HDPE TUBING IN ROD PUMPED WELLS

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Abstract

Production tubing string failure and rod failure contribute significantly to the lifting cost of some wells produced by rod pumping and in some instances, may even be a determining factor in the decision to discontinue producing a well.

This paper deals with the design, installation and field testing of a polyethylene liner for production strings in rod pumped wells. The paper reviews the causes of rod and tubing failure in production strings of wells produced by rod pumping, suggests polyethylene lining as a possible solution for those failures, and provides details, through a case history, of the results of field testing.

Introduction

High density polyethylene has been successfully utilized as a liner for corrosion control in piping systems for more than twenty years and more recently, as a liner for corrosion control in tubing utilized for water injection. In January, 1994, a field test was devised to test the viability of high density polyethylene liners in production tubing strings of wells produced by rod pumping where frequent failures of tubing joints and/or rods and rod couplings add significantly to a well's operating cost. High expectations for success were due to the extraordinarily high abrasion resistance of HDPE and extraordinarily low coefficient of friction of HDPE when its surface is wetted with oil and water.

Causes of Tubing & Rod Failure in Rod Pumped Wells

The causes of failures in tubing and rod strings in rod pumped wells are well documented. They are generally accepted to be: corrosion, well bore deviation, design of rod string, well depth, operating procedures, rod and rod coupling handling, and produced solids. Obviously, in a given well, several of these causes may come into play. While there are several potential solutions for each of these problems, HDPE tubing liners for production strings can mitigate the damage created by most of them.

HDPE Liner and Joint

The liners tested in production tubing strings are high density polyethylene as defined by the Plastic Pipe Institute's specification PE 3408, almost identical to the material commonly used in "poly pipe". The liner is extruded to an outside diameter dimension greater than the ID of the tubing to be lined. It is fed through a "reduction machine" which rolls the polyethylene down to a smaller OD and feeds the reduced OD liner into the tubing with approximately eight inches extending beyond each end. The lined tubing is stored on a rack for a minimum of 24 hours to allow the liner to expand against the

tubing wall. The ends are trimmed to a specific length and, utilizing an infrared oven and a hydraulic mold, the excess liner material is formed across the ends of the tubing pins. A small amount of polyethylene is milled out of each end, and a polyethylene insert with the same ID as the liner is installed into the pin which will accommodate the coupling. This insert extends beyond the pin such that when the pin of the adjoining joint is screwed into the coupling, the insert slides into the milled out area of the adjoining pin, thus providing "top to bottom" polyethylene surface for the rods and rod boxes to work against. The insert forms an "annular area" with the wall of the coupling and this area is filled (in the plant) with an acrylic compound which protects the threads in the "J" section. This material is a putty like material which does not harden and can therefore accommodate thread wear.

Conditions of the Field Tests

In late 1993 a plan was drawn up to test polyethylene lined production tubing strings in a portion of the Yates field. The test was located in a part of the field where rod wear and corrosion (due to produced CO_2 and H_2S) caused frequent tubing and rod failures. An evaluation of the prior failures in that area of the field indicated that the tubing failures were divided about equally between splits due to rod wear and to deep pits from corrosion. The initial test string was run February 5, 1994, in a well that had experienced more than two tubing failures per year. The tubing string was 3 1/2" condition five (red band) tubing, the pump utilized was a 2 3/4" tubing pump run at a depth of 1439'. In order for the test results to provide a meaningful comparison to prior operating results of the well, no changes in operation were made except for changing the tubing string to polyethylene lined. Pump stroke length, unit speed, pump diameter and pumping cycle (24 hours) remained constant (see figure one for design and operating conditions).

In June, 1995, a second field test for utilizing polyethylene lined tubing in rod pumped wells was arranged with a major oil company in the Howard Glasscock Field near Forsan, Tx. This well was experiencing an average of two plus failures per year due to rod wear and corrosion. The tubing string was 2 7/8" red band tubing, the pump was an 1 3/4" tubing pump set at a depth of 3154'. Operating conditions remained constant (see figure one for design and operating conditions) and no rod guides were utilized. Since the initial test string, an additional twenty two strings of polyethylene lined tubing have been run in wells in the Howard Glasscock Field.

Results of the Field Test

In the Yates field an additional eight wells were equipped with polyethylene lined tubing, and there have been no tubing failures in any of the wells with lined tubing. The longest run time for a poly lined production string is 32 months. Two of the wells are no longer producing due to uneconomic GOR & WOR. Of the remaining wells, three have had reduced corrosion chemical treatments and two others have had corrosion chemical entirely cut off. Comparison of rod failure frequency before and after installing a polyethylene liner indicates the potential for a reduction in rod failure rates related to wear on rods and couplings.

Testing of wells before and after installing polyethylene lined production strings indicates a reduction in peak polished rod loading of 15 to 20% due to the reduction in forces related to rod drag.

In the Howard Glasscock field there have been no corrosion or rod wear tubing failures in the production strings of the wells with polyethylene lined tubing. The longest run, to date, is eighteen months. Rod failure rates indicate that rod string failures have also been reduced.

Due to the success of the initial test wells, more than seventy polyethylene lined tubing strings have been run in rod pumped wells by fourteen producers. To date there have been no tubing failures due to rod wear or corrosion and rod string failures have been significantly reduced. These wells range in depth from 1,500 feet to 9,000 feet. Ten wells have partial strings, the bottom one thousand to fifteen hundred feet, and one installation is in the "curved" one thousand feet of a horizontal well.

Summary of Advantages of the HDPE Liner

- Extended life of tubing strings
- Utilize lower grade of tubing for production strings
- Extended life of rod strings
- Forces related to rod drag reduced - peak polished rod load reduced
- Workover costs reduced
- Reduced well down time
- Potential of reduced paraffin deposition due to low anchor pattern and insulating qualities of HDPE
- Potential of reduced corrosion inhibitor injection

Conclusions

Polyethylene liners reduce the ID of the tubing lined such that careful consideration must be given to the design of the production tubing string, rod string, and the selection of the size and type pump. However, within the boundaries imposed by these considerations, polyethylene lined tubing can prove to be a long term, cost effective solution to production tubing and rod string failures in rod pumped wells.

Field Test	Run Date	Oil	Water	Gas	Pump Type	Depth of Pump	Failure
#1	Feb. 4, 1994	9 BOPD	923 BWPD	5 Mscf/d	TBG	1,438 ft.	2.10
#2	June 1, 1995	23 BOPD	219 BWPD	1 Mscf/d	TBG	3,158 ft.	2.50

Figure 1 - HDPE Lined Tubing in Rod Pumped Wells