses on drilling and operation of a horizontal well decrease.

Expansion is performed by hydro-mechanical or hydro-monitor dilators in case of occurrence of soft and poorly-cemented rocks, while in case of hard rocks the operation is done by mechanical or hydro-mechanical dilators. Expansion of a filtration interval, washing of a well and lifting of drilling tools out of a well are followed by running of the operational casing string equipped by slotted casing liner, the length of which is equal to the length of the interval of expansion, into the well. Then cementing of the operational casing string is conducted, leaving the slotted casing liner non-cemented.

**Key words:** drilling; well; operation; completion of wells; horizontal wellbore; productive formation; filtration interval; slotted casing liner; operational casing string.

#### **RAISING OF ENERGY EFFECTIVENESS OF NATURAL GAS PIPELINE TRANSPORTATION BY OPTIMIZATION OF COMPRESSION**

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The results of comparison and choice of compression system of gas pipeline compressor station are presented in the paper. The importance of solving the problem of optimization of gas pipeline compressing scheme, being operated in the mode of underutilization, to reduce energy consumption is shown.

**Key words:** gas main pipeline; compressor station; compression system; optimization compression scheme; energy effectiveness.

#### **FILTRATION MODELS OF ABNORMAL OILS IN A POROUS LAYER**

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Problems of modeling of filtration processes of abnormal structural oils with availability of coagulant structures in a porous layer are considered. Some new equation of Bingham liquids filtration in an oil layer that takes into account dependence of filtration rate on pressure gradient and shift stresses is drawn and offered. It is shown that some abnormal liquids, including oil, having fluidity limit and being bigamous, can demonstrate pseudo plastic properties while shift stress increase and in case of further stress increase can behave as dilatant or Newtonian liquids. Abnormal oils and their products under some definite conditions of their flow can be referred to rheological liquids like Oswald-de Ville type and can be described by power rheological equations. Calculations models of oil effective viscosity and mobility depending on the change of pressure gradient and particles concentration are developed. The developed models are

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compared with reference experimental data, obtained from various wells.

**Key words:** filtration process; porous layer; abnormal liquids; well; viscosity.

#### **THE UNIT FOR VAPOR RECOVERY OF OIL PRODUCTS WITH PERIODIC PROCESSING OF REFRIGERATION UNIT ON FILLING STATION**

The RF patent of utility model

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The unit allows to recover vapor of oil products effectively during fuel car tanks and the storage tanks by reducing the temperature in the heat-exchange unit and absorption by diesel fuel. The unit involves intermediate tank to collect vapors from the fuel tanks, the total steam pipe for vapor recovery, compressor, an underground tank with diesel fuel, equipped the shaft with the centrifugal wheels, the heat-exchange unit with a refrigerating unit, relay, electric motor.

**Key words:** fuel tank; steam pipe; compressor; heat-exchange unit; refrigerating unit; periodic processing; relay; electric motor; pump; shaft; centrifugal wheel.

#### **TEMPERATURE MONITORING TECHNIQUES IN PERMAFROST OF GROUND**

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Objects temperature monitoring is suggested to be performed in order to identify and eliminate emergency situations in permafrost regions by means of using various temperature monitoring systems to provide safe operation of transport infrastructure and oil and gas complex in the northern regions of the Russian Federation.

**Key words:** cryolithic zone; long-term changes; monitoring; soil temperature; trend; thermistor chain; controller, system.

#### **SENSORS FOR TEMPERATURE AUTONOMOUS MONITORING**

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The paper describes some logger of temperature digital sensors, designed for autonomous reading of temperature measurement data of multiband digital thermistor chains with specified intervals and used for measurements that show temperature distribution of ground, pipelines and other extended objects.

**Key words:** logger; temperature digital transmitter; geotechnical monitoring; monitoring; pipelines; multi-zone digital thermistor chain.