

Oct. 21, 1958

W. B. HUGHES

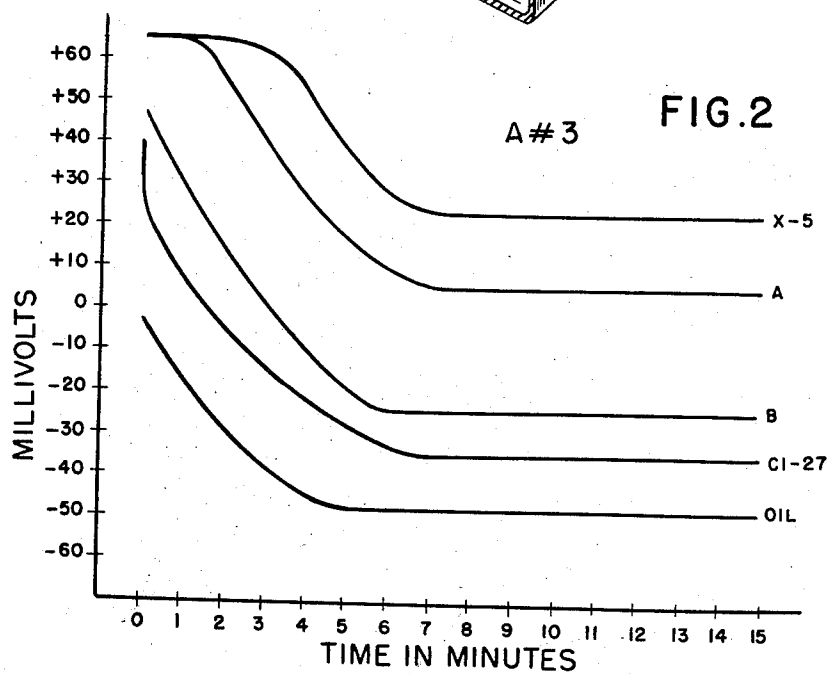
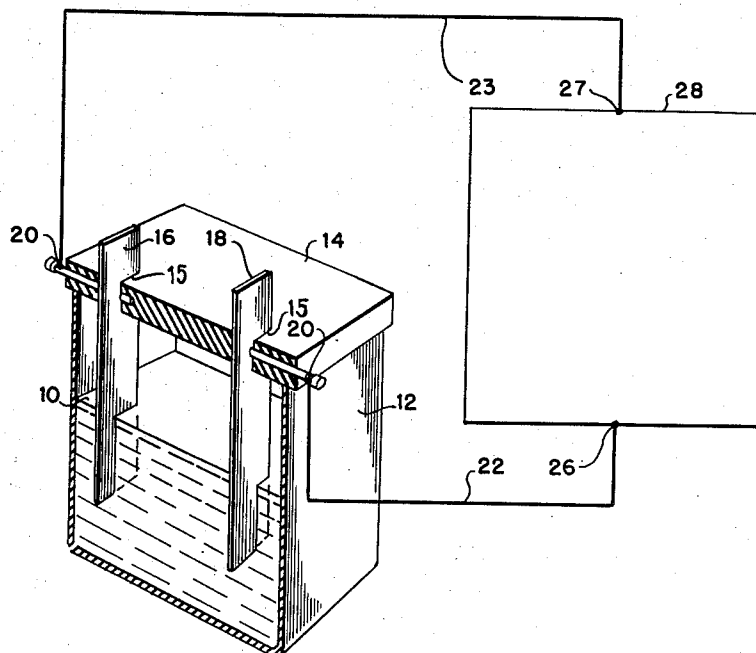
2,857,320

EVALUATION OF CORROSION INHIBITORS

Filed Feb. 25, 1955

2 Sheets-Sheet 1

FIG. 1



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FIG. 3

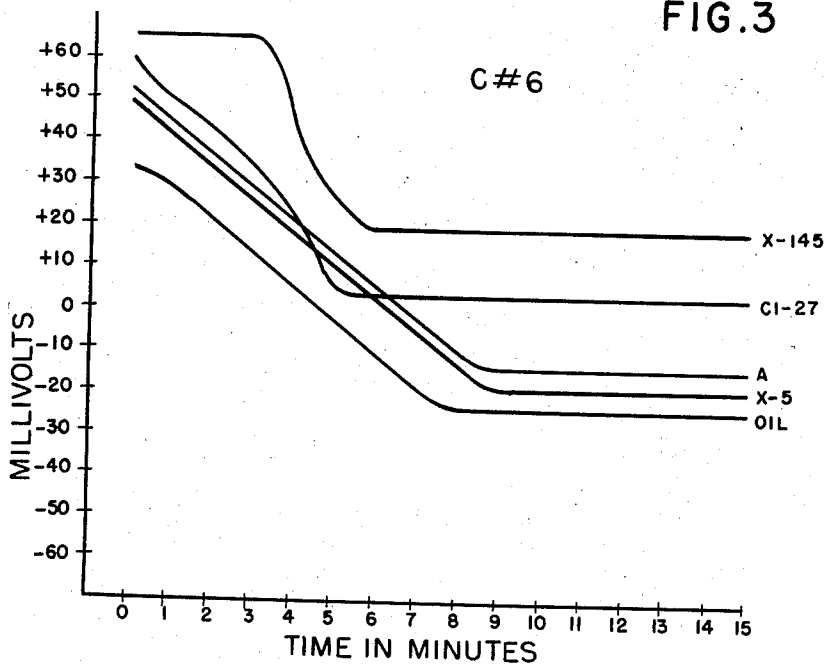
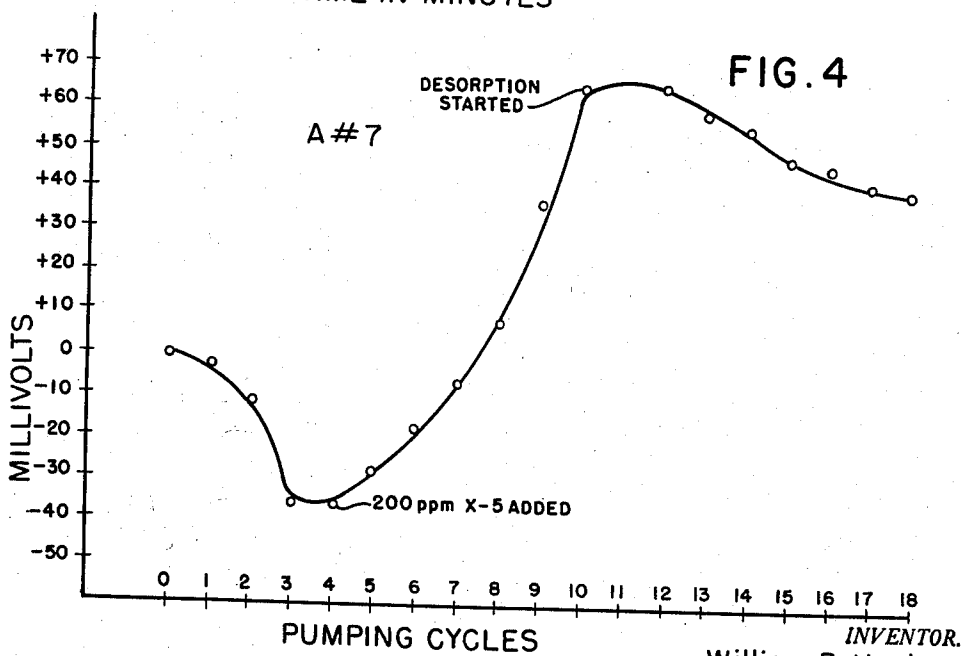


FIG. 4



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EVALUATION OF CORROSION INHIBITORS

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2 Claims. (Cl. 204—1)

This invention relates to the treatment of corrosive oil in gas wells and more particularly relates to a method of evaluating and selecting from a plurality of corrosion inhibitors the particular inhibitor best suited to prevent corrosion in a particular well or series of wells undergoing corrosion treatment.

In the production of oil and gas the problem of minimizing equipment corrosion has occupied the attention of producers for many years. The cost of replacing corroded pump rods, well tubing, and other equipment which comes into contact with the corrosive well fluids costs many thousands of dollars a year. Considerable sums of money and a great deal of effort has been expended on studies directed to determining the cause of corrosion and methods and materials best suited to minimize it. Some of this work has resulted in the discovery of chemical compounds of particular structure which have proven reasonably effective in inhibiting corrosion when added to operating wells.

Over a considerable period of time many types and varieties of these so-called corrosion inhibitor compounds have been synthesized. From experience, it has been found that while a particular inhibitor may be effective in one well it would be completely ineffective in adjacent wells or wells in the nearby areas. To date, no method has been provided whereby a specific selection and evaluation of an inhibitor from a group of potentially effective inhibitors could be made in the field with a minimum of equipment and in a comparatively short period of time. The desirability of such a method and its value in selecting the particular inhibitor best suited to minimize corrosion in a particular well will be appreciated when consideration is given to the incomplete information provided by presently used evaluation tests. Moreover, a method for evaluating the effectiveness of the job being done in a well by a particular inhibitor would permit a continuous evaluation of the strength of corrosiveness of the fluids in the well being treated. On the basis of such information, steps can be taken at varying intervals to maintain fluids in the well in a non-corrosive state or ineffective to corrode by the addition of more inhibitor.

In the course of evaluating corrosion inhibitors, several tests have been evolved which attempt to evaluate on the basis of prior knowledge of a particular well the inhibitor best suited for that well. Among these tests are the so-called efficiency test and the wetting test. In the efficiency or weight loss test, the weight loss principle is used either in static or dynamic form and provides on the basis of loss of weight of a metallic test strip a comparative figure as to the effectiveness of the inhibitor being tested. While this method provides one measure of an inhibitor's efficiency, it is obvious that the delicate balances required for the determination of weight loss, minimizes the use of such a technique in field operations. Moreover, a test made in the laboratory where balances are available on a particular brine solution would be effective only for the well from which that particular

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brine was taken and would be of no use in evaluating that inhibitor for wells in surrounding areas since it has been found that the corrosive nature of well fluids varies considerably from well to well even within a given field.

5 A further disadvantage to the efficiency test is the time requirement necessary to obtain corrosion of the metallic test strip which is subjected to the corrosive fluids.

Another test used with some success is the so-called wetting test. This test, similar to the efficiency test, also 10 has serious disadvantages. According to the wetting test, a comparative figure or indication can be obtained which distinguishes inhibitors of little value from those which could possibly provide some protection for the well under consideration. This method is based on the observation 15 that when an oil wets a metal surface it tends to spread out over that surface. This spreading or wetting is due to the reduction of the interfacial forces between the oil and the metal. The degree or extent to which an inhibitor wets a surface has a direct bearing on its ability to prevent corrosion since if an inhibitor does not have the 20 ability of preferentially wetting the tube surface it cannot provide the desired protective coating. Here again, obvious limitations exist on the use of this method in the field. Moreover, wetting is only one characteristic of an inhibitor. A wetting number does not give an overall 25 evaluation of the power or strength of the inhibitor to adsorb to the metal surface once it has wetted the surface.

It is, accordingly, an object of this invention to provide 30 a method for the selection and evaluation of corrosion inhibitors which is readily adaptable for field use.

It is another object of this invention to provide a simple, quick and effective method for evaluating corrosion inhibitors to provide the inhibitor best suited to give 35 maximum protection against corrosion in a particular well.

Another object of this invention is to provide a method for determining the relative strength of adsorption of a particular inhibitor under well conditions.

It is a still further object of this invention to provide 40 a measured control of the continuing effectiveness of a corrosion inhibitor in a well during pumping operations.

These and other objects may be accomplished according to my invention which may be broadly characterized 45 as a measure in terms of generated electric potential of the strength of adsorption of a particular inhibitor. I have found quite unexpectedly that I am able to measure the strength of adsorption of an inhibitor under well conditions in terms of E. M. F. generated by strips of metal placed in an electrolyte, one of which is made cathodic 50 to the other by reason of having its surface coated with the inhibitor being evaluated. According to my invention, I am able to select from a group of inhibitors the one inhibitor which will best overcome the corrosive conditions in a particular well. Such an evaluation method 55 has not been heretofore available.

In making the selective evaluation of corrosion inhibitors, according to my invention, I have found that the measure of the negative potential of the corrosiveness of a well and the effect of an inhibitor on this measurement 60 provides a method for selecting the inhibitor best suited to prevent corrosion in a particular well. In carrying out my invention, I employ a simple galvanic cell or well known simple electrolytic circuit. In utilizing this circuit I have found that if metallic electrodes, one of which has been plated by subjecting it to an inhibited oil, are placed in a well brine solution and allowed to stand for a short period of time, a measure of the E. M. F. generated in this electrolyte by the potential differences 65 existing between the electrodes may be obtained. This E. M. F. generation or production is due to the fact that one electrode is coated with the inhibitor being tested and

is thereby made cathodic to the other electrode. By a series of comparative tests carried out in the manner hereinafter described on a series of potentially useable corrosion inhibitors, a specific selection of the inhibitor most suitable for the particular well can be made. Moreover, by placing a series of electrodes in a well head during pumping operations and continuously applying the evaluation method of my invention, I am able to obtain over a period of time a continuous measurement of the corrosive potential of the well. With this knowledge, I am able to add inhibitor as desired to maintain that well in a condition which will substantially prevent corrosion from occurring.

The apparatus which I have found particularly suitable for carrying out my method of evaluation or corrosive measurement is the simple galvanic cell shown in Fig. 1. I have found that a cell such as indicated by numeral 12 which can be approximately 3" wide, 3½" high and 1¼" deep, serves adequately for purposes of this test. The cell may be constructed of glass, plastic, ceramic, or any other suitable material and may be of any size desired. To facilitate field use, I have found that a cell of the dimensions suggested serves very well, though obviously a larger cell may be just as effectively used. The open upper end of the cell 12 is fitted with a top 14 which acts as an electrode holder. Holder or top 14 is provided with slots 15 which are approximately 1¾" apart and are designed to accommodate the metallic test strips or electrodes 16 and 18. For electrodes, I have found that cold rolled steel provides satisfactory results. Obviously, other than cold rolled steel may be used. For example, alloy steels or test strips of pure nickel would provide equally satisfactory results. These strips can be approximately ¼" x 4" or of any length adapted to fit the particular construction and size of the cell used. The test strips must be long enough to extend into a brine solution 10 which is placed in the cell. Contact with the test strips which also function as electrodes is made through two spring tensioned pins 20 which are supported by the electrode holder or top 14 and are connected by conductors 22 and 23 to opposite poles 26 and 27 of potentiometer 28. Measurement of current generated in the cell is made by any suitable potentiometric device gauged in millivolts or any other convenient measure of electro-motive force desired. I have found that a null bridge type of potentiometer provides very satisfactory results though other potentiometric apparatus may serve equally as well. The measuring apparatus, however, should be of a type which provides maximum sensitivity with minimum drag since the potential difference generated is comparatively small and the indication means provided must afford accurate measurement of this small current generation.

It is essential and critical to the accurate measurement of the adsorptive power of the inhibitors being tested that the metallic test strips or electrodes used for the determination of adsorption be effectively cleaned. I have found that if the test strips are heated in an open flame until they glow cherry red, followed by immersion in hydrochloric acid solution of approximately 10% strength, until the surface of the metal strip is completely covered with hydrogen bubbles and thereafter washed and polished with an abrasive, best results can be obtained. To limit the corrosive effect of the acid utilized in treating, a small amount of an inhibitor may be added to the acid. For example, I have found that various arsenic compounds, such as arsenic trioxide will inhibit the corrosive effect of the acid.

To appreciate more fully the importance and value of the method of my invention, it may be desirable to briefly consider presently available methods utilized to a limited extent in evaluating certain characteristics of corrosion inhibitors. In carrying out the selection of the inhibitor best adapted to inhibit a particular well in the presence of a corrosive fluid, the presently used tests of efficiency

and wetting will provide some basis for eliminating those inhibitors which are clearly inappropriate or ineffective for the well under treatment. While it is not essential in evaluating according to the method of my invention to use these tests, I have found it convenient to do so if it is desirable to select a particular inhibitor from a large number of potentially useable compositions. For example, if a group of 20 inhibitors were considered potentially effective in combatting the corrosion in a particular well or field the weight loss test and the wetting test previously referred to could be used to reduce the initial group of 20 to a group of say 4 or 5 inhibitors. While these tests form no part of my invention, the efficiency and wetting tests under certain circumstances, if time and equipment permits, will rule out completely ineffective inhibitors.

One method of carrying out the efficiency or weight loss test is to insert a weighed steel strip into a well brine to which a measured amount of a known inhibitor has been added. Hydrogen sulfide is then bubbled through the solution for a fixed period of time. The steel strip after hydrogen sulfide treatment is removed from the brine, cleaned with acid, washed, dried and weighed to determine the weight loss due to corrosion. A duplicate test is run to determine the weight loss of a strip subjected to the action of uninhibited liquid. This provides a basis for a comparative determination of the effectiveness of the inhibitor used.

Similarly, in the so-called wetting test a metallic test strip is immersed for a measured period of time in the well brine being tested. This permits a coating of iron sulfide or other foreign material to build up on the strip similar to the deposit of contaminants on the surface of well tubing. At the end of the conditioning period, drops of oil are placed on the lower side of the metal strip by means of a fine end pipette. The ratio of the height of the drop to the radius of the drop is measured. If a number of 1 or less than 1 is obtained for the drop of inhibited oil, the oil is said to wet the metal. As previously indicated, the higher the degree of wetness or wettability of the inhibitor the greater the protection offered to the tubing surface.

By means of these determinations we are able to exclude from our initial group of inhibitors those which would be totally or completely ineffective in inhibiting corrosion by the particular brine in the well or wells with which we are concerned.

To select from the remaining group of say 4 or 5 inhibitors that inhibitor which is best adapted to combat the corrosive condition in the well being treated, a series of comparative tests are conducted on each of the inhibitors according to the method hereinafter described.

In evaluating a corrosion inhibitor according to the method of my invention, two metallic test strips are utilized for each inhibitor to be tested. These electrodes are pretreated as previously described and inserted in a brine solution obtained from the well to be treated. This brine solution will normally include such acid salts as sodium chloride, potassium chloride and other alkaline and alkaline earth acid salts. In addition, a considerable quantity of water will be present in the brine as well as varying amounts of oil. The amount of oil present in the brine may vary widely and depends on such factors as the nature of the strata surrounding the well, depth of the well, technique applied in bringing in the well, and other factors.

The purpose of placing the test strips in the brine solution is to obtain a build up on the surface of the strips of the metals and other contaminants present in the brine so that as near as possible, conditions in the well will be duplicated. The immersion of the strips in the brine is continued for a predetermined time at the end of which period one of the strips is withdrawn, dried, and immersed in a portion of oil containing a small measured quantity of inhibitor. This period of time can be varied accord-

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ing to the nature of the brine being tested. I have found that from 2-15 minutes provides a sufficient period for the contaminants in the brine to build up on the metal surface. The importance in the period of time used is that oil test strips being utilized in the evaluation of inhibitors for a particular brine be subjected to the brine for the same period of time. It is also essential in obtaining comparative data that the amount of inhibitor added to the oil in each case be an equal amount. For test purposes, I have found that from 10 to 500 p. p. m. of inhibitor provides an adequate basis for a comparative determination when utilizing an ordinary or average brine solution. In the evaluation plotted in Figs. 2 and 3, as hereafter described, 200 p. p. m. of inhibitor were used.

The immersion of the test strip in the inhibited oil is similarly continued for a predetermined fixed period of time so that consistency in the comparative readings will be obtained. This period of time may be varied, but I have found that a period of from 2 to about 10 minutes is sufficient to obtain maximum adsorption of the inhibitor on the surface of the metal test strip. This strip on which the inhibitor has been adsorbed is thereafter removed from the inhibited oil solution and placed in the cell containing brine solution, wherein it becomes the negative pole of the galvanic cell. The other test strip, the one not subjected to inhibited oil, is removed from the brine solution and placed in the cell as the positive electrode. The electrodes or metal test strips are then connected to a potentiometer on which the measure of current generated in the cell is indicated. I have found that a reading in millivolts provides a convenient measure. To determine the adsorption number or reading the E. M. F. was measured each minute until a constant value was reached. This constant value is considered the adsorption evaluation number. As will be apparent by referring to Fig. 2, the value of this reading may be on the positive or negative side depending on whether the inhibited test strip is cathodic to the standard strip. As described hereafter, the values plotted in Fig. 3 indicate the adsorptive strength of the various inhibitors tested over the plotted period of time. When plus values of millivolts are obtained, the well fluid or brine is said to be non-corrosive to the tubing. This is due, of course, to the effective plating of the tube surface by the inhibitor.

The basis for this number, as indicated, is the measure of current generated by the test strips in the brine solution. In a normal electric circuit, if two similar metals are placed in an electrolyte, no current will be generated. However, if one of the electrodes is replaced with a dissimilar metal, a current will be generated and measurement of this current can be made. For example, if iron is used as one electrode and copper the other electrode of a simple circuit, e. g., the wet cell battery, the iron would be the positive pole and the copper would be the negative pole, i. e., the iron would become cathodic to the copper. If, however, the copper electrode were replaced by a noble metal electrode such as gold, the iron would then become anodic on the negative pole of the battery. This phenomenon, as is well known, is due to the relative position of those metals in the electro-motive force series of elements.

Since corrosion takes place in the negative pole of a galvanic cell, the noble metal would of course be inhibited or pacified. It has been found that when an iron strip, which would correspond to well tubing, is subjected to the action of crude oil from a known corrosive source the first action which can be observed is the formation of a very active metal surface. This activity is evidenced by the precipitation of copper from a copper salt solution by the metal surface. It is this actuation caused possibly by the destruction of a sulfide or oxide film on the metal by some minute constituent of the oil which I am measuring when negative values of potential are indicated on my electro-motive force measuring device. When the inhibitor plates out or adheres to the surface of the strip,

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it is similar to substituting a different metal in the E. M. F. series which has the effect of making the inhibited test strip cathodic to the blank and thereby providing a plus value for the current generated.

Such a change in the electrode is, in effect, what occurs when according to my test method, one of the electrodes is immersed in an inhibited oil solution. I have found that the plating of the inhibitor on the surface of the metallic test strip makes that test strip dissimilar to the other standard metallic test strip. The degree of dissimilarity of the strips effected by adsorption of inhibitor will be recorded as the measure of adsorptive power or effectiveness of the inhibitor used.

If the inhibitor being tested is of very weak adsorptive power in the presence of that particular brine, little if any of the inhibitor will cling or plate out on the surface of the metal test strip. Correspondingly little dissimilarity of the metal test strips will result and no current will be generated. On the other hand, if a heavy coating of inhibitor is present on the test strip, that is if the inhibitor being tested strongly adheres to the metal test strip surface, a minimum of the surface of the electrode will be exposed and considerable dissimilarity of the metals will exist, thus a comparatively high reading of voltage will be obtained on the potentiometer or galvanometer.

Readings of the generated current are taken at fixed intervals for all strips being tested. In any one test of an inhibitor several readings of E. M. F. generation are taken over a predetermined period of time. I have found that readings taken once a minute for 10 to 20 minutes generally provide an equilibrium reading as hereinafter described. I have found that my initial readings in substantially all evaluations made have a tendency to read high. This is, of course, due to the initial high adsorption of inhibitor to the metal surface which slowly decreases to an equilibrium value in a matter of a few minutes. It is this equilibrium value which I utilize in evaluating and selecting a particular inhibitor for a particular well.

This effect can readily be seen by referring to Fig. 2 and Fig. 3 in which the same inhibitors are tested in two wells from different areas. In these graphs, time is plotted against millivolts for the inhibitors stated in concentrations of 200 p. p. m. In Fig. 2, A #3 well was being treated with evaluation of inhibitors being carried out according to the method of my invention. It will be noted that initial adsorption was high with adsorption slowly decreasing to an equilibrium value after about 7 minutes for all inhibitors tested. It will be further apparent that under the conditions existing in A #3, the X-5 inhibitor would provide the best protection for the tube surface since at all times comparatively higher positive values of adsorptive strength were obtained for the X-5 inhibitor indicating that the corrosive fluids would be less effective in the presence of this inhibitor.

A similar effect will be observed in Fig. 3 in which the same inhibitors were evaluated at 200 p. p. m. for the C #6 well. An equilibrium in readings was obtained after approximately 8 minutes, with readings being taken once a minute for a period of 15 minutes.

A comparison of the results apparent in Figs. 2 and 3 indicates the importance of the evaluation provided by the method of my invention. Under conditions existing in A #3, inhibitor X-5 provided the best surface protection. However, in the C #6 well shown in Fig. 3, X-145 offered the best protection and consequently would be the best inhibitor to use in that well.

It will be apparent from the foregoing that the highest positive mean value for an inhibitor expressed in millivolts provides a basis for the selection of the inhibitor best suited for the well being treated. In Table I which follows a series of inhibitors were tested in the brines of the various wells described.

TABLE I

The effect of various inhibitors on oils from the "T" pool, "B" district

[All inhibitors used at 100 p. p. m.]

Inhibitor No.	Well "B" No. 1 Adsorption (mv.)	Well "D" No. 1 Adsorption (mv.)	Well "A" No. 4 Adsorption (mv.)
X-5.....	-20.8	+39.0	-6.2
X-120.....	-26.4	+26.0	-16.1
X-140.....	-47.2	+8.0	-43.4
C. I. 27.....	-20.8	+34.2	-7.1
X-145.....	-25.8	+27.6	-7.0

These data indicate the extent of variations in corrosion potential in several wells and the desirability of having a method of selectively determining the inhibitor best suited for a particular well. In "D" No. 1, X-5 provides the best protection since a positive value of 39 was obtained indicating that the well was not corrosive to X-5. However, in both the "B" No. 1 and "A" No. 4 wells, X-5 while providing the greatest amount of comparative protection did not provide in the quantity used the protection necessary to prevent corrosion of the well tubing.

In the treatment of "B" No. 1, inhibitors X-5 and C. I. 27 provided a -20.8 evaluation which when compared with the other inhibitors tested in the same well indicate that best protection will be offered by X-5 or C. I. 27. However, it is also to be noted that the well is still corrosive to the inhibitors since negative values were obtained. This may indicate that the inhibitors were not used in sufficient amount or that the corrosive strength of that well was so great that known inhibitors could not provide protection unless utilized in prohibitively expensive quantities. If additional amounts of inhibitor, for example, X-5 were added to the "B" No. 1 well a positive value would be obtained indicating that the well was no longer corrosive. The effect of the addition of increased amounts of an inhibitor to overcome the corrosive condition in a particular well will be evident from Table II which follows:

TABLE II

Adsorption of X-5 from various crude oils

Concentration of X-5 (p. p. m.)	"B" No. 1 Well Adsorption (mv.)	"D" No. 1 Well Adsorption (mv.)	"A" No. 4 Well Adsorption (mv.)
0.....	-47.0	+7.5	-43.4
25.....	-32.4	+20.0	-23.0
50.....	-26.2	+34.5	-15.0
100.....	-20.8	+39.0	-6.2
150.....		+42.0	+4.0

The data provided in Table II is further evidence of the importance of the adsorption values of the various inhibitors obtainable by my method of inhibitor evaluation. Comparing the effects recorded in the "B" No. 1 well and the "D" No. 1 well, it is clearly apparent that increasing the amount of inhibitor increases the amount of protection provided or conversely reduces the corrosive potential of the brine in that particular well.

The utilization of the method of evaluation herein described in addition to selecting the inhibitor best suited for a particular well will also provide a continuous measurement of the corrosive conditions in the well. If for example, a selected particular inhibitor had been placed into the well being treated and continued pumping operations carried on, experience has shown that the inhibitor's power of adsorption will in time be weakened.

This weakening or loss of strength of the inhibitor to adhere to the well tubing surface and provide the required protection may be due to changes in the corrosive strength of the fluids in the well or other factors not readily con-

trollable. Decrease in tube surface protection may also be due to inherent limitations in the inhibitor used. In any event, knowledge of the time at which this weakness begins to occur or the point at which the well again becomes corrosive to the tubing, is most desirable. If it is known at just what point the well after a treatment again requires further treatment continuous and effective protection can be provided by the addition of more inhibitor.

It is another important feature of this invention to provide a continuous measure of a well's corrosive potential, thus providing the precise time at which additional corrosion inhibitor must be added to the well to maintain the well in a most protected state.

The manner of obtaining such an indication is based on an application of my invention in which a plurality of metallic test strips are placed in the lead line of a wellhead. As pumping is carried out, the oil containing inhibitor is continuously passed across the metallic test strips. At predetermined intervals which may vary from a few hours to several days depending on the nature of the well being treated, one of the test strips is removed from the lead line and placed in my test cell with the value of the adsorptive strength of the inhibitor being determined according to the method previously described. If results obtained indicate a decrease in the adsorptive value, which in effect indicates desorption of inhibitor is occurring, the addition of more inhibitor will be required. The addition of more inhibitor at this time should return the well to a less corrosive state, providing an increase in the adsorption evaluation indicating that the tubing is being more effectively protected. This effect can be clearly seen by referring to Fig. 4.

In Fig. 4 is shown the adsorption and desorption cycle obtained with X-5 inhibitor in the "A" No. 7 well, in which the pumping cycles are plotted against corrosive potential of the well expressed in millivolts. A pumping cycle is equal to 30 minutes and this corresponds to 5 hours in a field well. At the end of each pumping cycle a metal test strip is removed and tested to determine the strength of adsorption of inhibitor, or as expressed in another manner, the amount of inhibitor present on the test strip. It is, of course, understood that the test strip corresponds to the well tubing surface in the well. It will be noted that after the addition of 200 p. p. m. of X-5 at the 4th pumping cycle the corrosive potential is reduced, that is, the inhibitor is being adsorbed and protecting the tube surface. At the 10th cycle, however, desorption of inhibitor has begun indicating that shortly thereafter a further treatment or addition of inhibitor will be required to maintain the well substantially immune to the corrosive fluids present in the well. Addition of inhibitor at such a time will maintain the well for an indefinite period with a high degree of protection against the corrosive fluids.

It will be apparent from the foregoing that according to the method described herein I have provided a simple and efficient method for evaluating corrosion inhibitors and for continuously measuring their effectiveness in preventing corrosion during pumping operations. The method described is relatively simple and can be carried out with a minimum equivalent at the wellhead in a manner not previously available.

What I claim is:

1. A method for determining change in corrosivity and controlling the same in producing oil wells which comprises withdrawing a portion of an oil-brine mixture from the well, placing the withdrawn oil-brine mixture in a container and immersing therein a standard metallic test strip having a composition similar to the composition of well equipment metals, said strip having previously been treated to remove surface contaminants, permitting the standard test strip to remain in said oil-brine mixture for a period of time sufficient to obtain build-up of well contaminants on said strip, immersing a plurality

of like metal test strips into the withdrawal line of the well during withdrawal of the oil-brine mixture, periodically removing one of the plurality of immersed metal test strips from the oil-brine mixture draw-off line, immersing said strip in a portion of well brine contained in the cell of a galvanic circuit, said circuit including a device adapted to indicate E. M. F. generation in the cell, utilizing the metallic test strip removed from the draw-off line as the cathodic terminal of said galvanic circuit, utilizing the standard metallic test strip as the anodic terminal of said circuit, measuring at predetermined intervals the amount of E. M. F. generated in said cell until an equilibrium E. M. F. value is obtained, said valve representing the corrosive condition of the well, and adding corrosion inhibitor to the well as subsequently determined equilibrium values become increasingly negative.

2. A continuous method of determining change in corrosivity and controlling oil well corrosion which comprises withdrawing a portion of an oil-brine mixture from a producing well, placing the withdrawn brine in a container and immersing therein a standard metal test strip, said strip being of a composition similar to the composition of well metals, allowing said test strip to remain in the brine for a period of time sufficient to obtain build-up of well contaminants on said strip, introducing a quantity of corrosion inhibitor into said well, circulating said inhibitor in the well, withdrawing an oil-brine mixture from the well, maintaining a plurality of metal test strips similar to the standard test strip in a draw-off line of a producing well, said strips being positioned to be in contact with oil-brine mixture during withdrawal of the oil-brine mixture, removing one of the plurality of test strips from the draw-off line, immersing said strip

in a portion of well brine contained in the cell of a galvanic circuit, said circuit including a device adapted to indicate generation of E. M. F. in the cell utilizing the withdrawn oil-brine mixture as an electrolyte, utilizing the strip removed from the well draw-off line as the cathodic terminal of said galvanic circuit, withdrawing the standard test strip from the original brine immersion step, and immersing said standard strip in the brine contained in the cell, utilizing said strip as the anodic terminal of said circuit, measuring at fixed predetermined intervals E. M. F. generated in said well until an equilibrium value of generated E. M. F. is obtained, utilizing this value as a measure of well corrosivity at the time of withdrawal of the test strip from the draw-off line, repeating at predetermined intervals the removal of a test strip from the withdrawal line, and determining an equilibrium value for each test strip withdrawn, the difference in values for the initially and subsequently withdrawn test strips being an indication of the change in well corrosivity, and adding additional corrosion inhibitor in proportion to the indicated increase in corrosivity.

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