J. F. McNAMRA

PROCESS AND APPARATUS FOR REDUCING CORROSION IN OIL WELLS

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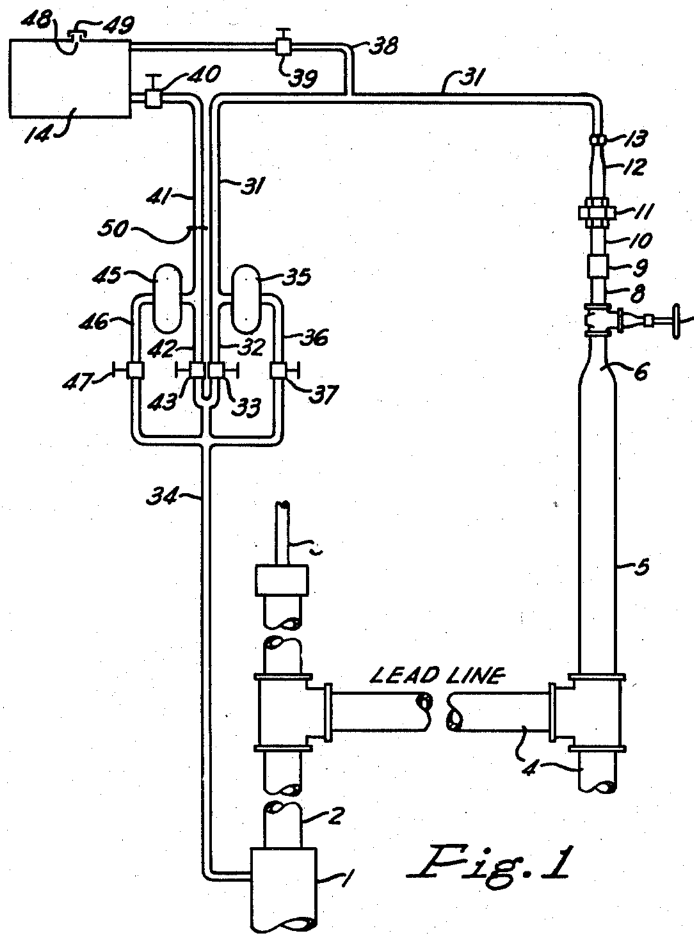

Fig.1

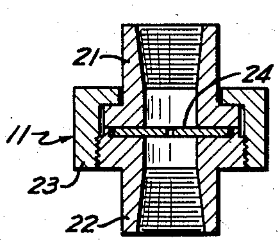

Fig.2

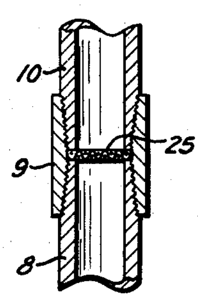

Fig.3

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PROCESS AND APPARATUS FOR REDUCING CORROSION IN OIL WELLS

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12 Claims. (Cl. 166—1)

This invention relates to a process and apparatus for reducing corrosion in oil wells, and more particularly to a continuous process whereby corrosion of casing, tubing, and pumping equipment of an oil well is minimized by separating out from produced well fluid a stream of relatively dry oil and returning the same to the annular space between casing and tubing in a particular manner and advantageously together with a small amount of corrosion inhibitor.

Production of oil is commonly accompanied by the production of more or less water and my process is particularly adapted to wells which produce well-fluid having a high ratio of water to oil such as in certain Kansas fields, where a proportion of three parts of water to one of oil is relatively low and where the ratio not infrequently runs even higher than fifty parts of water to one part of oil. In one Kansas field, for instance, five different wells produced the following amounts of oil and water in one day, and these figures may be regarded as not exceptional.

Oil:	Water
6	77
6	13
4	200
22	218
29	115

The water produced from oil wells ordinarily has high corrosive qualities and it has been observed that the higher the water-to-oil ratio in well fluid, the higher the corrosiveness of the well fluid.

The corrosive action of crude oil and of its accompanying water can be largely overcome by the use of corrosion inhibitors but the use of these materials, as practiced in the past, involves considerable expense and labor, much of which can be avoided by my process. The process of my invention reduces the consumption of these inhibitors without reducing their effectiveness, and my process has the further advantages that it economically maintains a continuous supply of inhibitor to the parts that are to be protected, and simultaneously reduces the corrosiveness of the well fluid by reducing the water-to-oil ratio thereof.

In combatting corrosion in wells producing a high proportion of water such as previously described it has been common practice to charge a few pints of corrosion inhibitor at intervals of from one to several days. These intermittently introduced batches of inhibitor have been carried to all parts of the well by recirculating all effluent of the well (unseparated oil and water) into the well annulus for several hours after the periodic introduction of inhibitor. This has required several hours of labor for each such treatment and it has involved an interruption of production of oil during the treating interval. Also, during the intervals between treatment, some parts of the equipment would lose their protective coat of inhibitor.

In the process of my invention a small amount of the produced oil, ordinarily about four to twelve barrels per day, is continuously and automatically separated from its accompanying water and this relatively dry oil together with a small proportion of inhibitor is continuously recirculated to the annulus between the well casing and the well tubing, thereby building up a body of inhibitor-containing oil in the annulus. The tendency of the oil level in the annulus to remain uniform causes a like amount of the inhibitor-containing oil to pass from the well annulus to the pump, and that inhibitor-containing oil is pumped up the tubing in company with the currently produced well fluid. In pumping this material up the tubing in company with currently produced well fluid the inhibitor is carried to the pump, the sucker rods, and the interior of the well tubing and it tends somewhat to adhere to these metal parts and to be absorbed into the normal coating thereof. At the same time, by increasing the quantity of oil pumped while not increasing the quantity of water, it decreases the water-to-oil ratio in the tubing, and as has been previously stated, the fluid of lower water-to-oil ratio has a lower corrosiveness even apart from the effect of the corrosion inhibitor.

The following figures serve to emphasize the effect of my method on the water-to-oil ratio. A not uncommon daily production of oil from a well in the Kansas fields is six barrels of oil and ninety-four barrels of water, in which case the water-to-oil ratio is substantially 16 to 1. In the practice of my process I would recirculate to the annulus say six barrels per hour of water-free oil and that would cause the continuous flow of a like amount of water-free oil from the bottom of the annulus to the pump and up the tubing, this oil carrying its appropriate content of corrosion inhibitor. In that operation there would be no increase of water passing up the tubing but the oil handled by the pump and passing up the tubing would be twelve barrels, one half of it charged with corrosion inhibitor, and the water-to-oil ratio would be cut in half to a ratio of approximately 8:1. In other words, my method, in this typical case, reduces the corrosiveness of the well fluid by cutting in two the water-to-oil ratio, and it simultaneously reduces the corrosiveness of the well fluid by the incorporation thereinto of an appropriate amount of corrosion inhibitor.

The amount of corrosion inhibitor introduced into the top of the annulus will depend upon the natural corrosiveness of the well fluid and upon a balancing of considerations of economy. I find the introduction of one pint of inhibitor for each 200 barrels of water produced to be a satisfactory treatment, with a minimum of one pint per day and a maximum of three pints per day. These figures are for common commercially provided inhibitors such as those sold under the designations Kontol 118, Kontol 120, Kontol 147, and Visco 987. These corrosion inhibitors are usually oil soluble and water dispersible although some are not dispersible in water. They come in liquid form and resemble heavy motor oil in appearance.

In the case of a well in which there is no oil standing in the annulus there is a distinct advantage in providing a continuous supply of inhibitor to the annulus because the annulus in such case channels that supply directly and continuously to the pump, tubing, and sucker rod.

Many wells are capable of fluid production greatly in excess of the capacity of the pumping equipment. In these wells the high fluid-producing capacity causes the annulus between casing and tubing to be partially filled with fluid. Gravity settlement of the water out of this fluid and toward the bottom of the annulus results in removal of the water by the pump and creation of a substantially water-free column of oil in the annulus. This column of oil may attain a stable balance at any height from near the pump to a couple of thousand feet or more, depending on the various forces. From this it will be seen that except for those wells with a very low column of oil in the annulus there is a large body of oil in the annulus for the corrosion inhibitor to be dispersed through, even with periodic introduction of inhibitor. Taking the common case of a well with 7" O. D. casing and 2⅞" O. D. tubing, the annular space will hold approximately thirty barrels per thousand feet of column. The slow but continuous circulation of oil from the top of the body in the annulus to the bottom thereof suffices to effect substantially complete mixing between oil and inhibitor. Once the production of fluid and the removal thereof by the pump have created a substantially stable level of oil in the annulus, every barrel of dry oil introduced into the top of the annulus in the practice of my method results in the displacement of a barrel of oil from the bottom of the annulus to the pump and the tubing.

By way of specific example of the process, assume a well producing well fluid with a 10:1 water-to-oil ratio and provided with a pumping capacity of 100 barrels per day. The production will be 90.9 barrels of water per day and 9.1 barrels of oil. Assume also that 8.33 barrels of dry oil is separated from the well fluid in the lead line and returned to the top of the annulus according to my process. Then the 100 barrels per day raised by the pump will include the 8.33 barrels of recirculated dry oil and 91.57 barrels of well fluid, the latter made up of 8.33 barrels of newly-produced oil and 83.3 barrels of water. My process will have then resulted in a reduction of the water-to-oil ratio of the fluid at the pump and in the tubing from 10:1 to 5:1. Furthermore, and of equal importance, as that 16.7 barrels of oil (8.33+8.33) reaches the lead line from the top of the well there will be stripped from it 8.33 barrels (one half) for simultaneous recirculation into the top of the annulus. The oil from the annulus and the newly-produced oil undergo thorough mixing in their passage through the pump and tubing, and the one half of the oil which is recycled back to the annulus from the lead line carries back with it its original content of corrosion inhibitor and so proportionately reduces the amount of inhibitor that must be introduced into the system to maintain the desired concentration of inhibitor in the stream. Of course in the case of an inhibitor which is water-dispersible the amount of inhibitor returned from the lead line to the annulus is somewhat less than its original content due to the dispersal of a part thereof into the water content of the well fluid.

In the examples given above I have for convenience of presentation used situations in which the quantity of oil recycled from the lead line to the annulus is exactly equal to the quantity of newly-produced oil. But the ratio of recycled oil to newly-produced oil covers a wide range in actual practice, with a water-to-oil ratio anywhere between a low figure around 2:1 to a high even exceeding 50:1. The amount of oil recycled from the lead line to the annulus is not ordinarily varied in proportion to the water-to-oil ratio, but rather is ordinarily kept within the approximate range of four to twelve barrels of dry oil per day.

When I speak of dry oil being recycled to the annulus I mean thereby substantially dry oil. Total dryness is not indispensable but any accompanying water presents just that much more source of corrosion, small though it be, and so the desired degree of dryness is that which can be attained by gravity settling in an industrially feasible interval of time such as from approximately five minutes to fifteen minutes in a continuous separator such as that shown in Figure 1 of the accompanying drawing and more fully described in a subsequent portion of this specification. Settling for such a period of time will not produce an oil from which no further moisture could be driven off if heated to 350° F., but it will produce an oil with a moisture content which ordinarily is substantially less than one percent and from which no further large reduction in moisture content can be effected by prolonging the settling interval.

The apparatus used in the practice of my invention is shown in the accompanying drawings, and the method of my invention will be described in connection therewith. Referring to the drawings, Figure 1 is an overall view of the apparatus, in elevation. Figure 2 is a sectional view of orifice **24** and its mounting. Figure 3 is a sectional view of pipe coupling **9** and adjacent parts, showing the manner in which a screen is positioned in the apparatus.

Referring to Figure 1, numeral **1** indicates the head of casing in an oil well, and numeral **2** indicates tubing extending upward therebeyond. The space between is closed off tight at the top of the casing. A pump rod by means of which the well is pumped is indicated at **3**. Numeral **4** indicates a lead line through which the well fluid is delivered to tankage. The foregoing are common parts of a well. For the practice of my invention I provide a riser **5** together with the parts subsequently mentioned. This riser will ordinarily be of substantial size pipe, preferably of 3 inch size or larger, depending on the rate at which oil is returned to the casing and on the rate of its separation from the accompanying water. The upper end **6** of riser **5** is reduced to smaller size, e. g. 1 inch iron pipe size. A valve **7** is advantageously installed at this point to permit convenient removal and cleaning of subsequently mentioned elements. Immediately adjacent to valve **7** is a short length of pipe **8** followed by a pipe coupling **9** and a second short length of pipe **10**. The two short lengths of pipe **8** and **10** together with pipe coupling **9** are used to hold a disc-like strainer element **25**, as shown in detail in Figure 3. Pipe nipple **10** is followed in turn by a union indicated overall by numeral **11**. This union carries an orifice **24** in the manner shown in Figure 2. A short reducing nipple **12** and connection **13** continue the conduit and provide for jointure with tubing **31**. Tubing **31** connects through tubing **32**, valve **33**, and tubing **34** back into casing **1** near the top thereof. A small-throughput chemical pump **35** is positioned in a bypass line **36** around tubing **32** and valve **33**. A valve **37** controls passage of material through bypass **36**. When pump **35** is in use, valve **37** is maintained open and valve **33** is maintained closed. These positions of these two valves are reversed when pump **35** is out of use and returned oil then flows directly through tubing **31**, **32** and **34** to casing **1**.

A container **14** is provided to hold a stock of corrosion inhibitor and this container is fitted with an opening **48** to receive inhibitor and a tight closure means **49**. A conduit **38**, fitted with a valve **39**, connects into a high point of container **14** from conduit **31**. The inhibitor can be charged through conduit **41**, valved at **40**, through conduit **42**, valved at **43**, into tubing **34** for introduction into casing **1**. There may be some superatmospheric pressure in the annular space between casing **1** and tubing **2**, and therefore I provide a small-throughput chemical pump **45** or equivalent means for forcing corrosion inhibitor from container **14** into casing **1**. This chemical pump **45** is positioned in a bypass **46** around tubing **42** and valve **43**, bypass **46** being valved at **47**. When chemical pump **45** is in use, valve **47** is maintained open and valve **43** is maintained closed. The positions of these two valves are reversed when the pressure differential between container **14** and casing **1** is such as to permit the corrosion inhibitor to flow directly through conduits **41**, **42**, and **34** to casing **1**. However, regardless of relative pressures, pump **45** may be used at any or all times as a measuring or flow control device in addition to its function as a forcing device. Also, a readily removable orifice **50** may be placed in conduit **41** as a flow control device for the inhibitor when inhibitor is permitted to flow from container **14** to the annulus by gravity or when valve **39** is open in conduit **38** and the pressure of the lead line is used to force inhibitor out of container **14** to the annulus.

Figure 2 is a sectional view on an enlarged scale of orifice union 11. This orifice union comprises end sections 21 and 22 together with yoke 23. Orifice plate 24 is positioned between end sections 21 and 22 of the union and is held tightly in place by means of yoke 23.

Referring to Figure 3, this figure indicates the manner in which a screen 25 is positioned in the conduit, this screen being clamped in pipe coupling 9 between the ends of pipe nipples 8 and 10.

In the operation of my process a stream of well fluid consisting of oil and water issues from tubing 2 and flows through lead line 4 to a flow tank. A riser 5 positioned on flow line 4 and extending directly upwardly therefrom provides a chamber into which the mixture of oil and water passes. The dimensions of this chamber are deliberately selected with reference to the amount of oil to be returned to casing 1 and the rate at which this oil will separate from its accompanying water, so that the rate of flow through riser 5 will be low enough to give substantially complete separation of water from oil, with the oil flowing upward toward orifice 24 and the water settling back down into lead line 4. I have found that the desired degree of separation can be obtained in most cases with a chamber having a volume equal to or greater than about ten minutes flow. Specifically I have satisfactorily accomplished the desired separation with a riser 5 of 3½″ iron pipe size and 30″ long, although this seems to be about a minimum practical size.

The amount of oil withdrawn from the lead line for return to casing 1 is controlled by an orifice 24 in the passageway from riser 5 to conduits 31 and 34. The size of this orifice is chosen to give a flow of the order of 4 to 12 barrels of oil per 24 hours and the diameter of the orifice will ordinarily be of the order of from four to seven one-hundredths of an inch. This dimension is of course determined by the desired rate of flow, available pressure drop, and the viscosity of the oil.

There will ordinarily be a higher pressure existing in lead line 4 than in casing 1 and this difference is ordinarily sufficient to effect the desired flow through riser 5, orifice 24, conduits 31, 32, and 34 back to casing 1 without the aid of a pump. However, a low-throughput chemical pump 35 may be positioned in the conduit 31 or in a bypass 36, as shown, and in this case the pump 35 may serve also as a flow-control means and be used instead of orifice 24. When pump 35 is not used, valve 33 is maintained open and valve 37 is maintained closed, whereupon flow of oil is directly through conduits 31, 32, and 34 to casing 1. When pump 35 is operated, valve 37 is opened and valve 33 closed, whereupon flow of oil is through conduits 31, 36, and 34 to casing 1.

A container 14 is provided for liquid corrosion inhibitor.

Casing 1 being sometimes under some superatmospheric pressure, the corrosion inhibitor from container 14 can be introduced into it by various common means such as a small hand pump or by the pressure of oil from riser 5 operating through conduits 31 and 38 and past valve 39 into closed chamber 14. In that case the valve 40 is opened and the measured contents of chamber 14 are forced through conduits 41, 42, valve 43 and conduit 34 into casing 1. An orifice may be positioned in line 41 to control the amount of inhibitor flowing from container 14 to casing 1. As an alternative to this procedure, and with valve 39 closed, a low-throughput chemical pump 45 can be used to force the corrosion inhibitor from chamber 14 to casing 1. In this operation the inhibitor is directed through conduits 41, 46 and 34 to casing 1, with valve 47 in an open position.

My process builds up a column of relatively non-corrosive oil in the annulus of the well, thereby displacing water from the lower portion of the annulus, and by that means I am able to keep substantially the entire length of the casing free of accumulated water. This keeps the interior of the casing and the exterior of the tubing in contact with relatively non-corrosive oil. By the periodic or continuous introduction of a small amount of corrosion inhibitor I reduce the corrosiveness of the oil to relative insignificance. Over a period of time an amount of oil equal to that recirculated into the top of the casing passes from the bottom of the casing into the tubing. That is pumped up the tubing and a certain portion of it will again find its way into riser 5 and again be returned to the top of casing 1, all as previously described in greater detail. This oil recycled from the lead line contains its proportion of inhibitor and its return to the top of casing 1 results in maintaining at that point some concentration of inhibitor even though inhibitor be introduced into casing 1 from container 14 at intervals of several days.

As shown in Figure 1 of the accompanying drawing, the stream of oil withdrawn from the lead line is advantageously taken off through a vertical riser extending from some point along the crest (or upper ridge) of the lead line. While the time of residence in the riser or settling zone is spoken of as from five to fifteen minutes, the actual time will depend somewhat on the degree of separation that exists between oil and water in the section of the lead line from which the oil is removed.

What I claim is:

1. In the operation of a well producing both oil and water and having a high ratio of water to oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: continuously withdrawing from the upper part of the lead line a small stream of oil at a velocity low enough to effect gravity separation of said oil from accompanying water; introducing a small proportion of corrosion inhibitor into the withdrawn oil; continuously introducing the mixture of withdrawn oil and corrosion inhibitor into the said annular space and causing it to flow downward therein to the bottom of the tubing and pumping the same upward therethrough to the lead line in company with newly-produced oil and water.

2. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: continuously withdrawing from the upper part of the lead line a small stream of oil at a velocity low enough to effect gravity separation of said oil in substantially dry condition from accompanying water; introducing a small proportion of corrosion inhibitor into the withdrawn oil; continuously introducing the mixture of withdrawn oil and corrosion inhibitor into the said annular space and causing it to flow downward therein to the bottom of the tubing and pumping the same upward therethrough to the lead line in company with newly-produced oil and water.

3. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: continuously withdrawing from the upper part of the lead line a small stream of oil at a velocity low enough to effect gravity separation of between four and twelve barrels per day of said oil in substantially dry condition from accompanying water; introducing a small proportion of corrosion inhibitor into the withdrawn oil; continuously introducing the mixture of withdrawn oil and corrosion inhibitor into the said annular

space and causing it to flow downward therein to the bottom of the tubing and pumping the same upward therethrough to the lead line in company with newly-produced oil and water.

4. In the operation of a well producing both oil and water, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: continuously withdrawing from the lead line a small stream of oil at a velocity low enough to effect gravity separation of said oil from accompanying water; continuously introducing the withdrawn oil into the said annular space and causing it to flow downward therein to the bottom of the tubing and pumping the same upward therethrough to the lead line in company with newly-produced oil and water.

5. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: maintaining in the annular space a body of substantially dry oil; continuously withdrawing a portion of the said substantially dry oil from the bottom of the annular space and pumping the same upward through the tubing to the lead line in company with newly-produced oil and water; continuously withdrawing upwardly from the crest of the lead line, at a velocity low enough to effect gravity separation of the oil from its accompanying water, a small stream of substantially dry oil; and continuously introducing the withdrawn oil into the annular space to maintain a substantially constant body of oil therein.

6. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: continuously withdrawing from the upper part of the lead line a small stream of oil at a velocity low enough to effect gravity separation of said oil from accompanying water; continuously introducing the withdrawn oil into the said annular space, introducing a small proportion of corrosion inhibitor into the said annular space, and causing the two to flow downward therein to the bottom of the tubing and pumping the same upward therethrough to the lead line in company with newly-produced oil and water.

7. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: maintaining in the annular space a body of substantially dry oil containing in solution a small percentage of corrosion inhibitor; continuously withdrawing a portion of the said dry oil and inhibitor from the bottom of the annular space and pumping the same upward through the tubing to the lead line in company with newly-produced oil and water; continuously withdrawing from the upper part of the lead line a small stream of substantially dry oil at a velocity low enough to effect gravity separation of said oil from accompanying water; continuously introducing the withdrawn oil into the annular space to maintain a substantially constant body of oil therein; and introducing a small portion of corrosion inhibitor into that part of the system consisting of the stream of substantially dry oil withdrawn from the lead line and the body of oil maintained in the annular space.

8. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: maintaining in the annular space a body of substantially dry oil containing in solution a small percentage of corrosion inhibitor; continuous withdrawing a portion of the said substantially dry oil and corrosion inhibitor from the bottom of the annular space and pumping the same upward through the tubing to the lead line in company with newly-produced oil and water; continuously withdrawing upwardly from the crest of the lead line, at a velocity low enough to effect gravity separation of the oil from its accompanying water, a small stream of substantially dry oil; continuously introducing the withdrawn oil into the annular space to main a substantially constant body of oil therein; and introducing a small portion of corrosion inhibitor into that part of the system consisting of substantially dry oil withdrawn from the lead line and the body of oil maintained in the annular space.

9. In the operation of a well producing both oil and water in proportions of not substantially less than two volumes of water per volume of oil, the said well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, a pump located within the tubing to pump the oil and water upward therethrough, and an annular space between casing and tubing, the method of reducing corrosion which comprises: maintaining in the annular space a body of substantially dry oil containing in solution a small percentage of corrosion inhibitor; continuously withdrawing a portion of the said substantially dry oil and corrosion inhibitor from the bottom of the annular space and pumping the same upward through the tubing to the lead line in company with newly-produced oil and water; continuously withdrawing from an upper portion of a riser extending upwardly from the crest of the lead line, at a velocity low enough to effect gravity separation of the oil from its accompanying water, a small stream of substantially dry oil; continuously introducing the withdrawn oil into the annular space to maintain a substantially constant body of oil therein; and introducing a small portion of corrosion inhibitor into that part of the system consisting of the stream of substantially dry oil withdrawn from the lead line and the body of oil maintained in the annular space.

10. In combination with an oil well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, an annular space between said casing and said tubing, and a pump located within the tubing to pump produced oil and water upward therethrough, a device for introducing corrosion inhibitor into said well which comprises: a riser extending upward from the lead line and adapted to convey liquid therefrom; a small orifice in an upper part of said riser, the orifice being of a size to permit the passage of oil therethrough at a rate of the order of 4 to 12 barrels per day, and the riser and orifice being so proportioned to one another as to restrict the rate of upward flow of oil through the riser and so permit the settlement of water therefrom; a return conduit connecting from the discharge side of the said orifice into the said annular space between casing and tubing; a vessel adapted to hold liquid corrosion inhibitor, and a conduit connecting

from said vessel to the annular space between casing and tubing.

11. In combination with an oil well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, an annular space between said casing and said tubing, and a pump located within the tubing to pump produced oil and water upward therethrough, a device for introducing corrosion inhibitor into said well which comprises: a riser extending upward from the lead line and adapted to convey liquid therefrom; a small orifice in an upper part of said riser, the orifice being of a size to permit the passage of oil therethrough at a rate of the order of 4 to 12 barrels per day, and the riser and orifice being so proportioned to one another as to restrict the rate of upward flow of oil through the riser and so permit the settlement of water therefrom; a return conduit connecting from the discharge side of the said orifice into the said annular space between casing and tubing; a closed vessel adapted to hold liquid corrosion inhibitor; a second conduit extending from the return conduit to a high point of said vessel; a third conduit connecting from a low point of said vessel into the said return conduit at a point more remote from the riser than the point at which the said second conduit departs from the return conduit.

12. In combination with an oil well comprising an outer casing, an inner tubing and a lead line extending from the upper portion thereof, an annular space between said casing and said tubing, and a pump located within the tubing to pump produced oil and water upward therethrough, a device for introducing corrosion inhibitor into said well which comprises: a riser extending upward from the lead line and adapted to convey liquid therefrom; a small orifice in an upper part of said riser, the orifice being of a size to permit the passage of oil therethrough at a rate of the order of 4 to 12 barrels per day, and the riser and orifice being so proportioned to one another as to restrict the rate of upward flow of oil through the riser and so permit the settlement of water therefrom; and a conduit connecting from the discharge side of the said orifice into the said annular space between casing and tubing; a closed vessel adapted to hold liquid corrosion inhibitor; a second conduit extending from the return conduit to a high point of said vessel; a third conduit extending from a low point of said vesel to the annular space between casing and tubing.

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2,688,368 Rodgers et al. ---------- Sept. 7, 1954

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,843,206 July 15, 1958

John F. McNamara

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 26, for "91.57 barrels" read -- 91.67 barrels; column 8, line 26, for "main" read -- maintain --.

Signed and sealed this 23rd day of September 1958.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents