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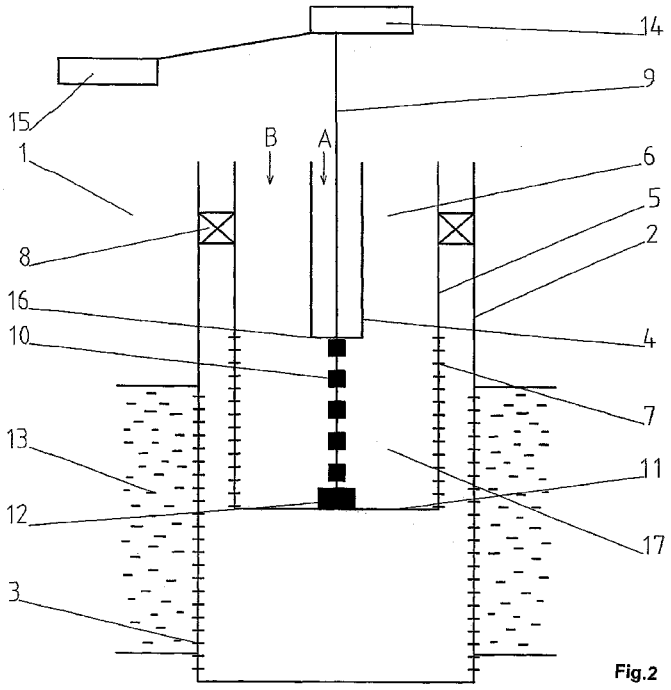

Fig.2

(57) Abstract: The device (1) for the efficient extraction of bitumen, shale oil, very heavy and light oil using a fully automated control system, which consists of a mining assembly (17) in the oil layer (13) and a control unit (14) connected to processing unit (15), which are on the surface, whereas the mining assembly (17) is provided with a casing (2) which is provided with a perforation (3), where in the casing (2) an inner riser (4) is arranged and around this inner riser (5), which is also provided with a perforation (18) and has a firm bottom (11), whereas the inner riser (4) is open at the bottom and its bottom (16) is above the bottom (11) of outer riser (5), whereas through the inner riser (4) is led a cable (9) which is with its end anchored in the oil layer to the bottom (11) of the outer riser (5) and with the other end is led to the surface of the control unit (14), whereas in the space between the bottom (11) and the end (16) of the inner riser (4) at least one sensor (10) on the cable (9) is arranged and it is connected by the cable (9) to the control unit (14) and the

WO 2019/057226 A2

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control unit (14) is connected to processing unit (15).

Device for efficient bitumen, shale oil, very heavy and light oil extraction using a fully automated control system and method of preparation of the mining equipment

Technical field

The invention relates to a method for efficient bitumen, shale oil and very heavy oil extraction by using its partial conversion into light hydrocarbons in situ using precise real-time temperature and partly also pressure control.

State of the art

Generally, the heavier the oil and the higher viscosity, the more difficult it is to extract. If its viscosity is reduced, extraction can increase abruptly. If its viscosity is permanently reduced, it is easier not only to extract the oil, but also to transport it especially in the Arctic, and such oil is usually sold at considerably higher prices. Partial conversion of complex hydrocarbon molecules into single molecules will greatly increase deposit yield.

Generally, the lower the porosity of the oil collector and the lower its permeability, the more difficult the oil (but also the gas) to extract from it. Typical example is shale, which additionally contains kerogens. If we change the porosity and permeability of the collector, it is much easier to extract hydrocarbons from it (using hydro-fracturing, for example, but if complex hydrocarbons can be converted to synthetic lighter oil, the yield of oil from the entire deposit increases In fact, not only the yield is increased, but also in the case of shale, the oil content of the deposit can increase even more.

In the past, several patents have been proposed to use water in supercritical conditions (temperature> 374 ° C, pressure> 22 MPa) in the presence of some catalysts to convert heavy hydrocarbons into light hydrocarbons.

For example, it is possible to note Canadian patent applications CA2208046A1 or CA2000251A1 or US patent applications US 20110049016 A1 and US 20090159498 A1 or Russian patent RU0002576267. However, all the solutions in these documents have one serious deficiency which either totally or almost renders impossible their practical use. None of them solves whether it is possible to bring water into a supercritical state directly in the oil-collector - they all assume that supercritical water can be brought down in some unspecified way. RU0002576267 even admits that in heat-insulated risers that would bring such water down, an energy loss of about 10% would be at every current kilometer. If the shale deposit lies 3-4 km deep (and that is the depth where most of the interesting deposits are found), there is a serious problem, even though the Russian patent proposes

to supplement the lost energy with suitable oxidants that would react with hydrocarbons. The catalysts mentioned in these patents are "heterogeneous". In order to fulfill their function, the catalyst molecule has to come into contact with a complex hydrocarbon molecule, which is a problem with the high viscosity of these materials and often with a very low porosity and permeability. Catalysts are difficult to get to the destination, and the reaction will not be uniform.

Shale generally yields 4-5% of the total stock, and the various proposed stimulating methods hypothetically shift it to 5-7%, which means a cost increase of nearly 50%. Estimates of experts say that when converting kerosene to synthetic oil, yields can be 40-50%. Kerogenes are in shale 10-30% by weight with respect to the density, but exceed more than half the volume. If the wishes of the experts are fulfilled and the kerogene partially transforms into synthetic light oil and/or gas, there would be very porous rock with high permeability, and mining would not be a problem. The problem, however, remains the transport of sufficient energy to the collector.

The most common stimulating method for extracting oil from these formations is so-called hydro-fracturing (hydraulic fracturing of the rock). It is only suitable for lighter oil, it is ecologically problematic and the cost per barrel is very high.

Concerning heavy oil and bitumen, conventional thermal methods use either hot water or superheated steam. Superheated steam is used for the extraction of bitumen and very heavy oil into depths of 800-900 meters. The vast majority of bitumen "softens" at temperatures in the range of 70-110 °C. Again, there is an important economic factor here. The bitumen yield is about 20%, but the quarter is consumed on the spot for heat production.

All the known technologies combine one principle - the high heating of volume of rock as much as possible to achieve a pyrolytic effect, and in all of them differs the way to achieve that goal. Some of the technologies can give very good results, especially on shallow shale wells or heavy oil wells. However, none of the known technologies seem to have a wider general use for shale extraction or bitumen extraction and very heavy oil, regardless of their geological structure and depth of deposit.

All technologies deal with the problem of efficient transfer of sufficient heat (energy) into a hydrocarbon complex containing complex hydrocarbons and transfer of suitable catalysts whose dimensions must be at least one level smaller than the dimensions of the micropores in the collector.

The aim of the invention is to introduce a method of extracting bitumen, shale oil and very heavy oil which would be reliably operable in a fully automated mode and apparatus for carrying it out.

Summary of the invention

The above mentioned deficiencies are eliminated by the method of efficient extraction of bitumen, shale oil including kerogen and very heavy oil according to the invention, which is characterised by the fact that an inner riser is provided in the casing pipe and an outer riser is provided around this inner riser, which is also provided with a perforation and has a firm bottom, whereas the inner riser is open at the bottom and its bottom is above the bottom of the outer riser, whereas through the inner riser is led a rope which is anchored to the bottom of the outer riser and by its other end is the rope brought to the surface to a control unit, wherein at least one sensor is connected to the cable in the space between the bottom and the end of the inner riser, which is connected by a cable to the control unit and the control unit is connected to the processing unit.

A further aim of the present invention is a method of preparing an extraction device for monitoring the well relations for subsequent efficient mining where a mining assembly with an internal riser is arranged in the oil layer at the mining site for feeding one chemical composition, the rope is dropped into the drilling assembly and anchored in the outer riser for feeding a second chemical composition which is arranged around the inner riser, wherein the rope is provided under the exit from the inner riser by at least one sensor connected by a cable to the control unit and according to the signals from the temperature and pressure sensors the control unit controls the processing units in terms of the feeds of compositions, catalysts and water at an in advise selected working point.

In a preferred embodiment, metal-based catalysts such as aluminum, zinc, iron, vanadium, molybdenum, tungsten, manganese, preferably in the form of solutions or suspensions are added to the composition either in advance or concurrently or with delay.

In another preferred embodiment, the method is analogously used for wells driven into oil layers obliquely or horizontally.

Preferably, either in advance or simultaneously or with delay, the metal-based catalysts from the group such as aluminium, zinc, iron, vanadium, molybdenum, tungsten, manganese, preferably in the form of solutions, suspensions, etc., are added to the composition, subsequently supplemented with suitable acids or bases and, optionally, the amount of water necessary to convert complex hydrocarbons to synthetic oil, whereas the water, upon reaching supercritical conditions in which it can decompose itself, allows a

condition where the water in the presence of catalysts breaks down the heavy polymeric molecules into the lighter and the whole process is regulated in real time irrespective of the depth of the oil layer, so that a sufficient working temperature can be set in advance, which will keep the system in the well within a narrow range and at the same time use the pressure of the gases produced for the gas-thermal breaking of the rock. It is important to bring sufficient amounts of hydrogen to the oil layer to make easier the production of synthetic light oil.

A further aim of the invention is a device for carrying out the above-mentioned method

Brief description of drawings

The invention will be further described using drawings, where Fig.1 is a phase diagram for water, Fig. 2 is a view of device for controlled oil extraction with an applied sensor for monitoring operating pameters in a deposit according to the invention, and Fig. 3 is a flow chart illustrating the arrangement and interconnection of the elements of the process unit that is connected to the mining assembly according to the invention of Fig. 2 located in the oil layer.

Preferred embodiments of the invention

The subject of protection is the effective method of extracting complex hydrocarbons from low permeable rocks, shale, oil-layers containing bitumen, heavy oil etc. The method consists in the treatment of a large area of the oil layer surrounding the well by a complex automated controlled thermochemical reaction system, at temperatures between 450-550 C and, in the presence of supercritical water and catalysts, complex hydrocarbons are converted to synthetic oil, and also a gas-thermic breaking of the rock occurs, with the overall effect, which is ensured by both of each of the active ingredients (phenomena, activity) alone and their overall combination. The key to an economically efficient result is the fact that all the reactions take place only partially in the well and most of them take place in the collector in certain distance from the well, whereas the designed precise control system checks practically with no delays regardless of the depth of the well optimal pumping speed of the reagents, or reaction inhibitors, and hence the temperature and partially the pressure, to avoid overheating and destruction of the well.

It is easy to achieve even higher operating temperatures (700 – 800 °C), but the question is the overall economy of the process, because it is mainly given by energy consumption and the rate of its efficient usage. It is also necessary to take into account the technical solution of the oil layer. Old wells could be damaged easily, but the new ones could be specifically constructed for such extreme conditions.

From a physicochemical point of view, to increase the extraction of complex hydrocarbons, amount of energy and hydrogen is fundamental which causes that a substantial portion of them is converted to simple hydrocarbons, thereby the viscosity is significantly lowered.

Shale containing oil and kerogenes, possibly phyllites and some other rocks are generally characterized by low porosity and permeability, and contain oil and kerogenes. Heavy hydrocarbons have a considerable thermal expansion and, when heated at 100 °C, their volume is increased by a several percent, which helps to increase the porosity due to the breaking of the rock by the expansion of the fluid present in the rock.

Mostly water is found in the deposit, and if it is not present, it can be deliberately delivered as a solvent for some chemical reagents to be used for thermochemical heating.

Properly chosen reagents will help to achieve a certain temperature of the rock without losses. In the next step, the oxidants, the products of the primary reactions with the catalysts and the water in a supercritical state or in its vicinity enter into reactions with the hydrocarbons and their fission is in the process, which alters their essence and lightens the mining. For the safe process of the reaction, it is necessary to use a regulation which prevents damage of the well, which could very easily occur if the temperature within a is not kept within a preselected range.

Fig. 1 shows a phase diagram for water. Beyond 374 °C and 220 atm, the water is in a supercritical state (supercritical fluid). The presence of some substances can shift the temperature of the critical point down (eg CO_2) or up (some salts and other materials). However, most substances usually shift the pressure value upwards (see Fig.).

In the oil layer under supercritical conditions hydrocarbons and suitable catalysts are present, the water can be partially decomposed, even at higher temperatures, and released oxygen will exothermically oxidize the hydrocarbons present to produce CO_2 and water vapor, and help maintain a high temperature while released hydrogen causes breaking of the largest hydrocarbon molecules, and the resulting CO_2 will help reduce the temperature threshold to create supercritical conditions (and oil viscosity).

The bonds between the carbon atoms are fissioned and free hydrogen atoms are attached to the loose bonds. To this fission the temperature contributes significantly, the

value of which is maintained at a level of at least 450-500 °C, where the fission takes place much faster than at temperatures above 300 °C (de facto pyrolysis). At the same time, water, which also partially fissions into hydrogen and oxygen, enters the reaction. This can significantly change the chemical composition of the fluid contained in the shale as the polymeric substances, which form kerogens, break into the molecules substantially smaller, and then to smaller ones, etc., until a "synthetic" light oil is formed permanently. The degree of kerosene transformation into lighter hydrocarbons is dependent on the size of the hydrogen index (HI). By selecting suitable reagents the hydrogen index can be increased under certain conditions. In general, it can be estimated that for kerogen type I, pyrolysis can transform up to 80% of kerosene to hydrocarbons and 20% to coke. For type II, the ratio may be around 50:50 and for type III, it is 20:80. The total volume of kerosene in the shale is conservatively around 15% by weight (but rarely 20-30 %), the total pore volume (including those filled with extractable hydrocarbons) is up to 5 %. The kerosene density is usually 1020 - 1070 kg/m^3, the density of the inorganic materials in the shale is around 2500 kg/m^3.

By kerosene pyrolysis the total pore volume filled with extractable hydrocarbons is multiplied. This method of increasing porosity will thus permanently help significantly increase the yield of hydrocarbons from the shale. Porosity can reach tens of percent. Maximum temperature values for maximum increase in permeability are typically around 500 °C, whereas a sharp increase in cracking usually starts at about 300 °C. At higher temperatures, it does not significantly increase. This is the optimal use of this process in combination with pyrolysis in the presence of supercritical water and catalysts.

It is not always possible to achieve the desired pressure (especially for shallow deposits), but the effect of temperature and suitable catalysts on the kerogen conversion process on synthetic oil may be higher than the effect of high pressure, especially since by heating of the deposit the temperature is kept relatively long and the deficiency of the pressure can be partly compensated by a longer time when the polymers (kerogenes, bitumens, etc.) can decompose into substantially simplier fractions.

If the temperature is increased above 450 °C, the water will partially decompose to hydrogen and oxygen, which will further accelerate the conversion process of heavy hydrocarbons.

The decomposition reaction of complex hydrocarbons (KXHC) in pyrolysis can approximately be described as follows:

$KXHC \rightarrow CO_2$

$KXHC \rightarrow C_{(m+n)}H_{2(m+n)+2} \rightarrow C_mH_{2m+2} + C_nH_n$

$Q_{reakce} = Q_{(the\ calorific\ value\ of\ the\ burned\ kerogen)} + Q_{(the\ calorific\ value\ of\ pyrolysis\ substances)}$

The calorific value already contains the enthalpy of the decomposition reactions (i.e., the energy that needs to be delivered at the beginning so that the reactions can occur at all).

By choosing from a wide range, temperatures around 500 °C of reagents can be easily reached. And there is no problem reaching high pressures. There, the limitation is de facto given only by depth, rock strength and well construction, while surface construction of the well can be at least temporarily changed.

Documents WO2010/043239 A1 and WO2017/041772 A1 describe a wide range of usable chemicals. In terms of the used concentrations, it is recommended using the maximum possible, yet safe, concentrations in contrast to the patents mentioned. These materials are referred as TGEC (Thermal Gas Evolving Component). In addition, initiators and, respectively, stabilizers called RIS (Reaction Initiation Stabilizer).

It is proposed to extend these materials with hydrogen peroxide, methanol and ethanol. In terms of catalytic properties, it is interesting to add to TGEC a relatively high percentage of the soluble salts of certain metals, for example iron nitrate, or to use it directly as an oxidant. As catalysts, for example, aluminum and zinc (for example in the form of powders, salts or oxides dissolved in a suitable solvent to obtain as much catalyst surface as possible) or some of the catalysts used in the cracking of crude oil (usually based on molybdenum, vanadium or tungsten – e.g. tunstig acid). Catalysts can be added to the active substance TGEC after the reaction has started in the collector, but they can be transported to the collector even before the reactions begin. Catalysts are added to the major active substance (TGEC) in a suitable ratio based on their efficiency. Catalysts are chosen according to wanted result: whether it is desirable to obtain a larger proportion of liquid or larger proportion of gaseous hydrocarbons.

In view of the often very low porosity and physical dimensions of pores, it is proposed to use catalysts in the finest form, so-called nanocatalysts or solution-based catalysts or liquids where the particle size is at the molecular level.

The device 1 for efficient mining consists of the mining assembly 17 in the oil layer 13 which is shown in Fig. 2 and the control unit 14 connected to the technological unit 15 shown in Fig. 2.

Fig. 2 schematically shows the lower part of the oil layer 13 with the mining assembly 17. It comprises some known parts as well as new parts according to the invention. In the oil layer 13 is a known casing 2 which is provided with a perforation 3. In it

an internal riser 4 is provided which is a new element according to the invention and around this inner riser 4, inner diameter of which is preferably 1.5 inches, outer riser 5 known per se is arranged, but is newly fitted with a perforation 7, whereas the outer riser 5 has a firm bottom 11. The inner riser 4 is open at the bottom and its lower end 16 is above the bottom 11 of the outer riser 5. The space between the casing 2 and the outer riser 5 is enclosed by a packer 8. It is located about 100 m above the perforation 3 but can be lower or higher depending on the heat resistance. Through the inner riser 4 a rope 9 is guided which is with its end anchored by weight 12 in the oil layer 13 and with the other end it is anchored near the control unit 14 on its surface. Into the space between the bottom 11 with the weight 12 and the lower end 16 of the inner riser 4, the sensors 10, respectively their cables 9 are aranged. On the bottom 11 of the outer riser 5, an anchored cable 9 provided with the sensors 10 is another important part of the mining assembly 17 according to the invention.

Through the inner riser 4, a chemical composition A is introduced, as indicated by arrow A and by the annulus between the inner riser 4 and the outer riser 5, and chemical composition B is fed, as indicated by arrow B.

The constitution of the chemical compositions is not a subject of the present invention, it is mentioned in the preceding paragraphs, especially those dealing with TGEC or RIS.

The control unit 14 is connected to the processing unit 15, which will be described in detail with reference to Fig. 3.

The aim is obtaining information by means of sensors 10 about the environment in the bottom part of the oil layer, where, as a result of the reactions of the chemical components A and B, hot gases are formed which penetrates the sensors 10, which can measure the temperature, pressure or other quantities, due to perforations 18 into the oil layer 13. Therefore, in the region around the sensors 10, there is a measuring environment, which essentially corresponds with the environment under the bottom 11 of the outer riser 5.

The sensors 10 and the connecting cables from the control unit 14 may be of an electrical or optical nature and the information they transmit continuously to the control system serves to maintain the temperature (and sometimes the pressure) around the preselected operating point which is optimal both in terms of the spread rate of the hot fluid to the collector, and the conversion of complex hydrocarbons to light ones, whereas the temperature and partially also the pressure is controlled by the system in real time by varying the speed rate or ratios of the heated reagents or reaction inhibitors by at least two

channels with the possibility of using a special injection device, whereas the channels end under the packer 8 in the vicinity of the perforation zone of the oil layer 13 (if it is an oil-based layer cased to the bottom).

It is evident that instead of the two concentric risers 4 and 5, a different technical solution can be used for transporting of compositions and measuring devices, such as, for example coiled tubing or risers with integrated injector line.

The control unit 14 is connected to the processing unit 15, which is schematically shown in Fig. 3. There is shown an arrangement and interconnection of the individual elements of this processing unit 15. Processing unit 15 generally serves to prepare composition A and composition B formed from water-mixed loose chemicals and their controlled delivery through a four-way control valve 41 and a high-pressure plunger pump 40 into an oil layer together with catalyst C where they react together and intensify oil extraction from the deposit. In terms of the preparation of composition A, the processing unit 15 consists of a water reservoir 18 which is connected by an overflow 45 with a reservoir 19 to which elements for composition A are fed. In terms of the preparation of composition B, the processing unit 15 consists of a water tank 38 which is connected to an overflow 46 with a reservoir 27 to which the elements for composition B are fed. The loose chemicals are fed to the tank 27 for composition B by a screw conveyor 39 with a conventional dispenser (not shown) and with a hopper (not shown).

There are two low-pressure pumps 31 for the primary water circuit 24 and the secondary water circuit 26 and a high-pressure plunger pump 40 and a four-way control valve 41 in the space 43 for pumps. The water is led from the source 37 via the low-pressure pump 31 through the secondary water circuit 26 to tank 18 and overflow 45 to tank 19 for composition A and also to tank 38 and overflow 46 to tank 27 for composition B. From tank 27 for composition B, conduit 28 for composition B is further fed through a four-way valve 41 and to a high pressure plunger pump 40. From the tank for composition A, the conduit 23 for composition A passes into the high pressure four-way valve 41 and also into the high-pressure plunger pump 40. The primary water circuit 24 is led from the first low pressure pump 31 to the distributing valve 25 and the secondary water circuit 26 is led from the second low-pressure pump 31 also to the distributing valve 25, so they interconnected in water distributing valve 25. It was already mentioned, that from there the water flows into the water basins 38 and 18.

From tank 18, the water also flows via the conduit 24 from the circuital low-pressure valve 32 either to the four-way valve 41 or to the water pump 31 of the primary and secondary circuit. The tank is connected to the high pressure system so that the water can

cool down the oil layer. The water in the oil layer flows through the space between the riser 5 and the casing 2, see Fig. 2.

In the tank 27 of composition B there a smaller tank 29 for catalyst C is arranged which is connected via conduit 30 to the catalyst C with a four-way valve 41. From the hot air supercharger 42, the hot air circuit 21 leads to the tank 19 for the composition A and to the reservoir 27 for the composition B through the air valves 22. From the four-way valve 41 the pipes 28, 23, 30, 24 are led onto the head of the oil layer 13, and on the basis of commands from the control unit 14, compositions A, B, C or water are optionally dispensed.

The tank 19 for composition A and the tank 27 of composition B is further equipped with a total of three sensors (not shown), namely a level meter which controls a low-pressure pump 31 for filling the tanks 18 and 38 for water. As soon as the tank 27 for the composition B is filled into the required volume through an overflow, the two-way valve 25 is switched and the water is pumped into the water tank 38 and flows through the overflow into the tank 27. By this system, water is continuously filled up, so it is always enough water in the tanks 18 and 38. Thus, the level meter switches the valve 25 on the basis of recording maximum and minimum volume in tanks 18 and 38.

The high-pressure plunger pump 40 controls the pumping of compositions or water into the oil layer 13.

The operation of the supercharger 42 is controlled by measuring the temperature in the tanks 19 and 27 connected to the system via the control unit 14, and thus the environment in the tanks can be adjusted.

Another function of the sensors in the tank 27 for composition B and in the tank 19 for composition is as follows: One sensor is located at the top so as to command in advance the switching off of the filling pump. The second one measures the temperature and gives the operating instructions for the hot air supercharger 42, and the third sensor measures the concentration of the composition and gives instructions for dispensing loose chemicals into the composition.

The tank 19 for composition A and tank 27 for composition B are provided at the bottom with a stainless steel conduit which is located about 100 to 200 mm above the bottom and has a length of about 25,000 mm and is in the first half of its length provided with full walls and in its second half is perforated. The hot air of the hot air supercharger 42 is blown into this conduit in the tank 27 of the composition B and heats the composition in the first half of its length, and the other half also heats it partially but mainly mixes it.

At the corner of the tank 29 for composition B there is a discharge device provided with a flange with a fitting for connecting low-pressure hoses. The integral part of the discharge device is a simple, manually operated spherical valve which is in the open position throughout the working time of the oil layer. After it has finished, the valve must always be closed manually.

In the same container as the tank for composition A and tank for composition B laboratories 20 are provided with a high and low voltage switchboard, a storage room 34, a dressing room with a control room 33, a coil seat 35 with cables and a measuring device.

The container B also contains barrels in which catalysts are stored, which are chemicals in the liquid state that are not diluted or heated, and serve filled with tank 29 during their operation.

From the tank 29 the conduit for the high-pressure pump 41 is led. The tank 29 must be provided with a screw fitting for the assembly of the low-pressure hoses and the discharge valve.

All pumps, hot air supercharger 42 and unit of main control valve to turn the high pressure pump on and off and basically follow the temperature and pressure measurements in the oil layer to drive the entire system, are installed in this container. In addition, two screw conveyors 39 are in the container together with the pumps 27, 29, 38 and the valve device, the high and low voltage distributors. The control of the four-way valve 41 and the high- pump 40 is provided with control unit connected to the sensors 10 in the oil layer 13 controlled by software that provides system security, real-time control of the process, and maintenance of temperatures and partial pressures in the range around the entered values either by the operator or automatically determined by the calculations based on the parameters in the oil layer, geological and other information.

It is economically attractive to inject high-humidity air with a very powerful compressor (naturally, after reaching a sufficient temperature in a sufficiently large volume of the collector to oxidize and hydrogenate the required amount of kerogen).

The control system for the performance of the method is preferably in a mobile version, where the required pumps, working fluid distribution system, and control valve system are arranged together with the control unit in containers which can be of the standard type with a length of 12 meters or in specially modified box vans in combination with separate tanks, whereas the control system can be controlled locally and remotely by means of telecommunication means including allowing detailed recording of its activity locally and remotely and it can operate both in fully automated mode and in manual control mode, and previous results can later be used to optimize future well stimulation processes.

The presented technical solution is maximally flexible and mobile. Standardized containers or a specially modified box vans are designed to ensure easy handling and implementation of the entire system. It also includes a measuring and dispensing (injection) unit which is sunk into the well to the perforation zone through a channel or is part of such channel. The surface fitting of the well must be adapted to the selected number of channels (at least two) and the system is connected via the control and safety valves and the flap valves to the surface fitting of the well in a standard way so that the pumps that are part of the system can be driven into the well by the individual channels the predetermined reagents required at a rate that the system determines according to the reaction process itself and in quantity and order as determined by the software. A suitably arranged solution enables to achieve virtually any reasonable and necessary temperature for the purpose of the present invention and also eliminates the disadvantages of all the heat and gas generators operating on the surface and injecting hot gases or liquids through the surface wells into the oil layer. The system enables to achieve very fast and high pressures sufficient to cleavege in the collector, whereas hot fluid breaking using is more effective than cold water breaking because high temperature reduces rock strength. All this without the use of extremely powerful pumps and a huge amount of liquid, because all the liquid in the system (hot reagents) turns into hot gases and creates high pressures directly in the well.

The proposed procedure does not require any special investment (for already drilled wells), but requires the use of a considerable amount of chemicals, which can reach up to many hundreds of tonnes for longer horizontal wells (and we can draw thousands of tons of shale, with the long-term effect of extraction). It is important that the reactions will take place for the most part directly in the collector and therefore the heat losses will be minimal. The whole process is controlled by a fully automated system that ensures maximum efficiency and safety, and respects the technical parameters that each well was designed and built, and thanks to up to a dozen fast-response sensors, it allows the temperature (and partly the pressure) to be kept in the well in a very narrow interval around the in advance adjusted "operating point". If we wait until the collector get hot enough and the heat extends farther from the well, we can expect a very long-term effect.

The overall and single effect of all these factors leads to the conversion of a substantial portion of complex hydrocarbons to lighter synthetic oil without the heat losses caused by the transport of hot fluids produced on the surface for increase of the pressure in the collector, breaking of the rock and thus a multiple increase in the production of hydrocarbons from difficult to extract collectors.

Industrial applicability

The presented technology is intended to return to operation wells that have been stimulated by hydraulic breaking or by thermal methods (steam, SAGD) or are strongly irrigated and have ceased to produce oil efficiently. In these oil layers, when supercritical water conditions are reached, it can be assumed that water is mixed with oil perfectly (supercritical water dissolves oil), and if it is a suitable deposit, the conversion of complex hydrocarbons into lighter ones occurs. Oil solubility factor in supercritical water can be applied to highly irragated oil layers.

The applicability of proposed procedure is mainly in the following areas:

-shale deposits where wells are already drilled and where (with a high probability, but not necessarily) hydraulic fluid technology has been used.

-"Tight formations", which have not yet been exploited for economic reasons or are considered to be depleted (with lighter oil it is not necessary to heat so much, the gas-cracking of the rock is sufficient)

-bitumen deposits or very heavy oils that are difficult to extract by conventional methods, it is possible to work both with the conversion of complex hydrocarbons to lighter and even without conversion

-deposits already "extracted" mainly using overheated steam

deposits that lie at greater depths and therefore have not yet been opened for economic reasons.

-other wells (including newly drilled to use this technology) virtually unlimited, only taking into account the economy

In all cases, it is necessary to consider the depth and thus the maximum pressure safely attainable if we want to use supercritical fluids to permanently change the chemical composition of the oil. In shallow oil layers, it may be difficult or impossible to achieve the necessary pressure.

CLAIMS

1. The device (1) for the efficient extraction of bitumen, shale oil, very heavy and light oil using a fully automated control system, which consists of a mining assembly (17) in the oil layer (13) and a control unit (14) connected to processing unit (15), which are on the surface, whereas the mining assembly (17) is provided with a casing (2) which is provided with a perforation (3), **characterized in that** in the casing (2) an inner riser (4) is arranged and around this inner riser (5), which is also provided with a perforation (18) and has a firm bottom (11), whereas the inner riser (4) is open at the bottom and its bottom (16) is above the bottom (11) of outer riser (5), whereas through the inner riser (4) is led a cable (9) which is with its end anchored in the oil layer to the bottom (11) of the outer riser (5) and with the other end is led to the surface of the control unit (14), whereas in the space between the bottom (11) and the end (16) of the inner riser (4) at least one sensor (10) on the cable (9) is arranged and it is connected by the cable (9) to the control unit (14) and the control unit (14) is connected to processing unit (15).

2. A method of preparing an extraction device for monitoring the well conditions for the following efficient mining when a processing unit and a control unit are arranged on the surface, **characterized in that** a mining assembly with an internal riser is provided at the oil layer for the supply of one chemical composition, the cable is sunk into the drill assembly to anchor it in the outer riser for supplying a second chemical composition which is arranged around the inner riser, wherein the cable is provided under the exit from the inner riser by at least one sensor connected by a cable to the control unit and according to the signals from the temperature and pressure sensors, the control unit controls the operation of the processing unit in terms of the inputs of the compositions, catalysts and water according to the preselected operating point.

3. The method according to claim 2, **characterized in that** metal-based catalysts such as aluminum, zinc, iron, vanadium, molybdenum, tungsten, manganese, preferably in the form of solutions or suspensions are added to the composition either in advance or simultaneously or with delay .

4. The method according to claims 2 and 3, **characterized in that** it is applied analogously to wells led into the oil layers (13) obliquely or horizontally.

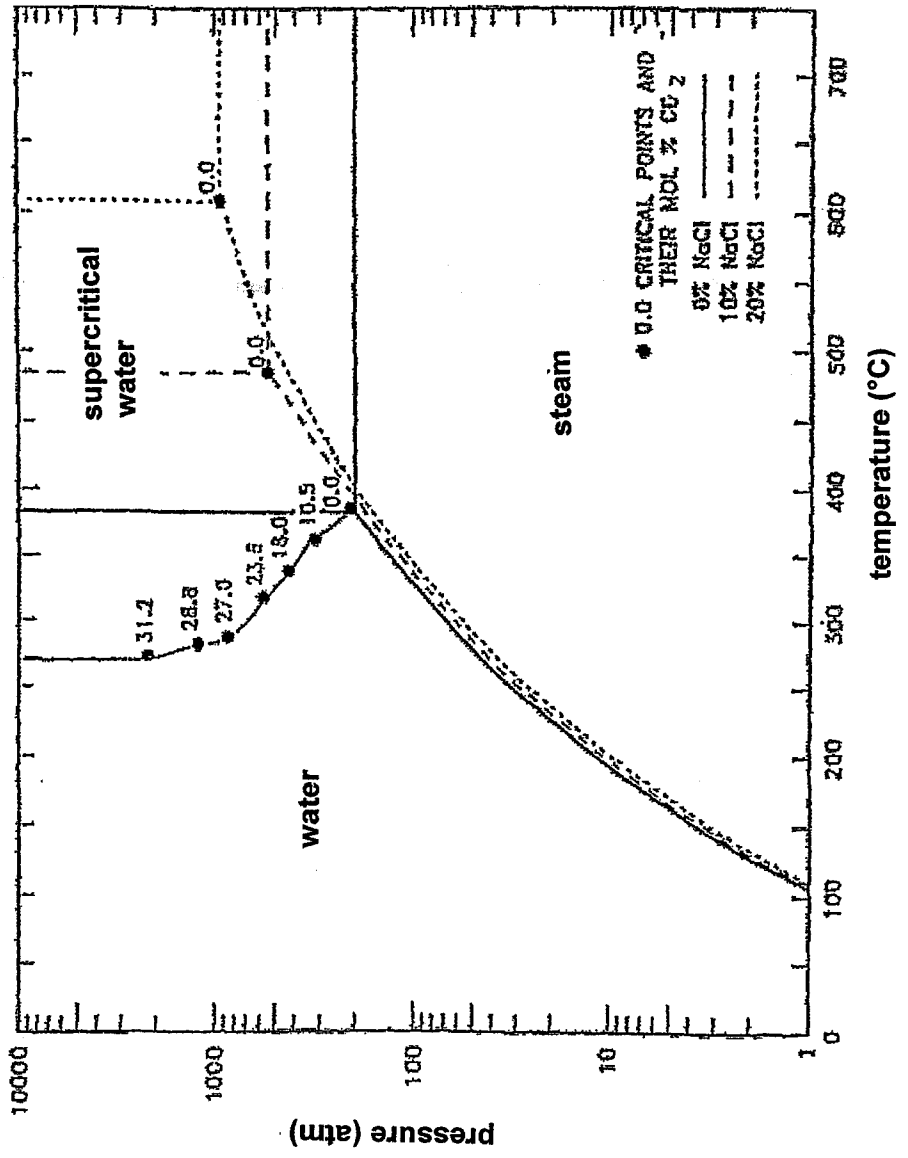
supercritical water
water
steam
0.0
0.0
0.0
10.5
18.0
23.8
27.9
28.8
31.2
* 0.0 CRITICAL POINTS AND THEIR MOL % CO 2
0% NaCl
10% NaCl
20% NaCl
pressure (atm)
10000
1000
100
10
1
temperature (°C)
0
100
200
300
400
500
600
700

Fig.1

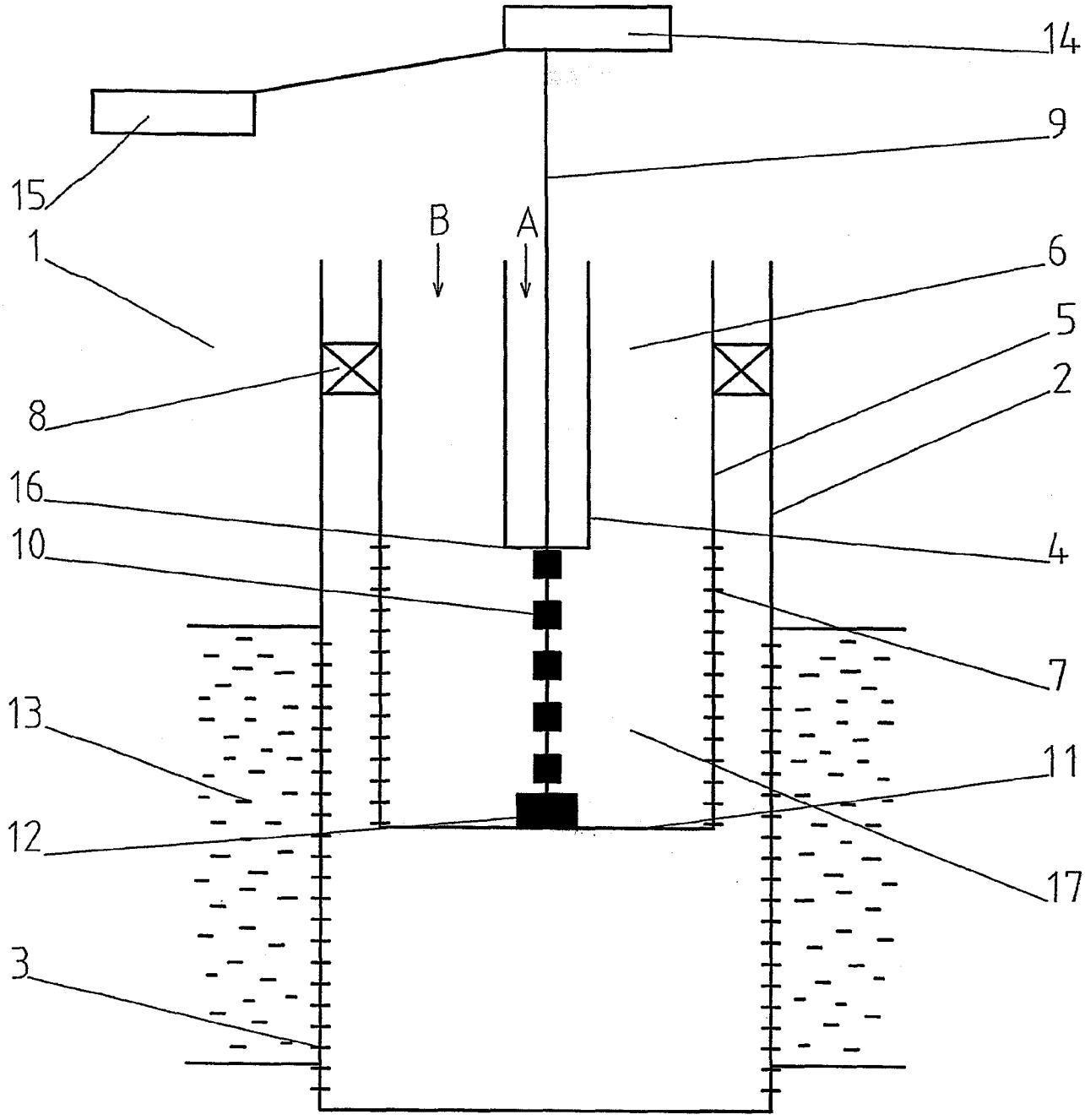

Fig.2

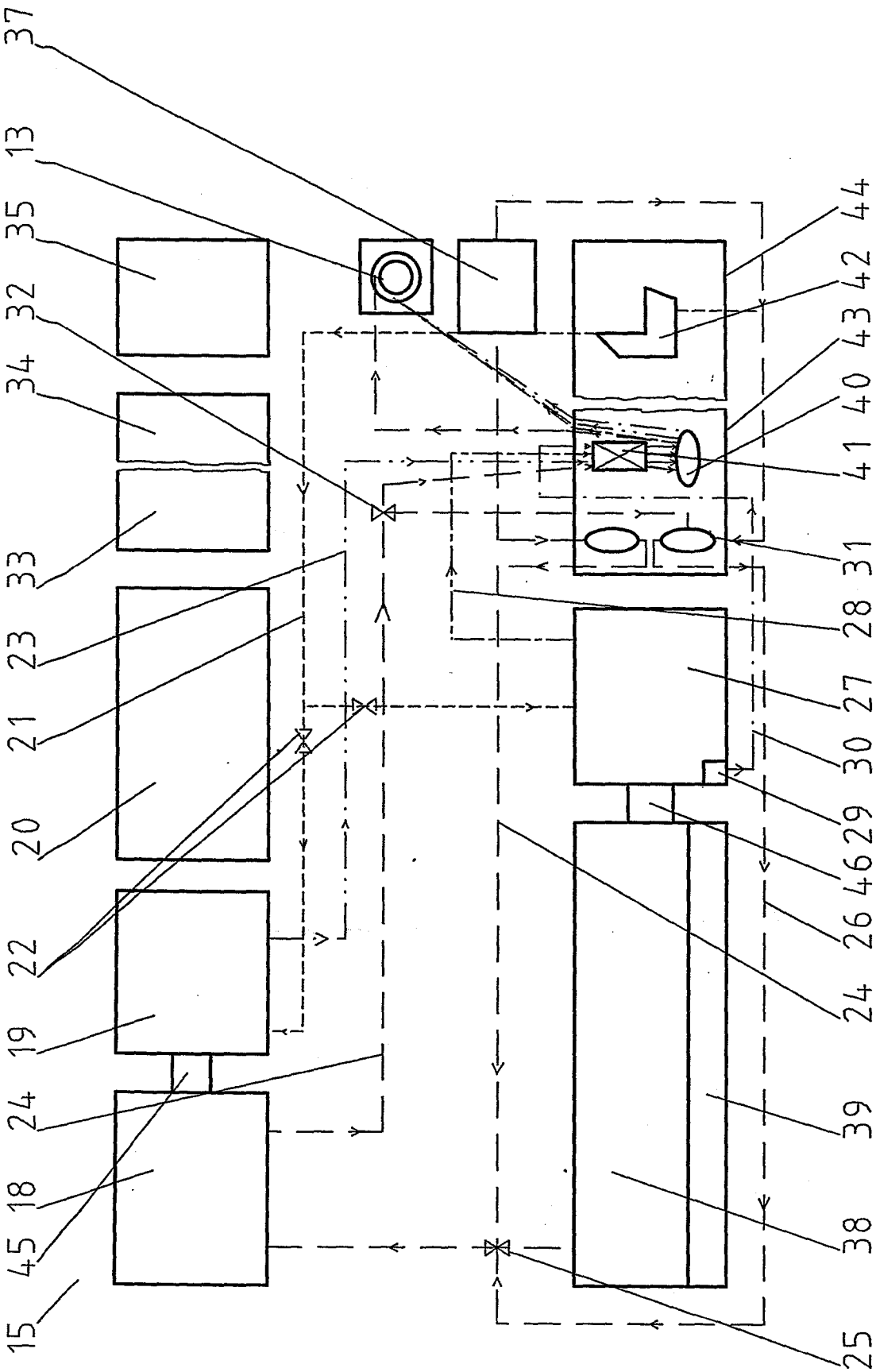
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Fig.3