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HEAVY OIL PRODUCTION

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Under conditions of traditional energy resources depletion heavy oil and gas hydrates become increasingly important in global economy. They have particular importance in Russia where light oil deposits are more than half depleted and, at the same time, in most cases operating and potential processors have no direct access to resources. Meanwhile, according to experts, world reserves of heavy oil reach more than 810 billion tons. Therefore, in the near future production of tight oil by means of pumps for oil products will become one of the most important industries.

According to the classification most widely used in the world heavy oils are hydrocarbonic liquids with density of 920-1000 kg/m3 and viscosity from 10 to 100 mPa·s.

However, the analysis of modern pumps and their case record has revealed many problems which are connected with the use of pumping equipment in development of high-viscosity oil fields. The main problem is that wells have a small radius of curvature and they are located horizontally, therefore production of resources with the help of auger and screw pumps is impossible.

In the past centrifugal pumps would be used in vertical wells for production of heavy oil with impregnation of sand. At present the latest materials and the modified details of pumps are used in the industry. It makes possible to use pump units even in the most difficult conditions. They also allow reducing amount of liquid in gas wells. Technologies of bitumen and high-viscosity oil production used nowadays are developed insufficiently as quantity of extracted heavy oil is extremely small. Considerable investments are necessary for development of oil fields by means of modern technologies, as well as for oil transportations and processing.

In recent years foreign companies have achieved considerable success in improvement of equipment and technology of high-viscosity oil production by means of pumps of various types. It was favoured by creation of such equipment as a long-stroke sucker-rod pumping unit, deep well plunger pumps with increased flow areas for viscous liquid passing, screw pumps and hydraulic centrifugal pumps. Technology, when viscous oil is mixed with pumped lighter liquid at the bottom hole, is widely implemented. These trends should be followed and developed at domestic viscous oil production fields.

In a result of in-situ combustion thermal oil distillation and carryover of decomposition products in a zone before the combustion front take place. Solid residue of thermal oil distillation in porous medium is the fuel which maintains combustion source. A combustion zone moves radially from walls of an injection well. Being formed hot gases push oil and water to exploration wells.

Along with already known conventional thermal technologies with application of vertical wells (steam injection, hot water injection, in-situ combustion) new technologies based on use of directional wells, horizontal wells and multilateral wells are developed and are starting to be applied at production fields of a number of countries. On the basis of new well designs the newest technologies of heavy and bituminous oils reserve recovery are created (the technologies are based on gravitational and thermal effect, including electrical heating).

SAGD (steam-assisted gravity drainage) method is new technology for production of heavy oil; this method implies that two horizontal holes are parallel and are in one plane close

to each other (7-10 m). A top hole is a steam-injector, and a bottom one is an exploration well. At the main stage of production steam is injected in an injection well. Because of difference in density injected steam makes its way to the top part of productive formation, creating the steam chamber increasing in size. On an interface of the steam chamber and cold oil-filled thickness there is a constant heat exchange process, as a result of which steam is condensed in water and, together with the heated oil, gravitate to the exploration well. The steam chamber grows up until it reaches the formation top, and then it starts extending. Besides, oil is always in contact with a high-temperature steam chamber. Thus, heat losses are minimal that makes this way of development economically advantageous.

A new N-Solv technology, being a modified method of solvent injection in a formation, allows increasing oil production from oil-bearing sand, reducing prime cost of oil and minimizing impact on environment. In N-Solv technology natural gas (propane) is used as solvent that demands much less energy in comparison with steam use. Solvent is heated to low temperature (~ 50 °C) and injected in oil-bearing sand. The solvent decomposes bitumen, the heaviest components of bitumen remain underground, and lighter oil and the solvent suitable for a reuse, flow upward. Besides, pulp turns out to be less viscous than it is at a conventional underground method, and it can be transferred through an oil pipeline right away.

New methods, such as, for example, in-situ combustion method (ISC) using horizontal wells, are also being introduced. This method implies that heat generating reaction zones moving along formation are formed, and when a part of formation oil is being burnt they make it possible to facilitate and increase extraction of other part of oil.

CHOPS (Cold Heavy Oil Production with Sand) method can be considered as one more new method of heavy oil production. This method assumes oil production with sand by means of purposefully done destruction of a slightly cemented reservoir and creation in the formation the conditions for oil and sand mixture flow (Lloydminster field, Canada). Application of CHOPS method does not require solid investments in development and ensures insignificance of operating costs; however, oil recovery rate in this case doesn't exceed 10% as a rule. At cold production specialized pump equipment (for example, screw pumping units) is successfully used; by means of this equipment pumping of specially created mixture of formation fluid and sand is made. Sand recovery leads to appearance of long channels, or the "wormholes", that have high permeability.

Foreign experts offer THAI technology ("TOE-TO-HEEL" AIR INJECTION) as a new technological process of heavy and bituminous oil production. The process combines advantages of known thermal technologies (ISC, steam injection) and application of horizontal wells. Laboratory experiments showed possibility to achieve oil recovery factor at the rate of 0.85 from initial oil in place (with viscosity from 0.05 to 100 Pa·s). THAI process can be implemented both at primary production, and at new technologies of oil recovery.

The latest technology in oil production is pulsed stimulation of formation. This environmentally friendly innovation – development of technology of plasma impulse excitation on formation – makes it possible to increase oil recovery factor of all types of wells: vertical, directional and horizontal, including marginal ones. Some hundreds of powerful impulses with formation of dense plasma clear a bottom-hole area and extend deep down the formation clearing perforation intervals. The main advantages are efficiency, simplicity of processing, safety, high accuracy selective action and possibility of reuse.

The world practice shows that experience of development of heavy oils and natural bitumen fields by various methods is solid. Each method can be applied in various situations and has its advantages and disadvantages. Therefore, prospects for the development of oil industry in XXI century are connected with the development of heavy oils and natural bitumen fields.