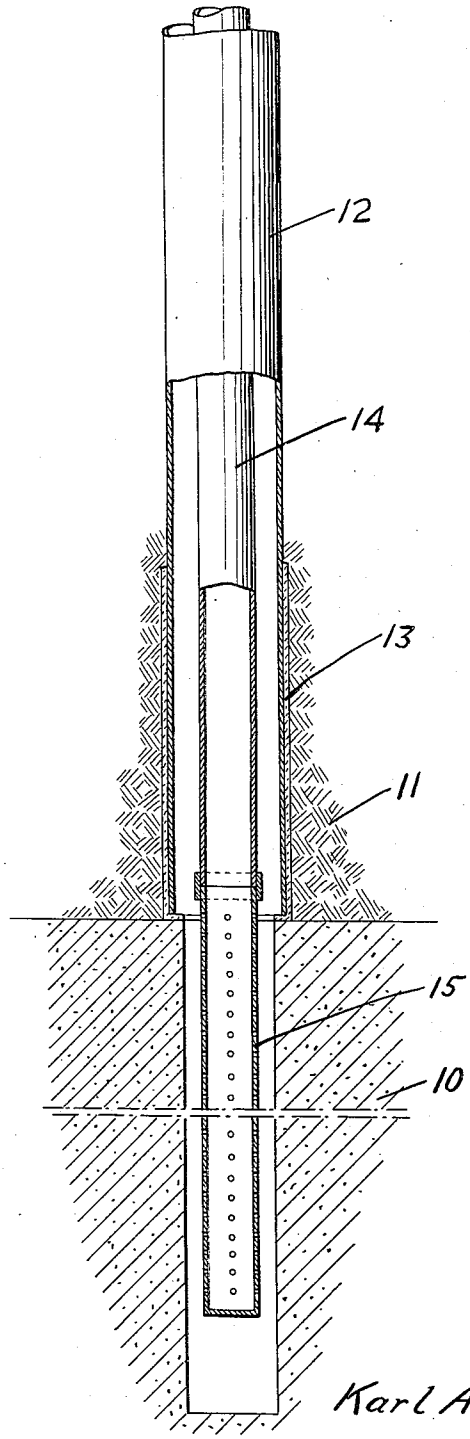
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METHOD OF TREATING OIL WELLS

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WITNESS:

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METHOD OF TREATING OIL WELLS

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The present invention relates to a method for removing paraffinic, resinous, asphaltic or other organic or inorganic substances from oil sands in order to increase the production of petroleum therefrom and relates particularly to a process for causing a chemical reaction in the vicinity of such producing sands in order to generate heat, violent agitation and produce in situ an emulsifying agent for semi-emulsifying or holding in suspension the substances impeding flow of oil from the capillaries in the oil sand adjacent a bore hole.

Most wells when brought in flow freely. However, when the formation pressure becomes reduced pumping must be resorted to in order to produce oil in commercial quantities. As soon as the passage of oil from the sand into the bore hole slows up, paraffinic or asphaltic substances settle from the oil and tend to clog the pores or capillaries in the sand adjacent the bore hole and also tend to clog the openings in the well screen if such device is used. When the wells have been drilled by the rotary method, the pores are often somewhat covered over with a deposit of drilling mud which is in very finely divided, if not colloidal, state, and while the wells are thoroughly washed when brought in, this does not always serve to remove the mud from the face of the sand.

I therefore propose to cause a violent chemical reaction in the vicinity of the producing sand within the bore hole in order to produce heat and violent agitation under pressure and at the same time form a material which will tend to emulsify any paraffinic, asphaltic or other substances which are impeding the flow of oil from the sands and thus render such material easily removable. I propose to place a predetermined quantity of water in the borehole adjacent the oil sand and to add thereto an alloy or amalgam of sodium, causing a violent reaction between the sodium and the water, thereby generating large quantities of heat to melt the paraffin and form sodium hydroxide by such interaction which serves as an agent to emulsify the melted paraffin or asphalt with the water present in the bore hole. The heat generated by the reaction and the hydrogen gas evolved produce a violent agitation, and if a considerable head of fluid is present in the bore hole the hydrostatic pressure caused by such fluid head together with the violent agitation and evolution of hydrogen, causes the hot hydroxide solution to penetrate the sand for a short distance, removing any paraffinic resinous or asphaltic substances which are clogging the capillaries near the face of the sand.

I am aware that it has been heretofore proposed to pump a hot solution of caustic soda or other alkali down to the producing horizon in an attempt to emulsify paraffin or other substances impeding the flow of oil. However, when it is considered that the shallowest wells, for instance in the Pennsylvania region, are about seven hundred and fifty feet deep, and the deepest wells range from seven thousand to twelve thousand feet, it is readily understood that it is practically impossible, due to heat losses, to place in the vicinity of the producing horizon a caustic solution having any large amount of heat therein and when such solution has reached the producing horizon there is an even flow and no agitation whatever. This method, therefore, has proved ineffectual.

I am also aware that it has been proposed to add metallic sodium to water placed in the bottom of a bore hole. This, however, has proved ineffectual since the action is extremely rapid, causing the water and sodium to spew up through the casing and dissipate the heat rapidly at a point where it is not needed or desired. Furthermore, since sodium has a specific gravity of .971, it will float on water and will not reach the lower portions of the formation which, depending on the locality in which the well is drilled, may be as much as seventy-five feet in depth.

As constrasted with prior art processes, my process consists in placing a predetermined quantity of water in the bore hole on top of which is placed a column of oil, which, being lighter than the water and immiscible therewith, will remain in position. I then lower a sodium alloy or amalgam at least to the top of the oil column and then permit the same to fall through the oil and contact the water. The sodium does not react with oil under ordinary conditions and consequently there is no chemical reaction and consequent evolution of heat and agitation, until the sodium contacts the water near the bottom of the drill hole. Since the sodium is alloyed with a metal heavier than sodium, its specific gravity will be greater than the sodium alone and consequently it will sink through the water while reacting therewith to the bottom of the bore hole. The reaction between the sodium in the alloy or amalgam and water forms sodium hydroxide with the evolution of hydrogen and at the same time produces great quantities of heat. The heat thus produced melts the paraffinic, resinous or other substance clogging the pores of the sand and the

violent agitation caused by the reaction and evolution of hydrogen causes the melted paraffin to emulsify or remain in a finely divided state of suspension in the water. The caustic soda formed as a result of reaction acts as an emulsifying agent.

By controlling the percentage of sodium in the alloy the rate of reaction of the sodium with the water and consequent evolution of heat and degree of agitation can be controlled, and by regulating the height of the oil column in the well, pressure may be maintained which will tend to force hot caustic solution into the sand adjacent the walls of the bore hole. The violent agitation produced also serves to dislodge from the walls of the bore hole any drilling mud or other substance which is not capable of being melted, but which is not firmly held. The agitation, unless the oil sand is extremely soft, will not tend to erode the oil sand from the wall of the bore hole.

Where wells are being pumped through strainers placed in the bottom of the bore hole, it is unnecessary in most cases to remove such strainers to treat the well, as the treatment may be carried out within the strainers, thereby cleaning the same and the hot solution of caustic soda will flow through the space surrounding the strainer and will also tend to remove paraffin and other substances from the face of the same. If the strainer is practically closed up by reason of the deposition of paraffin, it may, in some cases, be necessary to repeat the treatment in order to force sufficient hot caustic solution through the perforations in the strainer in order to clear the wall of the bore hole. This is of great advantage in that it has always been necessary heretofore to remove the strainer from the bore hole. It has been necessary to pull the tubing through which the oil flows and remove the strainer from the bore hole in order to clean the same of paraffin.

It is therefore an object of the invention to provide a method for producing a controlled chemical reaction in the vicinity of an oil producing sand within a bore hole in order to melt and emulsify paraffinic, resinous, asphaltic substances which clog the pores of the sand.

It is also an object of the invention to remove such materials which will clog a strainer set within a bore hole without the necessity of removing the tubing and strainer from the well.

Other and further objects will be apparent as the description progresses.

Referring now to the drawing, Fig. 1 is a cross section of an oil well which is producing from an oil sand 10 above which lies a formation 11 which is non-productive. The well has inserted therein to the top of the oil sand, a casing 12 which has been cemented and sanded off at the bottom by means of cement 13, forced up between the casing 12 and the formation 11 immediately above the producing formation 10. When pumping such a well, tubing having a strainer on the bottom thereof is lowered down the well to the vicinity of the producing horizon 10. The tubing is indicated at 14 on the drawing and the strainers by numeral 15. When the tubing 14 is placed, a pump (not shown) lifts the oil to the surface.

In practicing the present invention the well is first pumped or bailed dry. The pumping equipment is removed and the total depth of the well and the thickness of the oil bearing formation therein is determined. Water is then introduced into the well from the top through either the tubing 14 or the casing 12 and is allowed to stand therein until the height of the column of liquid becomes stationary, to determine the head of liquid which the oil bearing formation will support. A part of the water in the well is removed until the level of water therein is only slightly above the top of the oil bearing formation. If it has been found that the oil bearing formation will support a substantial column of liquid, oil is then introduced into the casing 12 and tubing 14 of the well on top of the water therein to a point preferably as near the top of the casing as the height the oil bearing formation will support. Better results are obtained from the use of my process on oil bearing formations which will support a substantial column of liquid, although the process has been practiced with beneficial results on formations which will not support any great column of liquid. The oil introduced as above specified exerts pressure on the water and prevents the dissipation of heat. It also acts as a protective cushion preventing particles of sodium from reaching the surface where conceivably they might cause an explosion by igniting the mixture of hydrogen evolved by the reaction and the air in the casing; in addition, if the oil formation will support a substantial column of liquid so that the oil reaches nearly to the top of the casing, the hydrogen evolved will build up pressure on top of the oil which will then force the alkaline solution formed into the oil bearing formation at the bottom of the well. An alloy of sodium, with a heavier metal such as lead, zinc or mercury, and having a specific gravity at least in excess of 1 and generally in the neighborhood of 1.7 to 2, is then lowered in the tubing or casing of the well through the oil column therein until it contacts the water at the bottom of the well. The alloy being heavier than the water will settle therethrough to the bottom of the well and on contact with the water the sodium reacts therewith, breaking down a portion of water to form sodium hydroxide and set free hydrogen. In addition to its ability to settle through the water to the bottom of the well it has found that when sodium is alloyed with any of the metals specified to an extent where the alloy has a specific gravity of the order of 1.7 or 2 the explosive nature of the reaction of the sodium with water is reduced and controlled to such an extent that better results are obtained in cleaning the well without deleterious effect on casing or screens. The reaction of sodium and water is accompanied by the evolution of a large amount of heat, 1 lb. of sodium producing 8771 B. t. u.'s on reaction with water. The hydrogen evolved also creates considerable agitation and thoroughly churns the water about.

The agitation and evolution of hydrogen sometimes prevents the sodium alloy, even though it is heavier than water, from settling through the water. It is therefore generally desirable to wrap or coat the sodium alloy with some substance which will permit the alloy to settle through the water to the bottom of the well before the water works through this coating and contacts the sodium. I have found that if the sodium alloy is wrapped in a paper it may be lowered to the bottom of the well before the water works through the paper and contacts the sodium. However, I prefer to coat the sodium alloy lightly with paraffin or some similar substance which may be readily removed from the well along with the reaction products and not be left therein to possibly cause difficulty in pumping. Where the oil bearing formation will not support a column of

oil on top of the water a considerable portion of the heat evolved is lost due to the water being thrown up the tubing or casing by the agitation caused by the reaction. However where it is possible to use a column of oil, due to the pressure of the oil the water is not thrown up the casing or tubing by the agitation and thus little of the heat evolved is dissipated or lost from that portion of the well covered with water, i. e., the oil bearing formation, and is available there to melt the paraffin. It is also generally desirable to cap or close in the well as soon as the sodium contacts the water, since by so doing a high pressure can be built up in the well by means of the hydrogen gas evolved. This is particularly true if the well will support a high column of oil so that the oil reaches nearly to the top of the casing. Additional pressure may also be applied to shallow wells by the use of compressed air or a compressed inert gas on top of the oil. In such cases, the alkaline solution formed by the reaction of sodium and water is forced back into the surrounding oil formation at the bottom of the well and, being hot, melts and partially emulsifies or holds in suspension the paraffin and other impurities. However, in certain cases as where a field is being repressured with compressed air so that there is danger of the hydrogen evolved forming an explosive mixture, it may be desirable to leave the well open. As a general rule, sufficient sodium is introduced in the form of an alloy of lead, zinc or mercury, so that the water in the bottom of the well after the completion of the reaction will contain in excess of 4% of sodium hydroxide. If such an amount of sodium is used, it has been found that sufficient heat will be evolved to melt the paraffin and at the same time the water will have sufficient alkalinity to hold the paraffin in solution or suspension. Great alkalinity is not desirable since it is unnecessary. The alkaline solution thus formed is permitted to remain in the well for a substantial time, generally at least a half hour and preferably for not more than one hour in order to avoid cooling the alkaline solution to a point where the paraffin will again be precipitated. The well is then pumped or bailed dry, bailing generally being used since the alkaline solution may have a deleterious effect on the regular pumping equipment.

After the reaction products have been removed from the well the regular pumping equipment may be installed and the well operated as previously, it having been found that the treatment above specified will materially increase the production from the well and the effects of the treatment will continue for a substantial period of time, increased production generally being such an amount and continuing for such a length of time that the cost of the treatment is easily more than covered by the improved production from the well.

For the purpose of better illustrating but not limiting my invention, the following specific example is given.

The rods and tubing were pulled from a well, the total depth of which was found to be 756 ft. and the depth to the top of the oil sand 708 ft. This well was producing at the time of treatment only ½ gal. of oil per 24 hours. After the rods and tubing had been pulled, the well was bailed dry and water was introduced in measured quantities to determine the approximate cubic content of the cavity in the sand. This was found to be approximately 5 cu. ft. The well was then filled with water to ascertain the height of the column of liquid the well could sustain. The water rose to and remained stationary at approximately 560 ft. The well was again bailed dry and 75 gals. of water, i. e., sufficient to entirely cover the oil sand formation, were introduced. 10 bbls. (420 gals.) of oil, the amount of oil determined to be necessary to raise the height of the column of liquid in the well to that which the oil sand would support, were then introduced on top of the water. In this particular case, the level of liquid was raised to a depth of 560 ft. giving a liquid column in the well approximately 200 ft. in height, with a calculated bottom pressure of about 70 lbs. 12 lbs. of sodium-lead alloy having equal parts of each metal and 24 lbs. of sodium-lead alloy composed of 25% sodium and 75% lead in the form of sticks, approximately 2¼ in. in diameter, 8 in. in length, were wrapped in paper and lowered in the form of a long flexible cartridge suspended from a wire and the well was capped. On reaching the bottom, the reaction between the sodium and water proceeded very quietly and the well was subsequently bailed dry. The temperature of the approximately 5% sodium hydroxide solution removed from the well was found to be 131° F. Considerable quantities of finely divided and suspended flocculent paraffin were removed during the bailing of the well. The quantity of fluid bailed was considerably in excess of the total liquid introduced. At the completion of the treatment the pumping equipment was reinstalled and the fluid in the well pumped off twice a day conforming to the routine practice of pumping formerly employed in this well. Due to the possible presence of introduced liquids in the well, no attempt was made to gauge the pump output during the first two days. Thereafter, the output of the well was found to be as follows:

	Oil—gallons
3rd day after treatment	15
4th day after treatment	7
5th day after treatment	12
6th day after treatment	6
7th day after treatment	8
8th day after treatment	3
9th day after treatment	6

This increased production has continued following the treatment for a substantial period of time and demonstrates that the well had been effectively cleaned.

The above example, while typical, should not be taken as limiting my invention. For example, where the oil sand will support it, a column of liquid in the well reaching substantially to the top of the casing is preferably used. When such a column of liquid is used, the hydrogen evolved by the reaction will cause a substantial increase in the pressure at the top of the well, a top pressure as high as 700 lbs. per square inch having been attained by the hydrogen evolved. This pressure may be increased to several thousand pounds per square inch where the oil formation and tensile strength of the well casing will permit it. When such high pressures are used, the alkali solution formed is forced into the oil formation surrounding the well as shown by the fact that when bailing a well after treatment on which such high pressures have been used, only oil is recovered at first, no alkaline water appearing until later in the well. This hot alkaline solution which is thus forced back into the oil formation loosens the various paraffinic, resinous and asphaltic impurities deposited therein, and also loosens up the oil

soaked sand tending to hold these impurities in suspension and remove them from the well.

While I have referred throughout to the use of sodium in my process, it is apparent that the other alkali metals, potassium and calcium, may be used, or various mixtures of sodium, potassium and calcium may be used. Potassium is substantially similar to sodium in its action, the only objection to its use being one of price. Calcium is not as efficient in its action as sodium since the calcium hydroxide, which is formed by the reaction of calcium and water, does not hold the paraffin and other waxy or resinous impurities melted by the heat of the reaction in suspension in the water as effectively as does the sodium hydroxide formed by the reaction of metallic sodium and water. However, mention should be made of the mixture of metallic calcium and sodium formed in the electrolysis of purified rock salt in the manufacture of metallic sodium. The most economical process for the production of metallic sodium is the electrolysis of purified rock salt, and in this process it is customary to add a small percentage of calcium chloride to the rock salt in order to lower the melting point of the salt. Due to a slight overvoltage in the electrolysis cells, a small amount of metallic calcium is formed along with the metallic sodium. Thus the metallic sodium obtained by electrolysis of fused rock salt contains a small percentage of calcium, and for use in the present process this calcium need not be removed from the sodium. However, where purified sodium is being manufactured, it is customary to remove the metallic calcium which is formed by filtration. Since, at the temperatures used in the electrolysis of the salt, only the sodium is molten while the calcium is solid, the calcium can readily be removed by filtration, the solid calcium with varied percentages of sodium remaining in the filter. Generally this mixture is in the neighborhood of 50% calcium and 50% sodium. This mixture being a by-product is relatively cheap and is well adapted for use in my process. Since the calcium reacts somewhat more slowly with water than does sodium, a smaller amount of inert alloying metals, such as lead or zinc. may be employed, as the calcium present in the mixture itself tends to stabilize the reaction of the sodium with water.

I therefore contemplate the use of potassium and calcium as equivalents of sodium in the above description of my process as well as various mixtures of these metals.

Any other metal, such as tin, or possibly copper, whose melting point is sufficiently low to enable it to be alloyed with the alkali metal and which will allow the alkali metal to react with water as herein described, may be substituted for lead, zinc or mercury.

Various modifications may be made in the practice of my process without departing from the spirit of my invention or the scope of the appended claims.

Where, in the claims, the word "alloy" is used, it is to be understood to include amalgams of sodium, such as sodium and mercury. The words "oil sands" and "sands" as used in this application are used in their generic sense as meaning oil bearing formations generally.

The present invention is a continuation in part of my copending application Serial No. 165,184, filed September 22, 1937.

What I claim and desire to protect by Letters Patent is as follows:

1. The method of treating oil wells which comprises introducing into said well a pre-determined quantity of water, introducing oil into said well in an amount sufficient to impose substantial pressure on the water, thereafter introducing into said water in the well an alloy of an alkali metal with such a proportion of a metal selected from the group comprising lead, zinc and mercury that the alloy has a specific gravity substantially in excess of 1, the amount of alloy so introduced being sufficient to produce on reaction with water an alkali solution in excess of four percent alkali hydroxide, permitting the thus formed alkali solution to remain in the well until after the reaction is completed but removing it before it has cooled to a point where a substantial precipitation of paraffin would occur.

2. The method of treating oil wells which comprises introducing into the well a predetermined quantity of water and introducing into the water in such well an alloy comprising an alkali metal and another metal alloyable therewith, said alloy having a specific gravity in excess of 1.

3. The method of treating oil wells defined in claim 2 in which the metal alloyable with the alkali metal is selected from the group comprising lead, zinc and mercury.

4. The method of treating oil wells defined in claim 2 in which the alloy is covered with a substance adapted to delay the action of the water thereon.

5. The method of treating oil wells which comprises introducing into the well a predetermined quantity of water and introducing into the water in such well an alloy comprising a mixture of sodium and calcium and another metal alloyable therewith, said alloy having a specific gravity in excess of 1.

6. The method of treating oil wells defined in claim 5 in which the alloy contains in excess of 25% by weight sodium.

7. The method of treating oil wells defined in claim 2 in which the alloy is introduced into the water in quantity sufficient to produce on reaction with water an alkali solution in excess of 4% alkali hydroxide.

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