CHEMICAL APPLICATIONS OF CORROSION INHIBITORS FOR IMPROVED HYDRAULIC PUMP PERFORMANCE*

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ABSTRACT

The hydraulic pump is a highly sophisticated means of artificial lift which has grown in popularity in recent years. This popularity combined with usage in diversified production fluids has led to several production problems that are very expensive to the operator. Though mechanical devices have been developed to limit production fluid problems, other corrosion causing problems in production fluids must be controlled by other means. The chemical industry is quite involved in research and product testing to aid in combating these outside problems. Chemicals are on today's market that will greatly aid in hydraulic pump performance, particularly if the proper analytical data, product selection, and application procedures are used.

The recent emphasis on energy has led to increased drilling programs throughout the entire oil-producing world. With it the demand for lifting equipment has also increased, and various lifting methods have grown in popularity and practicality. The hydraulic power fluid pumping method is one such means of lifting that has grown tremendously in recent years. The advent of a smaller power fluid vessel combined with individual triplex operations have made this a more common source of artificial lift. Also, developments in pump and triplex design have led to better production figures in all types of production fluids. This ability to pump diversified production fluids has caused many problems that are extremely expensive to the operator.

To anticipate possible problems that can occur from the production, fluids can be evaluated by professional technicians who provide expert water and crude oil analysis. Experience from field testing hydraulic pumps and triplex failures has led to valuable information regarding potential operating setbacks. Essentially, from the background we have, the problems evaluated can be categorized as (1) nonorganic compound problems, (2) organic- and gas-related problems, and (3) mechanical problems.

To alleviate these problems in hydraulic systems, much chemical research and field testing has been conducted to aid in reducing the adverse effects of produced fluid on hydraulic pumps. Several products on today's chemical market can greatly enhance hydraulic pump operations, particularly if the proper testing procedures and product selections are made. Taking into account the research and technology in this area, we will now offer information on the areas where chemical application has been beneficial to hydraulic pump efficiency.

NONORGANIC-RELATED PROBLEMS

Production fluids in every well contain some quantity of material that can be classified as solids. Normally these solids are drilling mud (evidenced for periods immediately after completion), sand, salt, scale and gyp formations, and iron sulfide. Separately or in any combination these solids can cause severe damage to hydraulic pump systems. Mud, sand, salt, and iron sulfide usually contribute to problems incurred at the power triplex. On the other hand, scale and gyp and iron sulfide generate most pump problems.

At this point we will cover the triplex problems caused by these solids. Plunger and liner scalding occurs when substantial amounts of solids are pumped under high pressure in the power source fluid. Mechanical means for solids extraction have been designed and are called cyclones. They are

*This paper complements "Effective Application of a Corrosion Inhibitor for Rod-Pumping Oil Wells" by Bob Sevin.

FIGURE 1—SOLVENT EXTRACTED SOLIDS. CYCLONE INLET. SAND GRAINS. 100 TO 400 MICRONS = 20%, 20 TO 100 MICRONS = 70%, LESS THAN 20 MICRONS = 10%. TOTAL SUSPENDED SOLIDS CONTENT = 96 POUNDS PER 1,000 BARRELS. MICROPHOTOGRAPH.

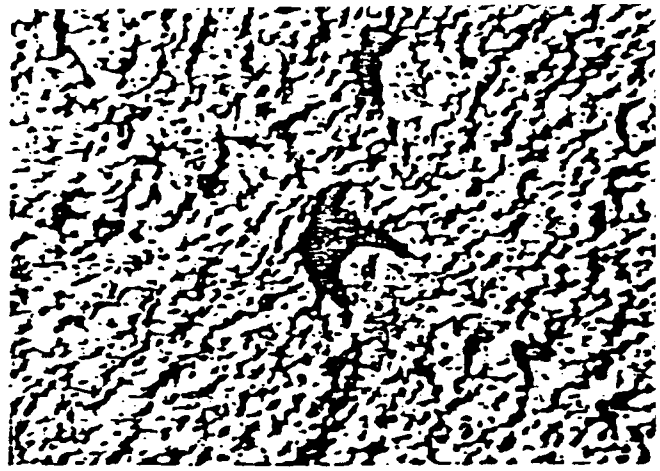

FIGURE 2—SOLVENT EXTRACTED SOLIDS. CYCLONE OVERFLOW. SAND GRAINS. 100 TO 500 MICRONS = 10%, 20 TO 100 MICRONS = 70%, LESS THAN 20 MICRONS = 20%. TOTAL SUSPENDED SOLIDS CONTENT = 12 POUNDS PER 1,000 BARRELS. MICROPHOTOGRAPH.

efficient to a degree, but as can be seen in Figure No. 1 and Figure No. 2 the ideal concentration of solids is hard to achieve by cycloning. Since the new plunger liner and hydraulic subsurface pump engines have a mechanical clearance of 0.002 inches, the largest abrasive particle which can be tolerated is approximately 50 microns. (Size conversions are shown in Table 1.) Moreover, not only must the power fluid not contain abrasive particles above 50 microns in size, abrasive solids as small as 5 microns will accelerate wear in hydraulic systems.

Internal and external plunger lubricators have been incorporated to alleviate and aid this problem. More effective, however, are highly oil- or water-soluble filming amines, which can drastically reduce the friction caused by the solids in these applications. Surfactants and wetting agents are often built into inhibitors and can serve as good lubricants as well as inhibitors. Due to the nature of

TABLE 1—CONVERSION OF MICRONS TO INCHES

MICRONS		INCHES
25	=	.001
50	=	.002
75	=	.003
100	=	.004
1 MICRON	=	.00003937 INCH

the tight polar bond upon metal surfaces, these inhibitors can exceed the performances of lubricating oils. Maximum efficiency of inhibitors is obtained by injecting them into the suction side of the power fluid triplex. The application of a filming amine serves three purposes: (1) control of iron sulfide buildup resulting from the corrosion process, (2) service as a wetting agent for solids removal, and (3) service as a lubricant. In cases where water is used as the sole source for power fluid, it is good to inject the proper chemical into the power fluid vessel to insure proper agitation for mixing purposes. If measurable amounts of water (0.2 of 1% water has proven to cause scale and gyp at the triplex operations) in the power fluid are present, it is good to use a scale inhibitor at the appropriate water contact.

Salt buildup problems have also been recorded in hydraulic operations where the power oil supplies have been saturated by brine. Normally a fresh-water wash is used in the older power oil systems, but surfactants with high dispersibility and lubricating features will aid in reducing this problem.

The treatments which we have mentioned for increasing triplex efficiency are also directly related to aiding the engine side of the hydraulic pump. Addition of filming amines, surfactants, and scale inhibitors to the power fluid will also automatically control the same problems which occur on the engine side of the pump. We must also consider the pump-side mechanism of the hydraulic pump with regard to the nonorganic-related problems. Since the pump is below the packer, surface treatments will not reach the production end of the pump until it is comingled with a power fluid at the exhaust ports; therefore, it is necessary to scale-squeeze this type of formation in order to eliminate scale and gyp buildup in the pump-end components. Corrosion problems predominantly on the pump end also require adequate corrosion inhibitor to be squeezed into the formation. Therefore, controlled nonorganic compounds can be attained through proper analysis, product selection, and proper application.

ORGANIC- AND GAS-RELATED PROBLEMS

Although we all consider crude oil a natural lubricant, refining and addition of additives is essential before many crude oils can exhibit any substantial lubricating properties. Although asphaltenes and paraffinic compounds are highly desired for product make-up in synthetic industries, they are, in this case, materials in crude oil which often lead to problems in hydraulic pumps. Usually these types of problems are found in the engine end of the subsurface pump. Due to the high volumes of fluid, the number of mechanical strokes per minute, and the downhole temperatures, these compounds dehydrate, come out of solution, crystallize, and cause excessive drag and plugging. Although these compounds can cause severe problems, they are relatively easy to control due to the nature of the hydraulic system. Dispersants, surfactants, and inhibitors are highly effective in breaking down paraffin and asphalt buildups where good surface contact is maintained. Continuous injection of these chemical compounds into the hydraulic system aids the chemicals' effectiveness as the system is constantly treated by the systems' own power fluid or, in other terms, it is continuously circulated.

Crude oil throughout the country has different emulsifying tendencies due to the crude makeup, gravity, solids, water ratio, and pumping methods. In some instances wet (0.4 of 1% water and up) power fluid can be agitated by the action of the hydraulic pump into an emulsified condition which decreases pump efficiency. Since the power fluid is in a continuous circulation process, the oil eventually becomes extremely difficult to treat to pipeline specifications. This mechanical emulsion causes the power-supply vessel to malfunction due to the inability of the unit to decipher oil from water. Thus, it supplies cut emulsified oil as a power fluid, which in turn causes new production to be contaminated. This particular problem is also readily handled. The use of the proper emulsion breaker at the suction side of the triplex will afford treated oil throughout the system, thus maintaining a clean water-oil interface in the power-fluid vessel and easily treated pipeline oil.

Another hydraulic-system problem can occur in an extremely gaseous production system. Although the power vessel is equipped to separate valuable gas, instances have occurred in which separation was inadequate due to a high gas content and the nature of the crude oil. This problem usually causes pump pounding or a gas lock, which again is easily controlled. The uses of a commercial antifoam in the power fluid will aid in gas release and reduce gas-related interferences.

MECHANICAL PROBLEMS

This specific area is in the hands of experts in the manufacturing field. Pump companies have sophisticated means for evaluating pump performance for maximum efficiency in lifting in every type of producing well. Our background in this area relates only to certain mechanical problems: well pump-off and over-stroking problems due to an individual's perference with regard to the unit's lifting capabilities. Such problems cannot be classified as a pump malfunction. Abiding by recommendations provided by pump manufacturers normally contributes to longer pump life and maximum lifting efficiency.

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