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ELECTRIC OIL WELL HEATER
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Fig. 1

Fig. 2

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The invention relates to a heating device to be inserted in a flow string of an oil well, and more particularly to a heat exchanger to heat a localized area of flow in a string of pipe and to create an intimate contact between the oil flowing through such string and the heater.

One of the primary disadvantages with heating devices for use in an oil well to eliminate solid paraffin from the oil flowing in a string of pipe in a well, is that such devices distribute the heat over too large an area of pipe. This prevents heating of any portion of the fluid flow through the pipe to a sufficient temperature, whereby the solid paraffin may be eliminated and also due to the large amount of pipe which is normally heated any heat in such pipe is quickly dissipated in the oil. Therefore if the rate of flow of oil is even moderately slow such rate is too fast to impart enough heat into the oil to reduce any solid paraffin therein into liquid form.

A primary object of the instant invention is to provide a device for heating a localized area of fluid flow in a string of well pipe to a sufficient temperature whereby the solid paraffin in the oil flowing through such localized area will be eliminated therefrom.

Another object of the invention is to provide a device for eliminating solid paraffin from the oil flowing in a string of well pipe by creating a turbulence in a localized area, whereby intimate contact is effected between the oil and a heating coil placed in the area.

Still another object of the invention is to provide in a device for eliminating solid paraffin from the oil flowing in a string of well pipe, a hollow cylindrical housing, a perforated liner through which the oil flows, and a heating element on said liner, electrical conduits extending down through the housing and connected to the heating element, to heat such element, said liner having flow passages extending laterally therethrough whereby oil passing through such liner is circulated outwardly and around said element to intimately contact the flowing oil and element in a localized area of flow.

A further object of the invention is to provide a heat exchanger wherein fluid is intimately contacted with a heating element or coil.

A further object of the invention is to provide a heat exchanger wherein fluid is intimately contacted with a heating element or coil said heat exchanger being so constructed and arranged that a minimum of heat is transmitted to the pipe in which the device is positioned.

Still another object of the invention is to provide in a heating device which is to be positioned in the flow string of an oil well, an element through which the oil flows, said element being perforated and having heating coils on the periphery thereof whereby oil flowing through said element may be heated to remove the solid paraffin from the oil, the perforations in said element acting to pass the oil flowing through the element outwardly and around the element whereby intimate contact between the oil and the heating coils is effected.

Other and further objects and advantages of the invention will become more readily apparent from a consideration of the following description and drawings, wherein:

Fig. 1 is a vertical sectional view of a portion of a well bore showing the flow string of the oil well in elevation with the device secured in the flow string, and

Fig. 2 is a vertical sectional view partially in elevation showing an enlarged portion of the heater and the details of construction.

In Fig. 1 of the drawings, a well bore is indicated at 2, having the usual casing 3 extending longitudinally of the well bore. Disposed within the casing 3 is the tubing 4 which is provided with suitable connections 5 and 6 whereby the oil from the producing formation may be conducted to various tanks.

Secured in the casing at some suitable height in the well bore is the heat exchanger device denoted generally by the numeral 7 comprising the present invention. Fig. 1 shows only one of such devices mounted in the tubing. It should be noted that one or more of these devices may be mounted in the tubing at various elevations in the well bore depending upon the particular condition in each well. However, for purposes of illustration, there is shown only one of such devices in the tubing of the drawing.

The device 7 may be secured by any suitable means in the tubing, such as by welding or by a threaded connection between the ends of the devices 5 and 6 and the tubing 4.

In Fig. 2 the device 7 is shown as comprising a hollow elongated housing or body 11 in which is mounted the perforated liner or element 13. The element 13 is preferably hollow, and may be concentrically arranged within the housing or body 11 and extends longitudinally of such housing. It is to be noted that the hollow element 13 serves as a conduit for the flow of oil through the heat exchange device.

The element 13 is preferably of a smaller diameter than the body of housing 11 whereby a pas-
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2,615,114 is formed between the inner wall 16 of the body or housing 11 and the outer periphery 17 of the element 13. Spiral heating coils 18 are provided on the outer periphery 18 of the element 13. The heating elements or coils 18 are of a high resistance, low conductivity type material whereby electrical energy supplied through the conduit 20 connected through the housing or body 11 at 21 and secured to the coil at 23 effects heating of such coils. The conduit 20 extends upwardly and out of the well bore and as shown at 24 in Figure 1 whereby suitable surface control may be provided (not shown).

The element 13 is provided with perforations 25 or lateral passages extending preferably throughout the length thereof and arranged between the spirals of the heating coil 18. The perforations or lateral passages 25 provide a means of communication between the interior of the heating element 13 and body or housing 11. However, these perforations are made obliquely in the heating element, with some of them slanting upward and some downward.

The purpose of the oblique slant of these perforations is to encourage fluid to pass into and out of the passage or cavity between the element 13 and housing 11, and thus pass directly over and around the heating coil. In this manner the liquid or gas passing through the tubing or pipe line in which the unit is assembled is intimately contacted with the heating element and heater.

As oil flows upwardly through the tubing and through the element 13, which extends for a portion of the length of the tubing, it is heated in the localized area where the perforated liner is positioned. The oil flows outwardly through the perforations 25 and into the chamber or passage 15 and thence back into the element 13. This creates a turbulence in the localized heating area and effects an intimate contact between the coils and the oil flowing through the string of pipe.

While it is believed that the operation of the invention is apparent from a reading of the foregoing description, the following is given by way of further amplification and illustration.

Some oils carry an appreciable amount of paraffin-like substances. These substances remain in solution as long as the temperature of the fluid is above the melting point. As the oil leaves the sand its temperature is usually well above the melting point of these paraffins. In its passage upward through cooler strata heat is lost from the flowing column. When the temperature of the flowing column becomes lower than the melting point of the paraffins they solidify and either adhere to the wall of the tubing or cause trouble at the well head. Temperatures low enough to allow the paraffin to solidify are usually not found much below 2000 feet. This density is therefore logically placed at that level in a well which is slightly below the first evidence of paraffin deposit on the tubing wall.

The heat loss as the fluid rises through the cooler strata is not constant, but it is a simple procedure to calculate the amount of heat which would have to be added to the surface temperature of the oil, the rate of flow, the capacity of the heat exchanger and other factors are known.

One or more of the devices 7 can be spaced at various elevations in the tubing string or flow string of an oil well. Suitable surface controls are connected to one end of the electrical conduit 24 with the other end being secured through the housing or body 11 and to the heating coil 18 spirally mounted on the outer periphery 19 of the element 13.

As oil flows through the flow string it comes in contact with the perforated liner 13. It is to be noted that the area of the heating is localized with respect to the total height of the oil column present. In this manner, a greater amount of heat can be dissipated within a small area of the well bore so that the heat were distributed over the total column. This serves to heat the oil in such area to a sufficiently high temperature whereby the solid paraffin therein is eliminated. As the oil flows upwardly through the element 13 it will pass out through the perforations or lateral passages 25 in such heating element and into the chamber 15 formed between the element 13 and housing or body 11. This will create turbulence and a slowing down of the rate of flow in and around the localized heating area which effects a more intimate contact between the oil flowing through the heated area and the element 13. This turbulence increases the total amount of surface area of oil which comes in intimate or direct contact with the heating coils and improves the efficiency of the device. It is noted that the oil column as compared to the heating element has a low conductivity, the conductivity of the oil column, in effect, is increased because more surface area of the oil is exposed to the heating element. Or, in other words, since more surface area of the oil is exposed to the direct heating action of the heating coils by turbulence and the slower rate of flow in and around the perforated liner, the effective thickness of column being heated is correspondingly reduced.

As the oil continues its turbulent flow in the chamber 15 up around the perforated liner or element 13 it will be discharged back into such element adjacent the top 30 thereof.

From the foregoing description it can be readily seen that a heating device is provided which creates a turbulence and slows the rate of flow in a localized area of the flow string.

Particular attention is directed to the invention in that due to the increase in diameter of the housing 11 over the diameter of the pipe above and below, the flow is slowed as it passes through the unit allowing more time for the exchange of heat from the heating element to the fluid.

It is to be also noted that while the invention is described as applying particularly to the removal of paraffin from oil wells, it can also be used in surface pipe lines to prevent freezing and to keep the viscosity of heavy oils down to where they will flow freely either in an oil stream in a well or a pipe line. It can also be used to keep the temperature of flowing oil sufficiently high to keep inorganic hydrates in solution.

The device can also be readily adapted for sulphur mining. One or more of the units can be placed at the bottom of the "steam line" in a sulphur well as a source of primary heat, to eliminate the expensive surface boiler system now in use. The gas can be used in a manner in conjunction with the present boiler system as a super-heater for steam which has been forced into the line from above. Such a heater will make it possible to recover sulphur economically at far greater depths than the present "Fraasch system" will allow.

The device of course can be provided with suit-
able controls to operate it either intermittently or continuously, depending upon the particular conditions in the flow string in which it is used.

The invention also aids in the removal of paraffin substances from a flow string, because, as a general rule, heavier hydro carbons are soluble in lighter hydro carbons. Therefore, as the oil flows through the heat exchanger the lighter elements of the oil will tend to separate by the increase in temperature. There will, therefore, be a chemical solution of the paraffin substances by contact with these light fractions of the oil in addition to the heating and removing of such paraffin substances as herein previously discussed.

Broadly the invention contemplates an apparatus for creating turbulence and slowing the rate of flow in a localized area of a well bore or other pipe line and for heating the fluid flowing through such localized area of a pipe.

What is claimed is:

1. A device for eliminating solid paraffin from the oil flow in a string of well pipe and for eradicating accumulated paraffin from such pipe comprising, a closed hollow cylindrical housing, means to secure said housing to the flow string, a hollow element in said housing and connected at each end to the flow string, said element being of substantially the same diameter as the flow string and extending longitudinally in said housing and spaced from the cylindrical side walls of said housing to provide a passage for oil flow, spiral heating coils secured to the outer periphery of said element, an electrical conduit connected through said housing and said coils, said element having perforations between said spiral coils and extending throughout the length of said element whereby the oil passing through the flow string passes through and around said element and into said passage between said element and said housing to provide intimate contact between said heating coils and the oil in said flow string.

2. A device for eliminating solid paraffin from the oil flow in a string of well pipe by creating a turbulence and slowing down the rate of flow in a localized area whereby intimate contact is effected between the oil and a heating element placed in the area comprising, a closed hollow cylindrical housing, means to secure said housing to the flow string, a hollow cylindrical element secured in said housing and connected to the flow string, said element being concentric with and extending longitudinally of said housing and spaced from the cylindrical side walls of said housing to provide a passage for oil flow around said heating element, spiral heating coils secured to the outer periphery of said element, an electrical conduit connected through said housing and into said coils, said element having perforations between said spiral coils and extending throughout its length to provide egress and ingress for the flow of oil from the interior of said element to the passage between said housing and element whereby the oil is intimately contacted with said element in a localized area of flows as it flows through the well string to eliminate solid paraffin from said oil.

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