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ELECTRICAL BOTTOM HOLE HEATING SYSTEM (EBHHS)

Isaev P.P., Tsigankova E.V.
Scientific supervisor: Associate professor - Tsigankova E.V.

Siberian Federal University

Down-hole heating systems provide electrical heat right at the producing zone to help thin heavy crudes or prevent paraffin breakout or blockage, increasing well production from 2 to 8 times or more.

Standard systems are available for wells with primary production in ranges from 1 to 50 barrels per day. The heater assembly attaches directly to the tubing string and power is conducted through a steel armored cable (standard ESP) or continuous steel conduit. 480 VAC systems are standard for wells to 4000' depth and standard ESP power ratings to 44KW.

Higher voltage models are recommended for deeper wells or higher power requirements. Low power units can be furnished at 240 V. (other voltages are available).

In order to determine which specific model best fits your application, complete reservoir and well data are needed for wells with heavy asphaltic crudes or paraffin problems. Most economically effective well candidates are less than 4000' deep with heavy asphaltic crude of 8° to 16° gravity or paraffin problems whose viscosity drops 10 to 100 times with a 100° F rise in temperature, relatively low water cuts, and base fluid production less than 50 barrels per day. Standard systems for 5 1/2" casing tap and up; special slim-line designs for 4 1/2" casing. (Clearances are tight, so not recommended for deeper wells.)

Advantages of the Electric Bottom Hole Heating System are the following: first of all economical advantage: lowest cost of any thermal recovery method. The second advantage - non-contaminating: no foreign or corrosive materials are used. The third advantage - safety: no damage to well bore or production formation, temperatures are maintained well below coking point. The fourth advantage - efficiency: essentially all of the heat generated is delivered to the producing zone. The fifth advantage - simplicity: no special well completions are required, no need for complex support equipment. And the sixth advantage - continuous operation: no downtime, the well is pumped at all times during heater operation, unlike cyclic stimulation methods.

As for the setup of electric heating of crude oil using hollow sucker rod it should be noted that there are two types of electric heating of crude oil using hollow sucker rod: one is electric heating above hollow sucker rod pump, the other is electric heating through sucker rod pump. The electric heating equipment is mainly composed of surface electricity equipment and bottom-hole heating equipment.

Let’s consider surface power supply. The setup of surface power supply mainly consists of special transformer and electric control box. The special transformer is used to change voltage from 6.3KV to460–750V and supply power to the heat generation equipment down hole. The electric control box is used to protect the heat generation equipment and display the parameters of power supply.

The next significant point is heating in down hole. The setup of heating part in down hole consists of hollow sucker rod and special cable. The hollow sucker rod is the main body of heat generator. The cable itself is the body of heat generator too; besides, it can transfer electric energy to the down hole and form a current return together with the sucker rod. One end of the cable is connected with the surface electric control box; the other end is connected

with the bottom of the hollow sucker rod by means of conductive paste (the specifications and performance of the hollow sucker rod and the heating cable).

Much attention must be given to the hollow circumfluent. The hollow circumfluent pump is the core of electric heating of crude oil using the hollow sucker rod through pump. It not only has the function of the universal pump, but also has the function of allowing the hollow sucker rod and cable to pass through pump and achieve the purpose of heating the upper and lower part of the pump at the same time.

Some words concerning mechanism of the electric heating of crude oil using the hollow sucker rod. The scheme of electric heating equipment using hollow sucker rod is the following. After the cable is run down to the bottom of the hollow sucker rod, the connector at the bottom of the cable is connected with the hollow sucker rod. As soon as power is supplied, the skin effect will occur within the inner hollow sucker rod and the current will run on the inner wall of the hollow sucker rod. There is little electricity on the outer wall of the hollow sucker rod. In this way, electricity will be converted to heat. Because heating cable is made of copper and has linear resistance while the hollow sucker rod is made from the ferromagnetic material, this ferromagnetic material can produce nonlinear AC resistance which is much more than that of copper cable. The heat produced in the inner wall of the hollow sucker rod is much more than that produced in the cable, that is, the hollow sucker rod is the main part of heat generation.

At present, the technique used for monitoring the temperature change of flowing oil in well bore caused by electric heating is imperfect and field test data are difficult to get. In order to study the temperature change of flowing liquid in well bore, a mathematical model is built, with considerations for temperature, pressure, oil viscosity, swabbing parameters and the ratio of oil, gas and water The lower the oil temperature in influence of heat from the sucker rod after oil flows from the formation to the well bottom. The lower the oil temperature in well bottom, the longer the time of electric heating lasts and the larger the power consumed. Temperature doesn't rise if the temperature in the down hole is high. With the flow of crude oil from pay zone to well bottom and then from well bottom to well head, oil viscosity increases because temperature and pressure of oil decrease. The viscosity of heavy oil is more sensitive to temperature. When the temperature of heavy oil decreases lower than a value, its viscosity will increase rapidly with temperature decrease and this temperature is defined as the inflection point temperature. In order to make the heavy oil get enough mobility during lifting of heavy oil, it is necessary to keep crude oil temperature at well head higher than the inflection point temperature, so the inflection point temperature is used as the minimum temperature which crude oil should achieve by means of electric heating using hollow sucker rod.

Finally it is necessary to make the following conclusion. Oil production technique of electric heating using hollow sucker rod can be used to effectively solve the problem of oil viscosity reduction so that the oil can be absorbed into the pump during lifting. As compared to the technique of electric heating using tubing, it has higher heat efficiency. That power supply is cut off suddenly or that pumping is stopped has a trifling influence on the heavy oil production well using the technique of electric heating. Heavy oil will lose its mobility after pumping is stopped. That makes it difficult to start pumping. With the electric heating of crude oil using hollow sucker rod, preheating heavy oil one hour allows successful pumping.

The electric heating of crude oil using hollow sucker rod is a reasonable choice for heavy oil viscosity reduction in well bore if light oil can be obtained near the heavy oil reservoir.

It is very convenient for operations in the field. The heating power in the technique is adjustable. After the temperature of the liquid produced from well head is determined, power

supply parameters can be adjusted according to the temperature of the produced liquid and heating depth to adjust heating power.