FIP7912 XR 3,439,741

United States Patent Office 3,439,741 Patented Apr. 22, 1969

3,439,741

STEAM DRIVE OIL PRODUCTION PROCESS

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No Drawing. Filed Oct. 9, 1967, Ser. No. 673,937
Int. Cl. E21b 43/24, 43/16
U.S. Cl. 166—272 7 Claims

ABSTRACT OF THE DISCLOSURE

In producing oil from an oil stratum by steam drive from an injection well to a production well therein, a substantial slug of heavy crude oil is periodically injected thru the injection well to reduce fingering and the injected crude oil is upgraded by visbreaking. The injected crude oil is preferably of lower API gravity than the in-place oil.

This invention relates to an improved process for producing oil from an oil stratum by steam drive.

One of the significant problems in producing oil by steam drive from an injection well to one or more offset production wells comprises fingering whereby there is substantial bypassing of the viscous oil in the stratum by the steam which fingers thru higher permeability streaks in the stratum and tends to arrive at the production well(s) without producing a substantial quantity of oil.

This invention is concerned with a method of operation in a steam drive process which not only reduces fingering and improves the yield of oil but also has other advantages.

Accordingly, it is an object of the invention to provide an improved steam drive oil production process which reduces fingering. Another object is to provide a steam drive process for the production of oil from an oil stratum which upgrades oil other than that in place in the stratum. Other objects of the invention will become apparent to one skilled in the art upon consideration of the accompanying disclosure.

A broad aspect of the invention comprises periodically injecting a heavy crude oil together with or separately from the injected steam in a steam drive process from an injection well to one or more offset production wells penetrating the oil stratum to be produced. Slugs of viscous oil are injected into the steam injection well or wells intermittently or periodically with either continuous or intermittent injection of steam. It is preferred to inject a low API gravity oil which is more viscous or of lower gravity than the oil in place in the stratum being produced. Preferably, an oil having an API gravity in the range of about 8 to 20° is used.

In a preferred method of operation, steam is injected for a period in the range of about 3 to 7 days after which a slug of low API gravity oil amounting to from 100 to 1000 barrels, depending upon the thickness of the stratum, the porosity, the oil concentration, and other factors, is injected thru the injection well followed by renewed steam injection for a substantial period in the aforesaid range after which another similar slug of oil is injected. Intermittent injection of steam and oil in this manner causes 2-phase flow in the fingers and thereby decreases the amount of fluid moving thru the fingers.

The temperature of the injected steam is at least 550° F. and is usually in the range of 550 to 650° F.; however, steam at higher temperatures may be injected. This high temperature steam has the effect of visbreaking the injected heavy oil, thereby upgrading the injected oil as it is moved thru the stratum to the production well(s) so that the injected portion of the recovered oil is of substantially lower viscosity and lower sulfur content than that of the injected viscous oil. It is recognized in the art

that heating a low API gravity oil at a temperature in the range of 550 to 650° F. for a period of several days to several weeks substantially increases the API gravity as well as reduces the sulfur content of the crude. Thus, the heating of the injected low API gravity crude oil by the steam as the oil is pushed thru the stratum is an extra benefit obtained from using the crude oil to reduce fingering in a steam drive process.

The rate of steam injection is usually in the range of about 2000 to 60,000 pounds per foot of pay zone per day. The steam injection rate to be utilized depends upon the characteristics of the reservoir being produced and particularly the permeability and the viscosity of the oil in place.

In some oil producing areas there are two or more vertically spaced apart oil strata, each pair being separated by impermeable layers of shale or similar strata. In some cases, the API gravity of the oil in the different strata varies substantially. The invention operates to advantage in such a situation by producing the more viscous oil thru a tubing or conduit within the steam injection well used to supply the steam to the stratum containing the higher API gravity oil. In this manner, the more viscous lower gravity oil is heated as it is produced thru the injection well and a portion of the thus produced oil is injected while hot intermittently with the steam or periodically into the steam being injected into the higher API gravity stratum. When the stratum containing the heavier oil lies deeper than the stratum containing the less viscous oil, the heavier oil is produced thru a tubing string in the steam injection well, the annulus surrounding the tubing being packed off between the two strata. Steam is injected thru the annulus surrounding the tubing into the upper level stratum containing the oil of higher API gravity. When the reversed situation occurs, the lower API gravity oil is produced thru the tubing casing annulus and steam is injected thru the tubing to the lower stratum containing the oil of higher API gravity. The heavier more viscous oil may be produced by any suitable method such as by natural reservoir pressure, water flooding, or gas drive. Regardless of the source of the low API gravity oil intermittently injected with steam, it is desirable to preheat the injected oil in a suitable oil heater before inroducing the oil to the steam injection conduit.

A typical oil formation to which the invention is applicable has the following characteristics:

Formation thickness	feet	50
Oil saturation	bbl./acre ft.	1600
Oil gravity	° API	12
Oil viscosity (at 150° F.)	cp.	1000
Reservoir pressure	p.s.i.a.	1050
Reservoir temperature	° F.	150

Using a 7-spot well pattern with well spacing of 600 feet, a steam injection rate of 1,800 bbl./day, at a steam temperature of 556° F. and a pressure of 1100 p.s.i.a. with sweep efficiency of 70%, the oil displacement rate (at 85% oil displacement) is 1150 bbl./day. To obtain this sweep efficiency a 600 bbl. plug of crude oil of 8° API gravity, 3000 cp. at 150° F. (equivalent to 3 cp. at 550° F.), is injected at 7 day intervals. This results in an average production rate per production well as follows:

	Bbl./day
Net oil	575
Recovered oil slug	40
Condensate	900
Formation water	180
Total	1695

The steam injection period at 70% sweep efficiency is 2.7 years.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

I claim:

1. A process for producing oil from an oil stratum penetrated by an injection well and at least one offset production well and containing relatively high permeability streaks, which comprises the steps of:

(a) injecting steam at a temperature of at least 550° F. at a substantial rate into said stratum thru said injection well to drive oil toward said production well;

(b) after a substantial volume of steam has been injected in step (a) and while the stratum adjacent said injection well is near injected steam temperature, injecting a substantial slug of heavy crude oil amenable to upgrading when held at said temperature for a substantial period of time, to upgrade said crude oil and to decrease fingering of subsequently injected steam thru said streaks;

(c) resuming steam injection following step (b) to drive in-place and upgraded oil into said production well; and

(d) recovering the produced oil.

2. The process of claim 1 wherein steam and oil are simultaneously injected in step (b).

3. The process of claim 1 wherein steam injection is terminated during step (b).

4. The process of claim 1 wherein the steam injection period of step (a) is in the range of about 3 to 7 days at a rate in the range of 2000 to 60,000 pounds per day per foot of stratum thickness, the slug of oil injected in step (b) is in the range of about 100 to 1000 barrels and the injected oil has an API gravity in the range of 8 to 20°.

5. The process of claim 1 wherein the injected crude oil has a substantially lower API gravity than the in-place crude oil.

6. The process of claim 1 wherein said stratum lies vertically adjacent a second oil stratum containing a crude oil of lower API gravity than first said stratum and including the steps of:

(e) producing oil from said second oil stratum, and

(f) injecting oil produced in step (e) as oil of step (b).

7. The process of claim 6 wherein the oil produced in step (e) is heated by producing it thru a tubing string in said injection well and resulting hot oil is injected in step (b).

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U.S. Cl. X.R.

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