Baked-On Plastic Coatings

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ABSTRACT

This paper describes how baked-on coatings are being employed as economical corrosion and paraffin control devices in the Permian Basin area. To illustrate and explain the influence of "Quality Assurance" upon the economics which support having tubular goods coated, a string of tubing is followed through a baked-on coating process. It is concluded that the economics favoring baked-on coatings are no stronger than is the coating process.

INTRODUCTION

For the economical control of corrosion and paraffin deposition an estimated 20 million ft of Baked-on Plastic Coated tubular goods have been used in the Permian Basin during the last four years. The economics upon which the decision is based to plastic coat are no stronger than the coating applicator's ability to produce coated tubular goods, incorporating the assurance that the product is of top quality. It is the responsibility of the applicator to offer coatings that can cope with the chemical and physical environments peculiar to the oil industry and incorporate into his coating process measures that will result in the very best coating for the dollar spent. On the other hand, it becomes the responsibility of the user to select the coatings, not from a generical name, but from the ability of the applicator to provide the proper type of coating applied in such a manner that "Quality Assurance" is guaranteed. Only upon this premise can the user have his tubular goods coated with a baked-on plastic coating and be confident of the supporting economics. If he is to capitalize fully upon the economics of Baked-on Coatings, an operator cannot be satisfied with mere quality control but must have "Quality Assurance".

TYPICAL ECONOMIC APPLICATIONS OF BAKED-ON PLASTIC COATINGS IN THE PERMIAN BASIN

Gas Producing Wells

Baked coatings have found wide acceptance as effective and economical downhole corrosion control devices in the following gas fields: Emperor Field, Winkler County; Crawar Field, Ward County; Puckett Field, Pecos County, and Brown/Bassett Field, Terrell County. And recent developments and the marketing of a new high temperature (400 degree) coating will in the future, offer even more support to the economics of coating the tubing in the gas producing wells in these fields

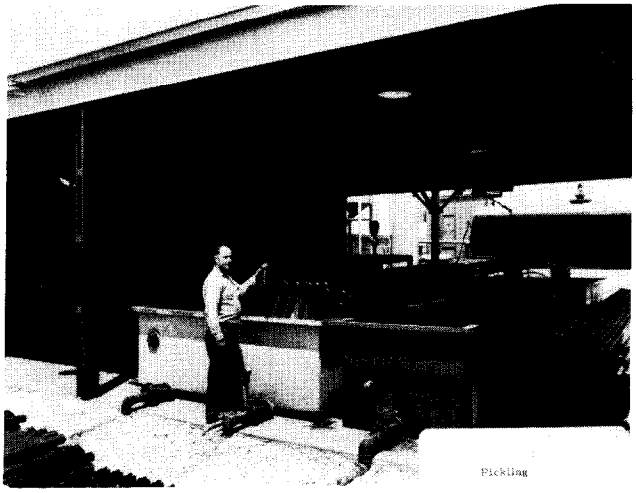

Fig. 1 Pickling

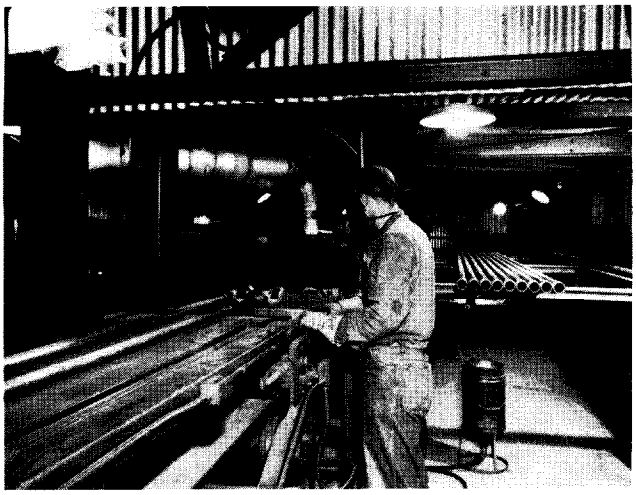

Fig. 2 Blasting

Gas Lift Wells

Baked-on coatings are being used extensively for both corrosion and paraffin control in gas-lift wells. For example, in the Headlee Field, Ector County, Texas, baked-on plastic coating of the tubing has proved to be the difference between successfully producing vs abandoning many of the wells. Further, in the Bakke Field, Andrews County, one operator has recently completed a gas lift installation program to include coating, for paraffin control, the top 2500 ft of tubing in each producing well. The economics were based upon savings resulting from the elimination of paraffin scraping and improved efficiency of gas lift equipment.

Oil Producing Wells (Flowing and Pumping)

The application of coatings for downhole paraffin control in flowing wells has become common place as the pay-out is often time less than six months (usually coating the top 1500-2500 ft of the tubing string). In many of the more severe paraffin problem fields some operators are realizing a money savings by coating the tubing and/or rods in pumping wells, while coating for corrosion control has been found economical in a few fields producing highly sour crude.

Specialized Applications:

1. Multiple Completions: Because of the producing problems and work-over costs peculiar to multi-completed wells, baked-on coated tubular goods for corrosion and/or paraffin control are being used

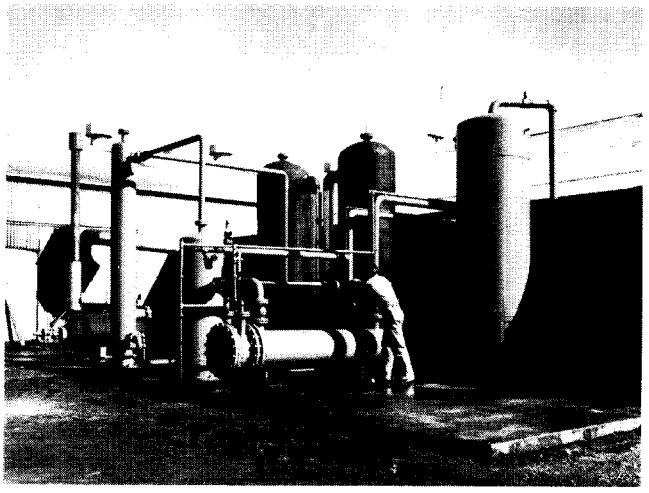

Fig. 3 Air Dehydration

extensively. Problems associated with down-hole injection of inhibitors, paraffin problems in smaller ID tubing, and deliverability, all favor the use of baked-on coatings.

2. Consolidated and Automation Projects: The consolidation of tank batteries and centralization of treating facilities necessitate the laying or utilizing of long flow and gathering lines handling paraffin based oils and corrosive waters. The maintenance or replacement of this equipment may well determine the economic success or failure of a project and the effectiveness of automation equipment. Baked-on coatings find a natural application in these types of situations.
3. Salt Water Disposal Systems: These systems provide the oil operator with no revenue; however, if they are not properly designed and protected against corrosion attack, they will dig even deeper into the oil and gas profits. Baked-on coatings here again are doing their intended job of saving the operator money.
4. Water Flood Installations: In conjunction with water flood operations, baked-on plastic coatings are finding, in the Permian Basin, their largest application as downhole corrosion control devices on water source and injection well tubing. The volume of water being handled and its corrosion potential demand that the very best corrosion control methods be employed less the economic success of a project be jeopardized. When an operator is considering his downhole corrosion protection program most influential are the following factors: depth of the zone to be flooded, type of water to be used, water injection rates, water injection pressures, life of the flood, characteristics of the reservoir, and injection well tubing program. With the above factors as major considerations over 95 per cent of the Permian Basin water flood operators are using baked-on plastic coating on their downhole injection well tubing. The economics are based upon the following:
   a. Used tubing can be coated and permit an operator to utilize tubing pulled from converted producing wells.
   b. Water flooding depths and pressures constitute no operational problems for coatings.
   c. Water injection rates are improved by coatings.
   d. Baked-on coatings eliminate the necessity for large volumes of inhibitors which can plug and contaminate some reservoirs.
   e. The long life of baked coatings are ideally suited to water flood operations.
   f. Injection well work-overs and normal acid treatments can be routinely performed with no damage to the baked coating.
   g. Baked-on coated tubular goods have a salvage value when the water flood is depleted.

THE SIGNIFICANCE OF "QUALITY ASSURANCE" WHEN CONSIDERING THE ECONOMICS OF BAKED - ON PLASTIC COATINGS

To illustrate and explain the importance of product "Quality Assurance", a typical string of tubing will be traced through a baked-on plastic coating plant and each of the "Quality Assurance" measures and their respective effect on the end product will be described in regards to a tubing string which is to be coated the following will be assumed: the tubing has been pulled from a producing well which is being converted to a water injection well; the tubing is 2 in. 8 rd. EUE (used); and the tubing is to be coated for protection vs the corrosive effects of a sour brine water being used to water flood a 7000 ft reservoir:

Receipt of tubing

Upon receipt of the tubing in the applicator's yard it is visually inspected for any evidence of damaged threads and for determination of its general condition. Tubes unsuitable for coating because of bent or mashed joints are so marked and set aside.

Pickling of Tubing

The tubing is routed to the pickle department where:

a. Thread protectors are removed, cleaned, degreased, oiled.
b. Collars are bucked off, and the excessive thread dope washed from the threads.
c. The collars are directed to the custom shop for cleaning and coating.
d. The pipe is immersed (50 joints at a time) into a boiling caustic solution where oil and paraffin and other organic materials including mill varnish is removed.
e. The pipe is then thoroughly rinsed in a fresh water.
f. After rinsing, the pipe is immersed in a Hydrocaloric acid solution of about 18 per cent - 21 per cent inhibited HCl. This solution will remove both all normal metallic oxides and mill scale.
g. The pipe is then removed from the acid, rinsed again

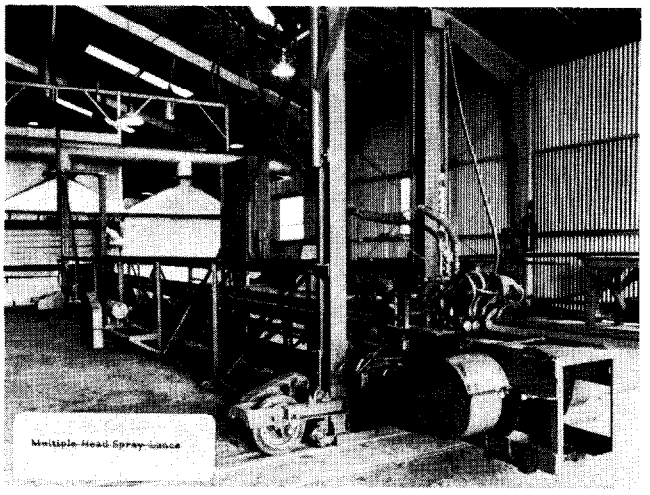

Fig. 4 Automatic Spray Carriage

in the fresh water, and placed on drying racks leading to the blast room.

Drying and Blasting

After pickling, the pipe is blown dry with compressed air and inspected to insure that there is no residue or scale or grease of any kind. Also, threads are masked to prevent damage, and the tubes are rolled into the blast cabinet four at a time. Inside the cabinet the tubes are rotated at a constant speed while a blast lance travels through the tubes. Forced by air at 100 psi, a flint abrasive material is fed through the lances. The flint is impinged on the interior surface of the tube at a 36 degree angle and through a small orifice. Meanwhile, the lances are moved back and forth as many times as are necessary to produce a white metal blasted surface. The pipe is then rolled out of the cabinet, blown free of flint residue, and moved to the coating priming area.

The cleaning and surface preparation thus far described is most important, for coatings will not bond to steel surfaces blotted with paraffin, mill scale, oils, etc. The flint abrasive blast also provides an anchor pattern for the coating, and insures maximum surface area upon which the coating can bond.

As previously mentioned, after pickling, the tubing is blown dry with compressed air, and, inside the blast house, air is used to force the flint abrasive against the inside of the pipe. After blasting, air is used to blow the flint residue free from inside each joint. Later it will be seen how air is used to atomize the plastic resin in the coating application proper.

A very significant "Quality Assurance" measure is the operation of the air drying system which serves to furnish a clean, dry, oil free air supply (Fig. 3). The system employs two dehydrators: one is regenerated while the other is on the line. This system serves to eliminate the possibility of compressor oil residue contaminating the blasting sand or being left on a supposedly adequately blasted surface interfering with the bond of the following prime coat. Further, a moisture problem which has the same adverse effect on blasting and coating is eliminated.

Inspection and Prime Coating

After blasting, the pipe is moved to the prime department where it is jarred hard several times and blown out again. Each joint is inspected for blasting efficiency, anchor pattern, and coating suitability. Those joints which pass this inspection are given a prime coat, reinspected

Fig. 5 Automatic Spray Guns

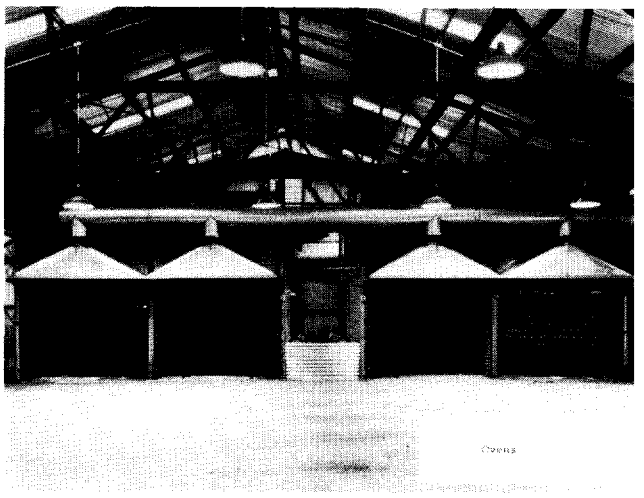

Fig. 6 Bake Ovens

and placed on oven carts. Since the string of tubing being coated is used tubing it becomes very important that each joint be closely inspected for coating suitability. The economics favoring coating the string are dependent upon the coating being applied only to those joints suitable for coating, for, should joints unsuitable for coating be coated, then the water flood operator is spending money for coating that will not serve to protect the pipe, plus jeopardizing the workability of the good coated joints. Thus, when an applicator rejects tubing as unsuitable for coating it represents a cost to all parties; however, to compromise good coating standards in this manner would serve to defeat a major service performed by the baked-on plastic coating industry.

Coating

The tubing is racked on oven carts, and the ends of the pipe are covered to keep foreign material from getting into the tubes. The cart is then positioned in the oven, and the spray application begins. The coating material has been mixed, checked for viscosity, measured into the pressure pot and mounted on the Automatic Spray Carriage (Fig. 4). All spray guns are automatic in actual operation, and the operator positions the guns in front of the tubes and pushes a button. The gun starts spraying, goes through the tube, stops, starts spraying again, comes back out through the tube, and stops. As a product "Quality Assurance" measure, the following is done before any pass is started: all spray guns are checked for fluid ounces per minute; each is centered; each is checked for 360 degree spray pattern; and each is checked for atomization and rate of gun travel (33 ft/10 sec).

All guns have individual fluid regulators controlling fluid flow from the main coating storage pot, and super-dry clean air serves to atomize the material on the tubing (Fig. 5). Three test joints, belonging to the applicator, are placed in the lower left corner of the oven load, and the spray passes begin in the upper right corner of the oven. During the pass the coating is inspected for runs, and the guns if required are re-adjusted. Then, after a pass (complete cart load) is completed, the disappearance of coating from the storage pot is noted and marked on the bake sheet. Also, after each pass, the cart is inspected for runs, and the ends of the tubing dressed. A series of such passes are applied and at intervals a "set-up" bake performed. This bake drives out solvents and sets up the coating film so that more coating may be applied. Enough passes are made to build up a film thickness in the 6-7 mil range, and,

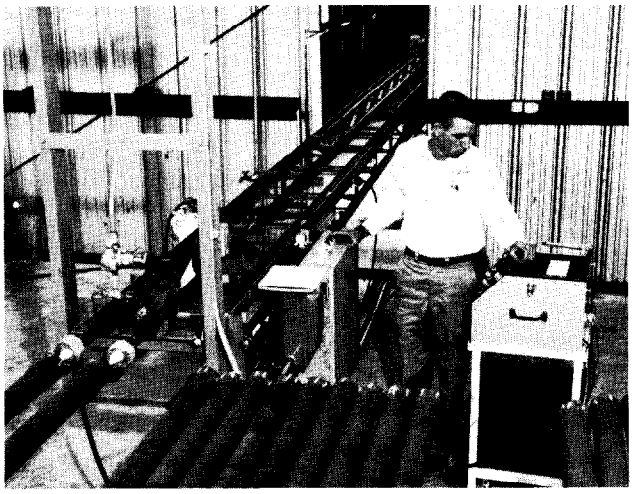

Fig. 7 Holiday Detector Installation

when this thickness is attained, the cart is inspected and the following checks performed: Actual volume of material used vs theoretical volume required, micrometer recordings of film thickness of coatings peeled from tapes on the test joints, mikrotest gauge measurements and random holiday testing for quality of applied coating. Finally, if the cart load of tubing is up to standard then the oven doors are closed and the final bake performed (Fig. 6).

It is assumed that our 2 in. tubing has been coated for corrosion control. As mentioned, the true economics of coating are tied directly to those techniques and procedures which result in product "Quality Assurance." A detailed description of those techniques as they serve to control film thickness are as follows:

a. One control of thickness is in the volume of coating material consumed. Made is a correlation between volume of coating actually consumed, linear ft of gun travel, and ID of the tubes being coated versus theoretical volume required.
b. Another control is by the three test joints on each cart in every oven load processed. Each test joint is in two pieces, coupled together in the center of the cart. Three tapes are placed in the front, center, and rear of each joint for a total of nine tapes per test joint. Before the final bake, these tapes are pulled, and the coating is peeled from the tapes and measured with a micrometer. The readings from the front tapes are averaged, as are those from the center and rear. This is a measurement of uniformity of film thickness full length and circumferential.
c. Twenty joints are selected in each cart and, by using a mikrotest gauge, readings are taken at four points in each end of each joint. These average readings are then compared to the micrometer readings and the calculated thickness.
d. By using a Plasticheck instrument before the final bake, 20 per cent of the joints in the oven are tested for holidays.

Coating for corrosion control, when the tubing is going into water handling service, places a premium on film coverage, and all four of the controls and measurements outlined above are directed to this end. All ovens are carefully controlled, and the temperature is brought up slowly and maintained, by a recorder-controller, at the desired temperature. Set up bakes are performed at a lower temperature and for a lesser period of time than is the final bake. The function of this set up bake is merely to dry out the wet film — no polymerization takes place, while the final bake serves to cure or polymerize the entire film from steel to surface.

Holiday Checking

After the cart is pulled out of the oven the joints are unloaded onto the holiday checking racks. A holiday, as referred to when speaking of plastic coated pipe, consists of a void in the plastic and one that exposes a small area of the inner pipe wall. These defects are normally detected by inserting a sponge — saturated with a saline solution — inside the coated pipe, and measuring the electrical resistance between the sponge and the pipe. Every joint is inspected, and those that pass are sent to the yard while those that do not pass are inspected to determine the practicality of re-work. Holiday checking constitutes the final step in the "Quality Assurance".

With all the links tied together the water flood operator is now assured of receiving the best downhole corrosion control coating for the money, and is satisfied that the economics which he used to support downhole baked-on coatings have not been jeopardized but strengthened by the coating process followed.

CONCLUSION

The economics associated with the use of baked plastic coatings in the oil industry are dependent upon the "Quality Assurance" measures incorporated into the baked-on coating application procedure. For this reason coatings cannot be selected strictly upon a common generical name and applicable price. It is mandatory that consideration be given to the ability of the applicator to provide the proper type of coating in such a manner that "Quality Assurance" is guaranteed.

ACKNOWLEDGMENT

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