Dec. 25, 1962 J. W. MARX 3,070,159

CONSOLIDATING INCOMPETENT ROCK FORMATIONS

Filed Oct. 5, 1959 2 Sheets-Sheet 1

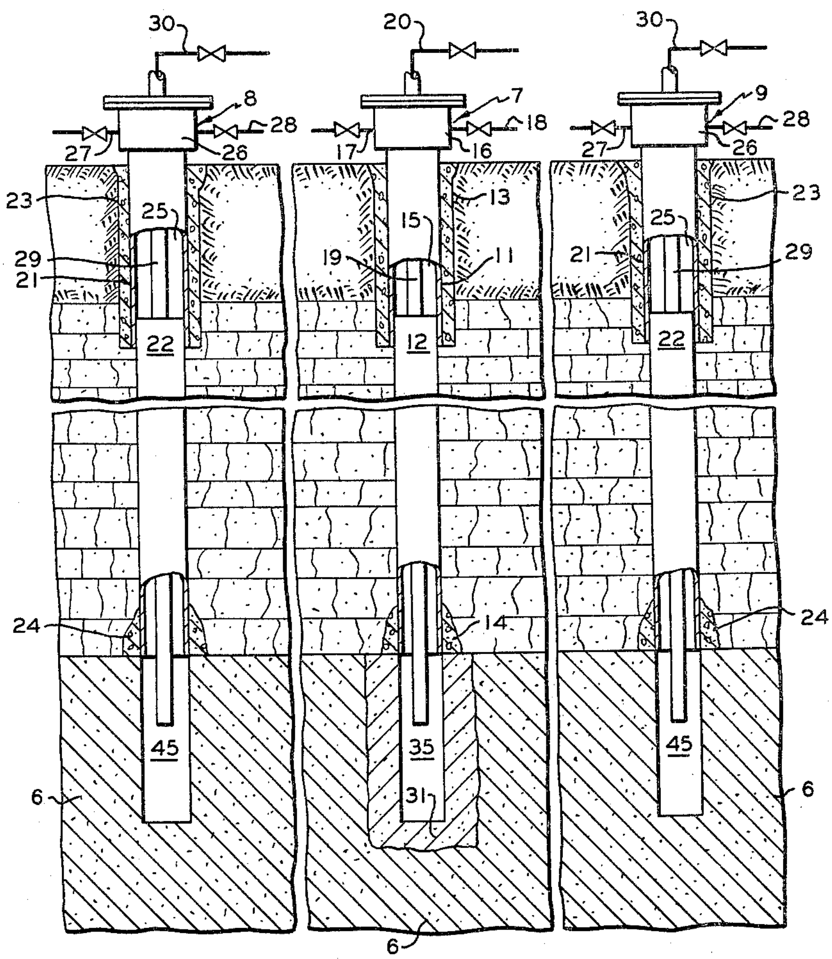

FIG. 1

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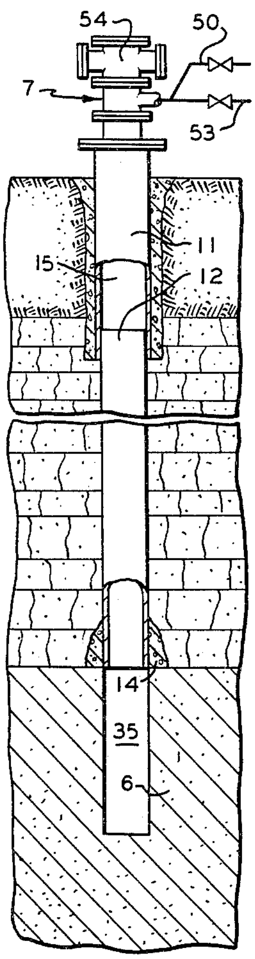

FIG. 2

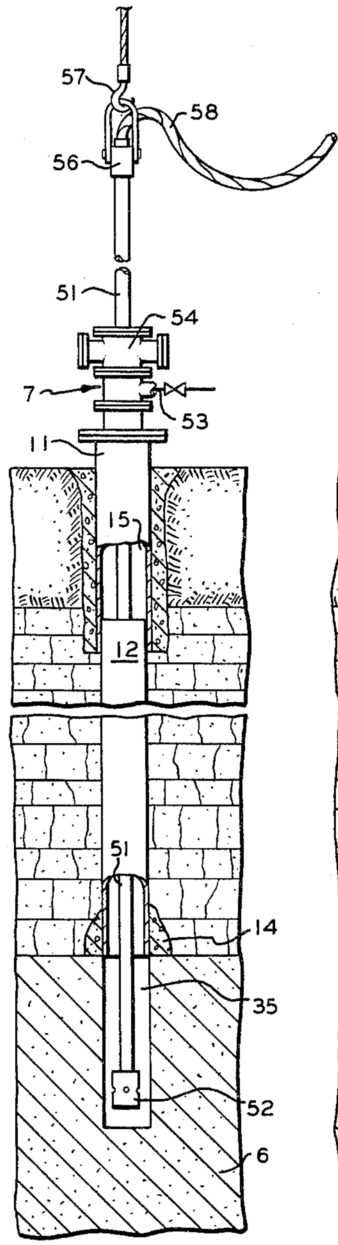

FIG. 3

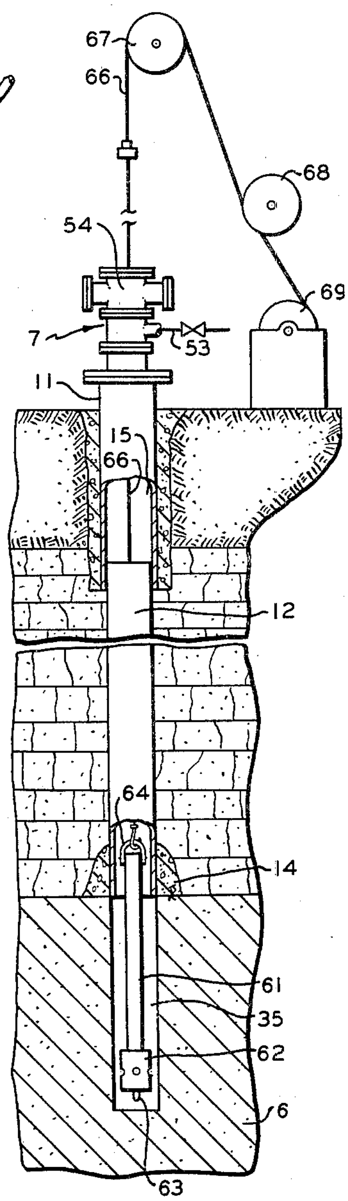

FIG. 4

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3,070,159
CONSOLIDATING INCOMPETENT ROCK FORMATIONS

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14 Claims. (Cl. 166—11)

This invention relates to the consolidation of incompetent formations, such as tar sand, traversed by an oil production well or other deep well. In another aspect, it relates to the recovery or production of fluid hydrocarbons from subterranean reservoirs or formations containing hydrocarbon materials or petroliferous deposits, such as heavy viscous crude oil and tar, which is physically trapped or too viscous to be produced by ordinary recovery methods and must be produced by subsurface thermal processing, such as in situ combustion.

This application is a continuation-in-part of my copending application Serial No. 780,510, filed December 15, 1958, now abandoned.

In the secondary recovery of oil from subsurface strata by methods known in the art, such as water flooding and gas repressurizing, the ultimate recovery of oil has not been as great as desired. Such methods are often ineffective in increasing the ultimate recovery of low gravity and viscous crude oils, and semi-solid and solid hydrocarbons, such as tar. Of the various methods for increasing the recovery of these materials, those thermal processes involving the application of heat to the carbonaceous stratum to increase the mobility of the oil by decreasing its viscosity have probably received most attention. A conventional recovery method of this type is that known as in situ combustion, in which combustion is initiated in the carbonaceous stratum and the resulting combustion zone or fire front is caused to move through the stratum by either direct or inverse air drive whereby the heat of combustion of a substantial proportion of the hydrocarbon drives out and usually upgrades a substantial proportion of the unburned hydrocarbon material. In the direct air drive process, the supply of air or other oxidizing medium is pumped into an injection well behind the fire front, while in the inverse air drive process, the oxidizing medium is pumped into the injection well ahead of or countercurrent to the advancing fire front. Such an "inverse air injection" method is disclosed and claimed in my copending U.S. application Serial No. 526,388, filed August 4, 1955. The in situ combustion process results in the melting, vaporizing, or cracking of a portion of the hydrocarbon material. The resulting fluid hydrocarbon products are driven out of the formation into a producing bore hole. From the producing well, the fluid hydrocarbons are pumped or flowed to the surface, depending on whether or not sufficient gas pressure exists in the formation. In addition to supporting combustion, the oxidizing medium also effects a reduction in the viscosity of the heated oil and aids in driving the fluid hydrocarbons from the formation.

In the direct air drive and inverse air drive in situ processes, the flow of the air, fire front, and fluid hydrocarbons is generally horizontal or radial. Another in situ process is the vertical drive process wherein air is injected along the bottom of the carbonaceous stratum to support a vertically moving fire front and the fluid hydrocarbons are produced from the top of the stratum, or vice versa.

The formations which contain these hydrocarbon materials or petroliferous deposits are frequently loose, granular, non-consolidated or incompetent. Typical of these formations are certain tar sands. During ignition and combustion of these hydrocarbon materials, the flow of fluid hydrocarbons resulting from the melting, vaporizing and/or cracking reaction into the producing well carries

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substantial amounts of grains, particles, or sand. The presence of this sand in the producing well is undesirable for a number of reasons. If sufficient sand or the like accumulates in the producing well, it may restrict the flow of the produced hydrocarbon from the formation, or this foreign material may accumulate in surface equipment, such as conduits, valves tanks, and the like. The presence of any significant quantity of sand in the hot, high velocity produced gas stream leads to severe erosion of pipe and fittings, and its presence in produced oils and emulsions is also undesirable since subsequent separation and recovery procedures are hampered.

Although some of these incompetent formations may contain a certain amount of natural cementing materials, such as tar, these natural cementing materials are not present in sufficient amounts necessary to consolidate the formation, either before, during, or after the combustion process. In the case of tar, the combustion process results in converting this material to coke which itself is not a very good consolidating or cementing material. Moreover, during the combustion process this coke may itself be consumed, as a result of thermal echoes, and the flow of sand or like foreign particulate materials into the producing well will occur.

The problem of sand influx is particularly severe during the ignition phase of the inverse air drive in situ combustion process, when high velocity gases are produced, and, therefore, the subject invention is particularly useful and applicable in this type of in situ combustion.

Accordingly, an object of this invention is to provide an improved method for consolidating incompetent formations, such as tar sands, traversed by an oil producing well or other deep wells. Another object is to improve the recovery or production of fluid hydrocarbons from subterranean reservoirs or formations containing hydrocarbon materials or petroliferous deposits such as heavy viscous crude oil and tar, which materials are physically trapped or too viscous to be produced by ordinary recovery methods and must be produced by subsurface thermal processing, such as in situ combustion. Another object is to prevent the influx of sand or other particulate foreign materials into the open hole of a producing well. Another object is to consolidate or solidify incompetent carbonaceous formations penetrated by a bore hole. Further objects and advantages of this invention will become apparent to those skilled in the art from the following discussion, appended claims, and the accompanying drawing in which:

FIGURE 1 is a simplified vertical view of an inverse air drive in situ combustion system illustrating this invention; and

FIGURES 2, 3, and 4 are views similar to FIGURE 1 showing other embodiments of this invention.

Briefly, the subject invention comprises a method of consolidating an incompetent hydrocarbon bearing or carbonaceous formation by injecting an aqueous solution of a water soluble alkali metal silicate, such as sodium silicate, into the incompetent formation surrounding a well bore traversing the same. After injection of the silicate solution, the permeability of the silicate-saturated formation can be restored, e.g., by injecting air into the treated formation. The silicate-treated formation is then heated, e.g., during the ignition phase in an in situ combustion process. The heat first dries and then melts the silicate, thereby resulting in the consolidation of the incompetent formation in the form of a consolidated porous matrix. As a result, the influx of sand particles, or like particulate foreign materials into the bore hole traversing the treated formation, and the sloughing or caving of the bore hole, will be prevented, thereby improving the recovery of fluid hydrocarbons from the formation.

Referring now to FIGURE 1, 6 designates a subsurface or underground, incompetent rock formation containing hydrocarbon material, such as heavy viscous crude oil or tar and the like. This hydrocarbon containing formation is penetrated by a production or ignition well 7 and one or more remote or spaced injection or input wells 8, 9. Although only one production well and only two injection wells have been illustrated in the drawing for purposes of simplicity, it is within the scope of this invention to employ any well pattern, such as a 5-spot, 7-spot, line drive, or other well patterns, and also to systems in which the flow is not radial, such as the vertical drive systems.

The production well 7 comprises a surface casing 11 and a bottom hole casing 12, the lower end of the latter being in proximity to the hydrocarbon-containing formation 6, preferably near the top thereof. Surface casing 11 can be encased in a sheath of cement 13, and the foot of casing 12 can be similarly anchored by cement 14. A conventional casing head 16 is affixed to the top of casing 11, this casing head being provided with one or more valved surface pipes 17, 18. Depending within surface casing 11 and bottom hole casing 12, is a production tubing string 19, an annulus 15 being formed between the production tubing and the casing strings. The lower end of the production tubing 19 preferably depends below the lower end of the bottom hole casing 12 and is in communication with open hole 35. The upper end of production tubing 19 passes through casing head 16 and is operatively connected to a valved surface conduit 20. If desired, the lower end of annulus 15 can be sealed from open hole 35 by means of a conventional packer affixed to the lower end of production tubing 19 adjacent the lower end of bottom hole casing 12.

Injection wells 8 and 9 are similar in most aspects to production well 7, and both of the injection wells can have, if desired, a center tubing string 29 which depends within open hole 45 adjacent the incompetent formation 6.

Consolidation of the incompetent formation 6 surrounding the open hole 35 of production well 7 is accomplished according to this invention in the following manner.

Prior to the ignition and combustion of hydrocarbon-containing formation 6, an aqueous solution of a water soluble alkali metal silicate, such as sodium silicate, is pumped down production well 7 and radially forced into the incompetent formation 6 surrounding a length of the open hole 35 which serves as a flow area for the produced hydrocarbons. The silicate solution can be pumped either down a tubing within the casing, or down the casing itself, and a positive pressure exerted on the solution. The silicate solution fills the pores or interstices in the incompetent formation, the individual sand granules or particles being covered with a film of the solution. The silicate-treated formation, designated 31 in the drawing, has a finite thickness, for example, 1 to 4 feet. Following the injection of this silicate solution, air or any other oxidizing gas can be forced into injection wells 8, 9 under pressure and injected into the formation 6 so as to restore the permeability of the saturated formation 31. This air injection can force any excess silicate solution back into producing well 7 and can effect some minor drying of the silicate but generally leaves a residual film of the viscous silicate solution over the sand grains. This air can be preliminarily dried and heated, if desired, before injection.

Ignition, at a temperature of 500° F., or lower, can be accomplished in production well 7 by any suitable means, such as by lowering an electrical heater or burner into the open hole 35, or by filling the latter with charcoal or other carbonaceous material and igniting the same. Consolidation of treated formation 31 is thus effected. With continued injection of air in injection wells 8, 9, combustion of a portion of hydrocarbon in formation 6 occurs and a fire front, having a temperature of about 600 to 1600° F., will advance outwardly from producing well 7 toward injection wells 8, 9 by continued injection of air, and melted, vaporized, cracked or liquefied hydrocarbons will form and will pass through the porous, consolidated area or matrix 31 into open hole 35. Air could alternatively be injected via either or both of pipes 27, 28; this air can be admixed in the injection wells 8, 9 with butane or propane injected via one or both of pipes 27, 28 when initiating combustion, the amount of these gases usually being less than that required for self-sustaining combustion, e.g., 1 to 2 percent. These gases can be preliminarily admixed with air and the mixture injected into the wells via pipe 30. The fluid hydrocarbons entering open hole 35 are then produced from production well 7, this production being facilitated by the gases generated during combustion or this production being effected by conventional pumps, the produced fluid hydrocarbons being withdrawn from the well 7 by production tubing 19. Because of the consolidation of the incompetent formation 6 around the bottom hole 35 of the producing well 7, the tendency for sand or other foreign particles to enter into the open hole 35 will be prevented or substantially reduced, thereby aiding in the recovery of the fluid hydrocarbons.

It is also within the scope of this invention to similarly consolidate the incompetent formation traversed by the injection wells 8, 9 since they often will be subsequently used as production wells themselves, and the treated formation of these wells will be heated by the flame front to consolidate the same.

Where the subject invention is employed in a direct drive in situ combustion process, ignition of the formation is initiated in the injection wells 8, 9 and the hot gases generated during this step flow toward the producing well, thereby drying and melting the silicate and effecting consolidation. The subsequent flame front then flows toward the producing well, as does the produced fluid hydrocarbons.

Where the incompetent formation desired to be consolidated according to this invention contains a substantial amount of water, it may be necessary to first "dry out" the formation, as is well known in the art. This generally involves injecting air or other gas into the production well to drive the mobile water present there away from the production well. In some instances, this drying out period may take several months, and will continue until sufficient air permeability is achieved. Near the end of the drying out period, the consolidating solution can be injected into the well along with the drying gas so as to form a mist, aerosol, or dispersion, the silicate solution entering the incompetent formation along with the drying gas. For example, in FIGURE 2, tubing 53 is used to inject air for the purpose of drying out formation 6 and silicate solution can be injected into the air stream via tubing 50, the admixture in the form of a gas-liquid dispersion or mist being injected into the interstices of formation 6 surrounding open hole 35.

Alternative injection systems for injecting the silicate solution during the drying period are shown in FIGURES 3 and 4, where, as in FIGURE 2, in the interest of brevity only the production well is shown.

In FIGURE 3, a movable injection tubing 51 is shown suspended within casing 12 with a spray head 52 affixed to the lower end. The well head is provided with a blow-out preventor 54, a gas injection conduit 53 for the admission of drying gas to annulus 15, swivel 56 and hook 57 for raising and lowering injection tubing 51, and a flexible hose 58 for supplying radial spray head 52 with silicate solution. Gas and silicate solution are concomitantly injected into open hole 35, the injection tubing 51 being raised or lowered so as to inject the mist into all or only a desired portion of the incompetent formation 6 traversing open hole 35. Alternatively, tubing 51 can be rotated by any conventional means to uniformly spray or coat the face of the open hole.

In FIGURE 4, a dump bailer 61 is suspended within casing 12, the lower end of the dump bailer having a radial spray head 62 which is actuated in a conventional manner by lowering the dump bailer until valve actuator 63 contacts the bottom of the hole to open perforations in the spray head and allow silicate solution in the dump bailer to flow through the spray device under the influence of gravity and be sprayed against the exposed incompetent formation 6 and be carried into the pores thereof along with the drying gas introduced into the open hole via line 53. Dump bailer 61 can be raised or lowered by means of bail 64 affixed to cable 66 which passes over pulley 67 and depth measuring sheave 68 and is connected to hoist drum 69 or the like, thereby permitting the spray head 62 to be moved along all or only a desired portion of the open hole 35.

By injecting the silicate solution into the incompetent formation along with the drying gas, the in situ process can be carried on without interruption and with minimum loss of air permeability.

Although the subject invention is particularly applicable in in situ combustion processes, it is not necessarily limited thereto. Rather, any incompetent formation traversed by a well bore can be consoliated in a manner described hereinbefore. That is, in one of its broadest aspects, the subject invention provides a method for consolidating any incompetent formation by injecting an aqueous solution of an alkali metal silicate into the incompetent formation, restoring permeability of the saturated incompetent formation by means of air injection, heating the resulting silicate saturated formation so as to dry and melt the silicate, and thereby consolidate the incompetent formation thus treated. For example, following the drilling of a bore hole through an incompetent formation, the drilling mud can be displaced from the bore hole with water or other liquid or with a gas such as air, and the silicate solution injected into the bore hole as a liquid or in admixture with a gas, without relieving the positive pressure on the well bore when pulling the drill string. In some cases, a slotted liner can be placed in the incompetent formation before the silicate solution is injected so as to keep the incompetent formation from caving in.

The heating and melting of the silicate-saturated formation is believed to effect a chemical reaction between the melted silicate and the formation sands. This chemical change is evidenced by the fact that the newly consolidated mass does not disintegrate upon prolonged soaking in water, whereas simple drying and melting of sodium silicate would leave a water soluble bond between the sand grains. Tar sand samples from pits near Sulfur, Oklahoma, which were consolidated in this fashion have been soaked in water for five days and longer and have shown no tendency to disintegrate.

In making up the aqueous silicate solutions of this invention, either fresh water or salt water (e.g., sea water or field brine) can be used and the term "aqueous" is used in its inclusive sense, generically covering both fresh water and salt water, unless otherwise classified. These silicate-consolidating solutions are non-corrosive. They are true solutions and as such are relatively solids-free.

By conventional, alkali metal silicates, which are often products of indefinite composition, are often specified in terms of the molecular ratio of silica, SiO_2, to alkali, Na_2O or K_2O. The silicates useful in preparing the consolidating solutions of this invention can have a silica/alkali molecular ratio varying over a wide range, generally between 1.60/1 to 3.90/1. The concentration of the silicate solution can also vary over a wide range, generally between 25 to 45 degrees Baumé. Representative sodium silicates useful in preparing the consolidating solutions of this invention include sodium orthosilicate, sodium metasilicate, sodium sesquesilicate, sodium disilicate, and the like.

A number of commercially available aqueous solutions of sodium silicate useful as consolidated solutions of this invention are set forth in Table I. A particularly useful commercially available sodium silicate solution is one having a density of 11.5 pounds per gallon, a silica/alkali ratio of 3.2/1 and 40 degrees Baumé. Silicate solutions of from 65 to 75 percent of 40 degrees Baumé and 25 to 35 percent water are especially applicable.

TABLE I

SiO_2/Na_2O ratio by weight	Total solids, weight percent	Specific gravity, d_{20}^{20}	Vis. at 20° C., abs. poises
1.60	50.9	1.68	70
2.00	54.0	1.69	700
2.50	36.9	1.41	0.5
2.90	43.0	1.48	9.6
3.22	37.6	1.39	1.8
3.75	32.1	1.32	2.2

The silicate consolidating solutions of this invention can be prepared by any convenient manner, for example, by dissolving the sodium silicate in either hot or cold fresh or salt water. Where commercially available silicate solutions are used, such as those set forth in Table I, the solutions can be employed as such, or preferably can be diluted with fresh water or salt water to the desired concentration and density. If desired, the solution can be heated to increase the rate of solution of silicates and increase the solubility of the silicates. Either cold or hot silicate solutions can be pumped into the incompetent formations.

The density of the silicate consolidating solutions to be employed in any particular instant will depend upon various considerations, such as viscosity and the pumping equipment available. Generally, the density of these silicate solutions will be in the range of about 9 to 14 pounds per gallon.

The following example of an inverse air drive in situ combustion process is set forth to further illustrate the advantages of this invention, but it should be understood that the ingredients, temperatures, materials, etc., of this example are merely illustrative and should not be considered to unduly limit this invention.

Example

A tar sand, consisting entirely of rounded white sand with no natural cementing agent, was crushed and ground to a size of about −10 to +20 mesh size. This tar sand sample had weathered considerably and contained 3.75 percent tar and was representative of a commercially attractive tar sand treated by in situ combustion. This tar sand was then packed into a radial flow test pot constructed from a 6 inch length of 12 inch steel pipe. The bulk density of the packed tar sand in the test pot was 1.85 grams/cc. The top and bottom of the test pot was fitted with ½ inch thick steel plates 15¼ inches in diameter, these plates being bolted to the pot body and sealed. The packed tar sand sample was provided with a central production well and four surrounding injection wells, provisions being made in the top steel plate for these wells as well as for twelve thermocouples. An amount of 26° Baumé sodium silicate solution calculated to treat a zone 4 inches in diameter was injected into the production well. Air was then injected into the injection wells to remove excess sodium silicate back into the production well and restore gas permeability. Sufficient sodium silicate remained in the tar sand to result in an approximately 70 percent liquid saturation about the production well bore. The treated tar sand was allowed to stand four days before being ignited. In this example, the injection rate of the combustion-sustaining oxidizing gas was 63 standard cubic feet per hour of air to which 4 percent propane was added. Combustion was initiated by dropping lumps of burning charcoal into the charcoal-packed production well. The resulting combustion was monitored by the thermocouples placed in the combustion pot and continuous oxygen and carbon dioxide analysis made of the produced gases. Combustion was allowed to continue until the coke was burned from the sand so that any consolidation would be the result of the sodium silicate treatment. This test lasted 5½ hours during which well bore fires occurred for three hours, maintaining the well and the adjacent sand at about 1,400° F. after cooling the sample was removed from the test pot as a coke-encased cylinder. Because of heat losses, the fire front reversed and burned back before reaching the outer boundary leaving a layer of coked sand adjacent the test pot walls. When the coke layer was removed, clean loose sand was found in the interior, except where the sodium silicate had consolidated it around the production well bore. The diameter of the consolidated portion varied from 4 to 5 inches, which was the zone which had been selected for treatment. This consolidated sand contained two fractures, but there was no sloughing into the production well bore. The consolidated section could be crushed between the fingers, but it had sufficient strength to maintain itself during the experiment and its removal from the apparatus.

Various modifications and alterations of this invention will become apparent to those skilled in the art from the foregoing discussion and accompanying drawing and it should be understood that the subject invention is not unduly limited to that set forth hereinbefore for illustrative purposes.

I claim:

1. In an in situ combustion process wherein an incompetent, carbonaceous formation is traversed by a producing well bore, a combustion front is established in said formation and is moved therethrough by the flow of a free oxygen-containing gas, and the resulting fluid hydrocarbon produced by said combustion front are caused to flow into said well bore, a method of consolidating said incompetent formation surrounding said well bore, which comprises injecting an aqueous solution of sodium silicate via said well bore into said adjacent incompetent formation prior to establishing said combustion front so as to saturate said adjacent incompetent formation, flowing free oxygen-containing gas into the resulting saturated formation to restore the permeability thereof, and subsequently heating said saturated formation to consolidate the same.

2. In an in situ combustion process wherein an incompetent, carbonaceous formation is traversed by a producing well bore and at least one injection well, the ignition of said carbonaceous formation is initiated in said producing well bore, a free oxygen-containing gas is injected into said carbonaceous formation via said injection well bore, a combustion front is established in said carbonaceous formation and caused to move therethrough countercurrent to the flow of said free oxygen-containing gas, and fluid hydrocarbons are recovered in said producing well bore, the improvement comprising injecting an aqueous solution of sodium silicate into said incompetent formation surrounding said producing well bore prior to said ignition of said formation so as to saturate said formation adjacent said producing well bore, allowing said free oxygen-containing gas to flow into said saturated formation to restore the permeability thereof, and utilizing the heat generated by said ignition to heat said saturated formation so as to consolidate the same before said combustion front is established.

3. The method according to claim 2 wherein said incompetent, carbonaceous formation is a tar sand.

4. The method according to claim 3 wherein said aqueous solution of sodium silicate is in the range of 25 to 45 degrees Baumé.

5. The method according to claim 3 wherein said sodium silicate has a silica/alkali ratio in the range of 1.60/1 to 3.90/1.

6. The method according to claim 3 wherein said aqueous solution of sodium silicate comprises 65 to 75 weight percent of 40 degrees Baumé aqueous sodium silicate and 25 ot 35 weight percent water.

7. The method according to claim 3 wherein said sodium silicate is sodium orthosilicate.

8. The method according to claim 3 wherein said sodium silicate is sodium metasilicate.

9. The method according to claim 3 wherein said sodium silicate is sodium sesquesilicate.

10. The method according to claim 3 wherein said sodium silicate is sodium disilicate.

11. In an inverse air drive in situ combustion process wherein an incompetent tar sand is traversed by a producing well bore and at least one injection well bore, air is injected into said tar sand via said injection well bore, igni ion of said tar sand is initiated in said p:oducng well bore, a combustion front is established in said tar sand and caused to move therethrough countercurrently to the flow of sa'd air therethrough, and fluid hydrocarbons are reco ered in said producing well bore, the imp:ovement comprising injecting into said tar sand surrounding said producing well an aqueous solution of sod'um silicate prior to injecting said air into said tar sand, thereafter commencing said injection of a'r so as to allow it to flow through said tar sand and into the re_ulting silicate treated tar sand, so as to restore the premeability of said treated tar sand, thereafter initiating said ignition of said tar sand, and utilizing the heat generated by said ignit'on step to heat said treated tar sand and effect the consolidation thereof.

12. In an in situ combustion process wherein an incompetent, carbonaceous formation is traversed by a producing well bore and at least one injection well, the ignition of said carbonaceous formation is initiated in said inj:ction well bore, a free oxyg:n-containing gas is injected into said carbonaceous formation via said injection well bore, a combustion front is established in said carbonaceous formation and caused to move therethrough cocurrent to the flow of said free oxygen-containing gas, and fluid hydrocarbons are recovered in said producing well bore, the improvement comprising injecting an aqueous solution of sodium silicate into said incompetent formation surrounding said producing well bore prior to said ignition of said formation so as to saturate said formation adjacent said producing we'l bore, allowing said free oxygen-contining gas to flow into said saturated formation to restore the permeability thereof, and utilizing the heat generated by said ignition to heat said saturated formation so as to consolidate the same before said combustion front is established.

13. In an in situ combustion process wherein a water-containing, incompetent carbonaceous formation is treated with a drying gas injected therein to drive mobile water therefrom, the combustion of said formation is initiated, a resulting combustion zone is caused to move through said formation by the flow of air, and wherein the resulting fluid hydrocarbons produced by said combustion are caused to flow into a well bore traversing said formation, a method of consolidating said formation adjacent said well bore, which comprises injecting an aqueous solution of an alkali metal silicate into said well bore along with said drying gas so as to form a gas-liquid dispersion, which enters said formation, and subjecting the resulting treated formation to heat by initiating the said combustion of said formation, thereby consolidating said formation.

14. In an in situ combustion process wherein a water-contain'ng, incompetent, carbonaceous formation is traversed by a producing well bore and at least one injection well, air is injected into said formation via said producing well bore to drive mobile water from the locus of said producing well bore, the ignition of said formation is initiated in said producing well bore, air is injected into said forma:ion via said injection well bore to support combustion of said formation, a combustion front is established in said formation and caused to move

therethrough countercurrent to the flow of said combustion-supporting air, and fluid hydrocarbons are recovered from said producing well bore, the improvement comprising injecting an aqueous solution of sodium silicate into said producing well bore along with said air used to drive said mobile water, injecting the resulting air-sodium silicate dispersion into said formation adjacent said producing well bore prior to said ignition of said formation, and utilizing the heat generated in said formation to heat the resulting sodium silicate-treated formation so as to consolidate the same.

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