USING COATINGS TO IMPROVE ESP WELL PERFORMANCE

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ABSTRACT

Coatings of various materials are used to improve corrosion, abrasion and scaling resistance of ESP components. This paper will briefly discuss some of the coatings with a focus on Teflon and it's potential to increase run time. A specific application will be discussed in detail. A completely coated pump was run between uncoated pumps in a New Mexico well that produces significant solids. The well was pulled after a 224-day run and all pumps torn down and examined. This paper will review the findings of the tear down and implications for future Teflon coating applications and tests.

INTRODUCTION

Coatings are used to minimize corrosion, resist abrasion and prevent solids build up on ESP components. This paper will address only internal coatings and not external housing coatings. Coatings are targeted towards different problems. High sand production that erodes diffusers and impellers is combated with a hard coating. Applications would be primarily in areas of sand and sandstone type reservoirs. In the Permian Basin, most production is from dolomite, limestone and other hard rock.

Water produced from these wells often contains compounds that precipitate out of solution and onto artificial lift equipment, tubing and other production components. These solids can be generally categorized as scales. Internal coatings can reduce scale build up on sub pump components such as impellers, diffusers and intakes. These coatings provide a slick surface that offers a less attractive surface for bonding.

Iron Sulfide is another solid produced in some areas of the Permian Basin. It is a product of iron in the water and sour gas that originates in the producing formation. It has a tendency to adhere and build up within pumps restricting fluid flow, increasing friction and causing wear that reduces run time. Teflon is the latest coating being tested to potentially combat this problem. A slick coating is required to minimize the bonding tendency between the pump and the iron sulfide. The Indian Basin and Dagger Draw regions of southeast New Mexico are particularly prolific iron sulfide producers. A specific test application of the Teflon coating will be discussed later.

COATINGS

Coatings have historically been used to protect the impeller vanes from erosion wear associated with abrasives. This practice is still successfully applied. There are a variety of coating materials available. Sand is the primary abrasive related to this wear. A hard coating is applied to the impeller and diffuser so that the sand blasting effect is minimized or eliminated. Only those areas of the pump exposed to high velocity fluid need to be coated or treated.

ESP's in wells characterized by scales and iron sulfides require a much different coating. A smooth coating surface is needed to discourage the bonding between scale and the equipment. Here is where Teflon may find an application. Metals used in artificial lift components and other oilfield applications attract these solids because of the nature of metal surfaces. While these surfaces appear smooth to the naked eye, they are actually very rough on a microscopic level. Rougher surfaces have a greater surface area providing more locations for scales and iron sulfides to attach themselves. **As** solids attach to metal surfaces, they may cause impeller vanes to plug, friction and wear to increase and impellers to seize to the shaft. A smooth, slick surface like that of a Teflon coating can significantly reduce the bonding opportunities of scales and iron sulfide. Solids can be passed through the pump leaving the pump cleaner and enhancing run life.

THE TEST

A test was performed to see what benefits might be derived from Teflon coating. An ESP unit was installed with four different pumps. The pumps run on top and the pump on bottom were uncoated, floater type pumps. The center pump had a Teflon coating on all impellers, diffusers, miscellaneous parts as well as the pump shaft. The pump shaft was coated to prevent iron sulfide build up that would result in premature thrust wear when impellers seized to the shaft. The pump was

coated with Teflon as completely as possible. The unit was installed in a New Mexico well.

THE WELL

The well was drilled and cased to a depth of 8200 ft. A window was cut in the casing and a lateral was drilled in the producing interval. The ESP unit was set above the window because of insufficient space below the lateral. The well initially produced *950* bfpd with a GLR of I300 and gradually decline below the operating range of the unit. The well was later converted to sucker rod pump.

PUMP CONSTRUCTION

A special approach was required to coat all pump components with Teflon. Coating the impellers and diffusers is simple. They were sent to a vendor for Teflon coating. Several other miscellaneous parts were also sent along with the impellers and diffusers. Coating the shaft is a more complex problem. Tolerance issues must be addressed for impellers to fit on a coated shaft. The impellers, while keyed to the shaft via a key-stock, are allowed to float up and down in a floater type pump. The thrust generated from the impellers is transferred to the diffusers, then the pump housing, onto the tubing and ultimately to the wellhead.

The shaft was sent for coating with a key-stock'in the key-stock slot. Once the shaft was coated, the key-stock was replaced with an uncoated, monel key-stock for clearance reasons. The impeller hubs had to be bored-out allowing additional room to accommodate the coating on the shaft and the coating on the impeller hub. A clearance of 5 thousands of an inch is required above the shaft outside diameter including the coating. The shaft diameter was measured before coating and after coating so that the Teflon thickness could be determined. Limitations existed in coating the shaft. Finding a Teflon coating vendor with an oven long enough to handle pump shafts proved challenging. At present, the largest oven will only handle a 12-foot long shaft. There are indications that longer ovens are in the plans of at least one Teflon coating vendor so longer shafts may be coated in the near future.

The pump was assembled and tested on a pump bench prior to coating. It was then disassembled, all components sent to the vendor for coating and the pump re-assembled and tested again. The pump efficiency from the test with the pump coated was higher than that of the uncoated test.

RESULTS

The test sub pump ran for 224 days and was pulled from the well for low production. The well was naturally depleting and the unit had been cycling due to gas and low fluid level. Paraffin mixed with iron sulfide was found in ***82*** joints of tubing. The lower pump was locked up. It was not coated. The remaining three pumps turned free. The motor and seals were good.

The three free turning pumps were tom down. The first uncoated pump had a large amount of solids present with roughly 50% of the stages 25% plugged. The solids were a mixture of iron sulfide, calcium sulfate and hydrocarbons. The impellers were stuck to the shaft unable to float. Evidence also suggested that the impellers were trying to seize in the diffusers due to scale buildup. Down thrust wear on the stages varied from light to moderate. The other uncoated pump also contained a significant amount of solids and exhibited down thrust wear on the stages. Photos of these stages can be seen at the end of this paper.

The coated pump looked considerably better than its uncoated counterparts. Some solids were present, but much less than with the uncoated pumps. There was a minimal amount of down thrust wear observed and the impellers were not stuck to the shaft. The Teflon was still intact throughout the pump except on the shaft where the head and base bushing are located. Overall, the condition of the pump looked good especially when compared to the two uncoated pumps. Pictures of the stages taken from the coated pump are at the end of this paper.

CONCLUSIONS

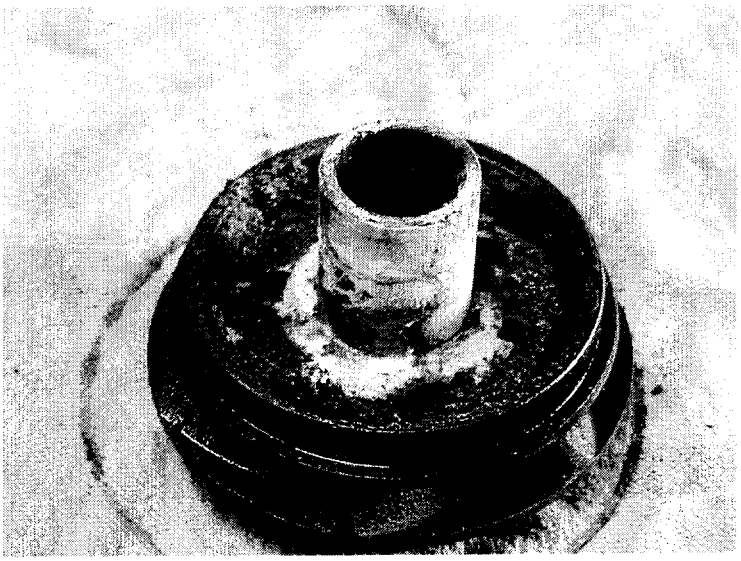
Indications/considerations based on this test are:

- Teflon coating of all pump components can reduce solids buildup in wells with scale and iron sulfide deposition.
- Longer run times can be expected from sub pumps coated with Teflon especially in wells that produce iron sulfide and scale.
- It is essential that the pump be completely coated because the fine particles of iron sulfide can get between

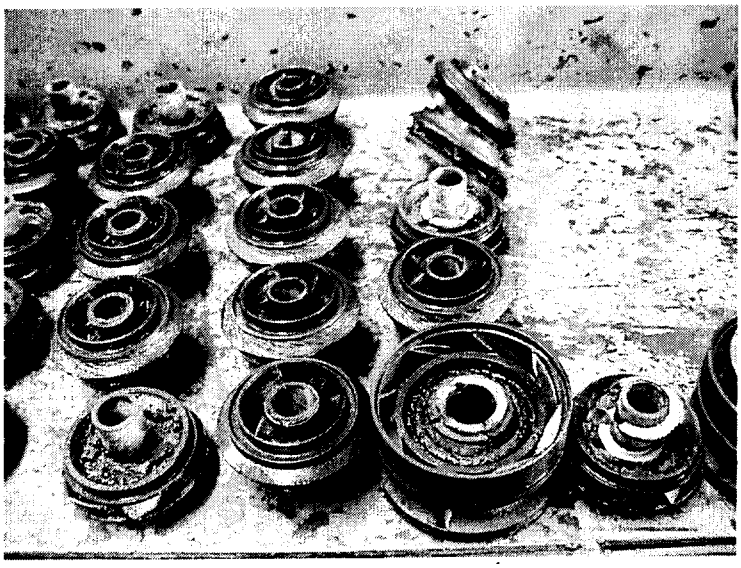
the shaft and the impellers.

- Uncoated metals experience more solids buildup than Teflon coated components.
- Special considerations have to be made to accommodate the coating thickness on the shaft and inside the impeller hub.

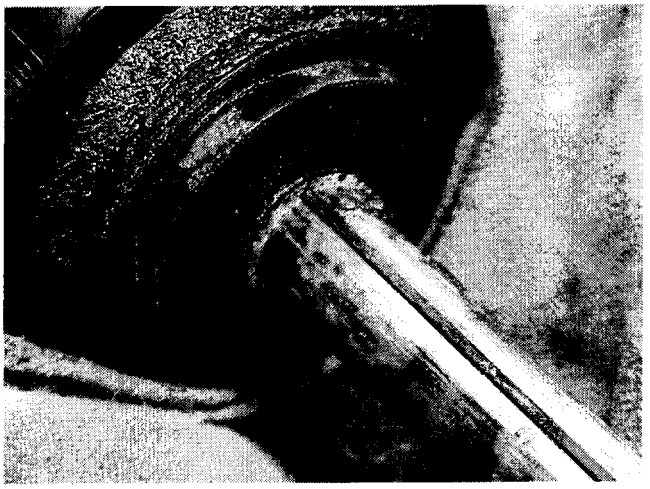
Other tests are planned in the future.



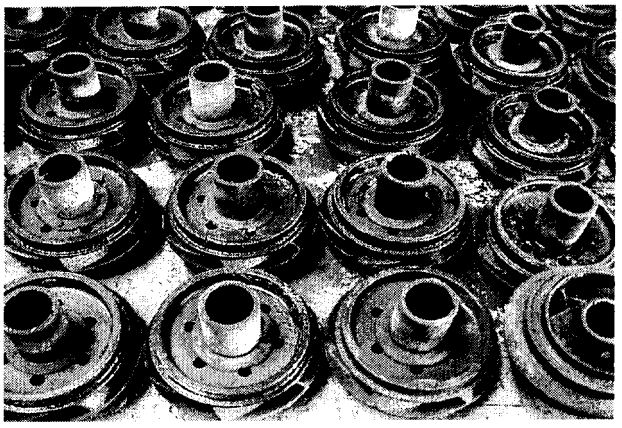
Impeller From Uncoated Pump With Substantial Solids Buildup



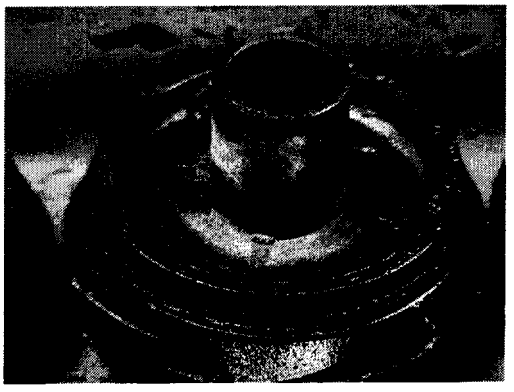
Stages From Uncoated Pumps With Solids Buildup



Impeller Stuck To Shaft Of Uncoated Pump



Clean Stages From Coated Pump



Impeller From Coated Pump In Good Condition