

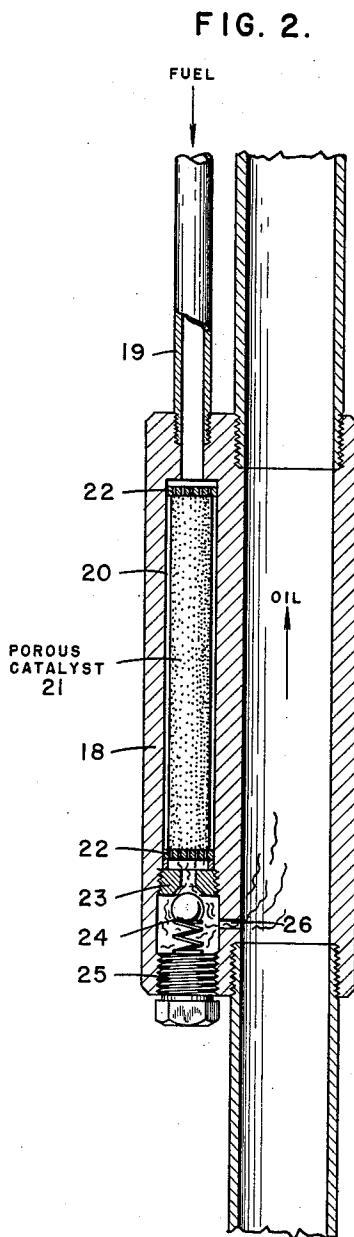
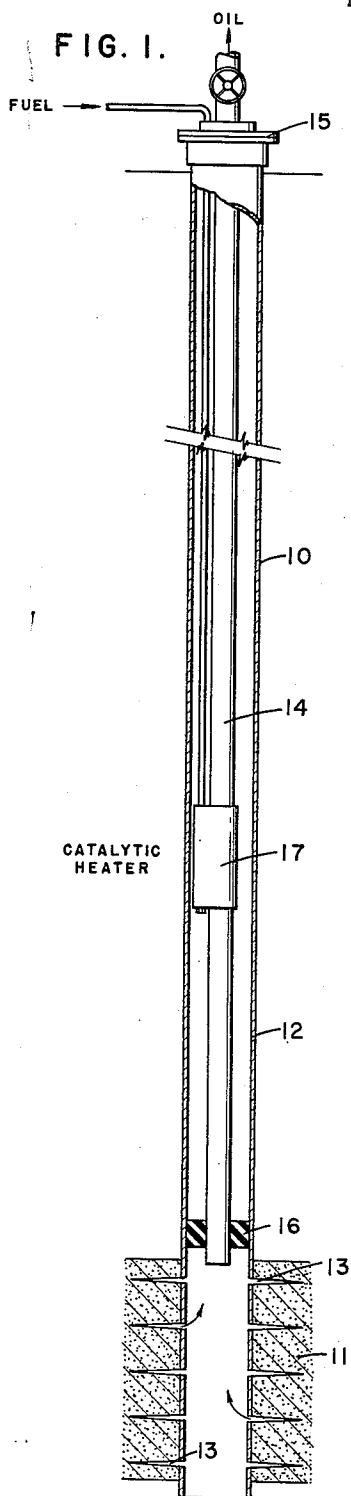
Oct. 22, 1963

D. M. KEHN

3,107,728

DOWN-HOLE HEATER

Filed Oct. 16, 1961



INVENTOR.
DONALD M. KEHN,
BY *John S. Schneider*
ATTORNEY.

1

3,107,728

DOWN-HOLE HEATER

Donald M. Kehn, Houston, Tex., assignor, by mesne assignments, to Jersey Production Research Company, Tulsa, Okla., a corporation of Delaware

Filed Oct. 16, 1961, Ser. No. 145,184

1 Claim. (Cl. 166—59)

The present invention concerns methods and apparatus for generating heat down hole to prevent deposition of paraffin in oil production pipe strings and, in particular, generation of this heat by catalytic oxidation of a combustible mixture.

In the production of crude oil from underground reservoirs, certain crudes precipitate solid paraffin hydrocarbons on the walls of production pipe strings and on the rods of the pumps when rod pumps are used. Paraffin deposition is very troublesome, because it (1) reduces the diameter of the production flow pipe, (2) increases pressure drop from the reservoir to the earth's surface, and (3) decreases well productivity. Frequent costly remedial measures which provide only temporary relief are necessary to inhibit or prevent the hydrocarbons from depositing in order to keep the well on production.

Deposition of paraffin in well pipes is caused by (1) cooling of the crude oil as it moves from the hot reservoir rock toward the cooler surface temperatures, (2) the loss of light hydrocarbons from the crude oil as the pressure is reduced, and (3) cooling induced by the expansion of free gas associated with the oil; and it can be eliminated if the production crude oil is heated to a sufficiently high temperature. Various chemical and electrical techniques to so heat the oil have been proposed and tried, but because these techniques proved expensive, impractical and/or otherwise commercially unsatisfactory, none of them has gained wide industry acceptance.

Thus, a primary object of the present invention is to provide an improved heating operation and system for the prevention of paraffin deposition in the production of crude oils.

The simple down-hole heater of the present invention is easily installed on the oil production pipe string at a depth below that at which paraffin begins to deposit. Briefly, the apparatus includes a heater sub connected in the oil production pipe string shortly below the point at which paraffin begins to deposit. The sub is provided with an offset mandrel, the upper end of which is connected to a combustible mixture supply pipe string which extends to a fuel (e.g., methane, ethane, propane) and oxidizer (e.g., air, oxygen) source at the surface of the earth. The interior of the mandrel is filled with a porous catalyst below which is a check valve and adjacent which, in turn, is a port or passageway fluidly communicating with the interior of the production pipe string. The combustible mixture ignites and burns on contact with the porous catalyst, and the heat generated is transmitted by radiation to the production oil stream through the wall of the sub, and by means of the exhaust combustion gases, which carry a part of the heat generated into the production oil flow through the check valve and passageway. Thus, heat generated in the combustion zone is transferred to the flowing oil by conduction through the wall of the sub and by physical mixing of the oil and the exhaust combustion gases.

The above object and other objects and advantages of the invention will be apparent from a more detailed description thereof when taken with the drawing wherein:

FIG. 1 is a schematic view of a cross section of the earth's subsurface showing an oil production pipe string arranged in a well bore and the catalytic heater of the invention connected in it; and

2

FIG. 2 is a cross-sectional view showing the catalytic heater of FIG. 1 in greater detail.

Referring to the drawings in greater detail, in FIG. 1 is shown a well bore 10 penetrating a hydrocarbon-producing subsurface formation 11. A casing pipe string 12 is arranged in borehole 10 and is perforated along with formation 11, as designated at 13. The arrows indicate production oil flow from formation 11. A production pipe string 14 is suspended in casing pipe 12 from surface wellhead equipment 15. A production type packer 16 is arranged adjacent the lower end of production pipe string 14 to seal off the annulus between casing pipe 12 and pipe string 14 above formation 11. A heater sub 17 is connected in production pipe string 14 at a depth shortly below that at which paraffin begins to deposit.

As seen in greater detail in FIG. 2, sub 17 includes an offset mandrel 18, the upper end of which is connected to a combustible mixture conduit 19, which extends to the surface of the earth and communicates with a source of fuel and oxidizer. The major portion of mandrel 18 consists of a tubular combustion chamber 20 in which is arranged a porous catalyst 21 in tubular form. Porous catalysts in tubular form are available and may be one of those such as marketed by the American Thermocatalytic Corporation under the trade name of Pyrocore or Infracore described in an article in the April-May 1960 issue of Industrial Research, page 24, entitled "Thermal Catalytic Combustion: Heat Without Flame," by Gerhart Weiss, Division of Research and Engineering, American Thermocatalytic Corporation. Catalyst 21 is confined in chamber 20 by upper and lower perforated spacers 22. The lower portion of mandrel 18 contains a plate member 23 containing an opening which is normally blocked or closed by a check valve 24 supported on a nut 25, which also functions to close off the lower end of mandrel 18. A passageway or opening 26 is formed in the common wall separating mandrel 18 and the interior of sub 17.

The operation is as follows. An air- or oxygen-hydrocarbon fuel mixture is injected through conduit 19 into chamber 20 in which a flameless combustion of the fuel mixture takes place on the surface of porous catalyst 21. The hot exhaust combustion gases from the combustion chamber 20 pass through check valve 24 and passageway 26 into the production oil stream flowing upwardly through production pipe string 14. Check valve 24 prevents the oil stream from entering combustion chamber 20.

The temperature in well bore 10 at the depth of sub 17 frequently will be sufficient to ignite the combustible fuel mixture adjacent catalyst 21; however, where sufficiently high temperatures do not exist to start the combustion, it can be started by spotting an emulsion of sodium-in-oil in pipe string 14 adjacent sub 17 and then pumping the combustible mixture downwardly through pipe string 19 into chamber 20. As the unused oxygen of the combustible mixture passes through the emulsion, heat is generated in production pipe string 14, which warms catalyst 21 and initiates combustion. By controlling the rate of air or oxygen injection and the richness of the combustible injection mixture, the amount of heat transferred to the production oil flow can be regulated. For example, assuming 50 bbls./day of production oil flow through pipe string 14, the following quantities of fuel would be required to heat the oil 100° F. above the temperature at which it flows into sub 17:

Methane	-----s.c.f.	730
Ethane	-----s.c.f.	405
Propane	-----gals	7.68

The initiation of combustion and satisfactory operation of the heater can be ascertained from the surface

3

by running a subsurface recording thermometer in pipe string 14. Subsequent checks on its operation can be made by analysis of the produced exhaust combustion gases for carbon dioxide and oxygen.

Having fully described the apparatus, method, and objects of the invention, I claim:

Apparatus for heating down-hole oil streams produced through a production well pipe comprising a sub connected in said well pipe and having an offset mandrel mounted thereon; said mandrel defining a combustion chamber; a second well pipe connected to an inflow end of said mandrel for supplying a combustible mixture to said chamber; a catalyst located in said chamber adapted to flamelessly burn said combustible mixture; a passageway fluidly communicating the outflow end of said mandrel below said chamber and the interior of said production well pipe for transmitting exhaust combustion

4

gases into said oil stream flowing through the interior of said production well pipe; and a check valve arranged in said mandrel downstream of said chamber adapted to prevent said oil stream or other well fluids from entering said combustion chamber and to permit exhaust combustion gases to flow from said combustion chamber into said production well pipe through said passageway.

References Cited in the file of this patent

UNITED STATES PATENTS

2,382,471	Frey	Aug. 14, 1945
2,506,853	Berg et al.	May 9, 1950
2,675,081	Nowak	Apr. 13, 1954
2,707,029	Van Hartesveldt	Apr. 26, 1955
2,941,595	Emery	June 21, 1960
3,010,516	Schleicher	Nov. 28, 1961