Care And Operation Of Hydraulic Pumps

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The subject for today is the Care and Operation of Hydraulic Pumps. Statements made hereinafter may or may not apply to hydraulic equipment in general. The thought in clarifying this particular point was to avoid, if possible, any later misunderstanding.

Before proceeding, there is one factor that probably merits attention. Should your speaker "slip up" and use any choice expletives during the program, please mark this up as a product of environment and accept the prior apologies offered. All of his working life has been spent in the oil fields with the last 15 years devoted to the subject equipment. During most of this time he has been in the field or "on the firing line" so to speak. As you are all probably aware, such atmosphere is hardly conducive of grammatical preciseness. Down thru the years field personnel have changed a rather unique trend toward a separate and distinct terminology. This tendency toward idiomatic, or perhaps colloquial nomenclature, has become so pronounced in the drilling and production branches of the industry that only a "new grounder" or "Johnny-come-lately" would stoop so low as to call anything by its correct name. Thus, it isn't the oil field anymore, it is the "patch," and the "patch" is full of "Weevils." Oil wells are not drilled with rotary or churn drills—these are "grease holes" dug or "stomped out" with "mudmills" or "Yo-Yo-outfits." Anything that does not measure up to expectation is either a "hay wire rig" or a "pot metal nightmare," or any of several less complimentary terms. Certainly the various machines and tools commonly used have not been excepted as regards such psuedonomous designation. These have been grandly lumped, together under the categorical name of just plain "pig iron". Unlike such terms as "Boll Weevil", in a broad sense there is some justification for the "pig iron" idiom. Probably some 95 percent of the equipment in general oil field usage today is processed from iron-based products. Thus a brief history surrounding the metallurgical evolution of this metal should be of interest.

Iron, while it makes up some 5 percent of the Earth's crust as an element, does not exist at or near the Earth's surface as a metal. Yet man has shown and used iron in the metallic form for at least five or six thousand years. This early iron was in the form of metorites which were laboriously worked into jewelry, charms and amulets. They were worn for personal adornment or to ward off evil spirits since the metal apparently came from Heaven and was assumed to possess miraculous properties. Contrary to this usage of metorite iron, man first put terrestrial iron to use to fashion weapons with which to demonstrate his superiority over his fellow man who had not yet discovered how to reduce this useful metal from its ores. Apparently this is characteristic of the species. Today, some 2500 years later, we still first utilize unique discoveries for such demonstrations. Actions of this nature are, of course, deplorable, yet it must be admitted that such usage adds impetus to the peaceful development of such discoveries. From this impetus man soon learned that what made good weapons was far more productive when fashioned for tools. Thus the iron phase of the metallurgical industry was founded. This industry, however, only showed mediocre progress until 1850 when it really "bloomed" with the advent of the Bessemer furnace. This type of retort made tonnage reduction of iron ores possible and thus iron and steel the cheapest metallic material on Earth. There are, however, considerations other than economy that determine the tremendously wide usage of these products. Undoubtedly the most significant property in the the material world today is the allotropy of iron. This ability to exist as a solid with various internal structures, plus iron's affinity for carbon and alloying materials, allows the metallurgical industry to produce iron and steel products to meet the vastly varied requirements of our machine civilization. It is estimated that since 1870, some 5000 different irons and steels have been concocted and thus made available to industry. From these and the many nonferrous materials, the engineer and metallurgist can select compounds that meet the design and stress requirements of specific applications. Hydraulic pumping equipment is no exception as respects such special purpose metallurgy. In fact, many materials that have received wide publicity as wonder metals or processes over the past few years have been standard in Hydraulic pumps for periods approaching 20 years. These include such items as sintered carbides, Nitrided surfaces, the hard cast iron alloys that show such remarkable abrasion resistance to some environments, and many other high alloys.

To sum up then, iron is accessible to man in quantity; it can be readily reduced from its ores as a metal, the metal can be easily processed into useful forms, it possesses the tremendous advantage of being allotrophic and thus its compounds can be so processed as to be highly flexible as regards physical properties such as strength, elasticity and toughness. In spite of these remarkable advantages, such iron-based materials suffer from two actions that might be called occupational diseases. When put to frictional usage it has a tendency to reduce in size or lose mass. This action occurs in varying degrees from the tearing away of minute particles, such as polishing, to the heavy cutting and scoring-welding or galling actions that gouge appreciable metal from the working surfaces. All such damage can be summed up under the broad conclusion—It wears!

Besides this, such metal possesses an inherent ability to take forms more stable in the environment to which it is exposed. In considering this action, you will recall that iron does not exist as a metal in the Earth's crust. Thus many authorities consider this tendency of iron as merely an effort to return to its respective ores which are more stable in Earthly environments. Such damage, of course, takes the form of broad etching, pitting, and intergranular reactions that result in loss of strength and endurance. Here again, all such actions and reactions can be included—with some poetic license—under the general heading; "It rusts!" or corrodes.

Unfortunately, these damaging actions are adjunctive one to the other. Corrosive attack can be greatly enhanced under frictional conditions. Likewise, wear increases several times over in intensity in corrosive environments. To combat such damage it is the manufacturers responsibility, within general economic limits, to give you the most resistant materials possible. Thus, as heretofore stated, the wonder materials are already available in your Hydraulic pumps. In normal crude oil and gas environments such metals and processing render remarkable performance and operate for years with only minor wear patterns. However, where such environments include saline solutions that possess preferential wetting ability over the crude involved, even the wonder metals suffer damaging actions. Such hot salt waters are splendid electrolytes and when in contact with metallic arrangements such as tubular goods, pumps, ect., promote extensive corrosion. The field problem involving the care and operation of Hydraulic pumps is mainly confined to combatting this type of environmental damage. In short, extreme operational liberties are being taken with Hydraulic equipment under normal conditions. Maximum speed and power ratings are being ignored with impunity. In many instances there is absolutely no justification for such excesses. Subsurface pumps are being operated 100 or more strokes per minute where 50 strokes would produce the wells at capacity. 25 to 50 percent overloads are being sustained by surface units merely to pressurize and circulate fluids without employing this energy for useful work. In many, many cases, these power fluids carry contaminates in the form of abrasives and salt water, yet the performance obtained from the equipment is considered satisfactory. When cautionad as to these excesses operators justify such malpractices with favorable lift cost data and chalk the whole matter up to the manufacturers ignorance in low-rating his product. In reply to such allegations let me again emphasize that such conditions only apply wherein the equipment is employed in dry crude environments, or where in wet environments, the crude is the dominant wetting agent. When and if—and incidentally such conditions now prevail in some areas—the salt water takes over as the contact medium, such abuses soon reflect in excessive wear and corrosion with resultant high repair costs. Obviously it is to the advantage of all concerned to eliminate, or at least reduce such costs to the barest practical minimum. Thus the purpose of this meeting is to discuss current knowledge and thinking as to how this economic minimum can be attained thru the care and operation of Hydraulic equipment. As aforesaid, this subject is mainly confined to the control of the two damaging actions—wear and corrosion—suffered in adverse environments, Also aforementioned, is the fact that these actions corroborate in their attack and thus multiply the severity of damage by combined effort. However, for immediate purposes, these actions and their effects on Hydraulic equipment will be considered separately.

In practically all mechanical devices resistance to wear is supplemented by lubrication. The petroleum industry of course supplies most of the lubricants in general usage today, yet they continually demand the perfect metal from the metallurgical industry. Metallurgists, of course, counter with the deduction that given the perfect lubricant, all metals are impervious to wear. Thus we are confronted with another "hen and the egg" sort of thing, or for the moment at least, a "Mexican stand-off." Actually great strides are being effected in both fields. Better, more wear resistant metals are constantly being supplied and certainly progress in the lubrication field has been nothing short of amazing. The specifications and applications of the remarkable lube oils, greases, and related products available today are common knowledge. These need no enlargment here. However, it should be pointed out that many portions of your Hydraulic pumping system must necessarily employ crude oil as a lubricant. Actually, the system under discussion exploits this principle by subjecting all frictional portions of the subsurface pump to this type of lubrication. This design was executed on the premise that treated and settled crude would be supplied to the units. and certainly this would be a better lubricant than straight well fluids that might consist of near 100 percent salt water and carry quantities of abrasives. That this design is justified. and clean average crude does constitute an acceptable lubricant. is witnessed by performance obtained from the pumps in this environment. Runs of several years are normal and operating periods of 8 to 10 years without repairs are not uncommon. However, like all good things ,this design is subject to abuses in that it presupposes clean crude will be supplied to the pump. If wet and abrasive ladened fluid is introduced into the power system, the protective features of the design are defeated and wear patterns develop rapidly. Besides the injection of contaminate into the "crankcase" of the system, so to speak, there is another factor that contributes to wear damage. In all closely fit dynamic mechanisms, speed and wear are so closely related as to be practically synonomous. Excessive high speed can result in a "wringing out" of lubricants in sliding arrangements by actually breaking the molecular film. This in turn, allows metal to metal pressure points to develop that can generate the necessary heat over localized areas to cause the welding-galling actions that produce heaving scoring. Even the finest metals are susceptible to such damage and manufacture ratings are based on such considerations rather than performance pictures from individual areas or operators. This, then, leaves us with two main operational considerations as respects wear. First, supply clean, dry crude as an operating medium. Second, operate the pumps at speeds commensurate with the desired production or the producing capacity of the well. This of course, assumes that equipment of sufficient size has been initially applied.

You have no doubt all heard the old "saw", "Corrosion is like sex. It is here to stay and you might as well learn to get along with it." Unfortunately, there is still considerable substance in this statement in that the universal solution to the corrosion problem has not yet been effected. There have been, however, developments in the chemical field that have enjoyed some successes in at least alleviating the various damages sustained from this action. In this endeavor, chemists have approached the problem from both the "environmental change" and "protectionary" viewpoints. Such applications merit attention. However, for the purposes of this discussion, such comments must necessarily be both broad and brief.

Most of the brines encountered in well bores possess acidic properties. Since the bulk of the visual damage sustained is acid activated, attempts have been made to neutralize the well fluids via the injection of alkalines such as the various caustics, etc. Such environmental change efforts have met with success in some areas, but the universal application of this practice is questionable. In many instances the volumes required are prohibitory; the handling of such solutions involve safety considerations, and if not judiciously applied such injections can instigate the formation of scales that are almost as objectionable as corrosive damage. Thus the use of such injections has not enjoyed wide application. Somewhat contrary to this during recent years, has been the rather widespread use of injected compounds that apparently employ to some extent both the "environmental change" and the "protectionary" inhibitor features. These are the socalled semi-polar compounds that are wetting agents or react in such a manner as to increase the wetting ability of the crude oil in the well bore. As you will recall earlier mention has been made to the effect that in wet environments corrosion only becomes rampant after the water has taken command as the dominant contact agent on metallic surfaces. The purpose of the semi-polar injections is to instill and maintain an oil wet environment for metallic arrangements in the well bore, and for that matter, portions of the surface equipment such as lines, tanks, etc. The widespread use of such agents of course, points up their successful applications. Thus, while benefits have yet to be ascertained where mechanical friction or impact forces are employed, their use for otherwise unprotected tubular goods is almost a MUST in some areas.

Besides the film forming agents there are the various coatings that are offered for protective service. Since most of these find application only in atmospheric conditions they do not merit attention in this discussion. However, in recent years, certain of the plastics, both thermosetting and thermoplastic, have been utilized as protectionary coatings for metal goods in the well bore. How much protection these will offer in corrosive environments is still a matter of conjecture. The existing data, both pro and con, is somewhat limited and probably the only definitely true statement that can be made, is that additional data should be compiled. In this regard comparable tests are now being conducted under rather close scrutiny. It is hoped of course that data assembled from such tests will justify additional plastic applications both for corrosion protection and other purposes. Such field preventative measures, if successful, can materially enhance the performance obtained from Hydraulic pumps in corrosive applications. Major benefits would result from the elimination or at least the decrease in particle contamination of the fluid system. In corrosive environments an appreciable portion of such particles consists of iron or byproducts of the iron-water reaction, sloughed from the walls of tubular goods. Since these products are water instigated they bear moisture and are thus water-wetted. When fluid ladened with such particles is forced through sliding mechanisims an action that might be termed "rub-out" ensues. Damages from "rub-out" can reflect in a three-fold manner. One, water-wetted particles repel lubricants and in thus defeating lubrication act to induce wear. Two, the "rub-out" of such particles results in corrosively active coatings or depositions on metallic surfaces. Thus through rub-out, or wear, corrosion is instigated at points in the system that would otherwise bear immunity from such action. Three, while such particles lack the hardness necessary to cause "cutting", they can, when injected into close fits, act as wedgants to create the high metal to metal bearing loads necessary to produce the galling-scoring type of damage previously described. This of course is another example of wear instigated via corrosion or induced by corrosive products. Thus the wear-corrosion cycle is completed and it is no longer possible to consider these actions separately where corrosive environments are encountered. The field problem then surrounding the Care and Operation of Hydraulic Pumps involves the operational efforts necessary to reduce such combined damages to a practical and thus economical minimum. In this there are three main procedures that should be put in practice. First: Supply clean, dry crude as an operating medium. In known or suspected corrosive environments extra precautions as to treating and setting of the power fluid will pay dividends. Second: Operate the pumps at the minimum speed possible to meet the production requirements. Here again this factor assumes added importance in corrosive environments. Third: Utilize such corrosion protective or preventative measures that have been justified by field testing.

The aforegoing completes the reading portion of the discussion. In this, as perhaps some of you have noted, there has been no mention as to the actual principles of Hydraulic pumping. Since there are literally hundreds such installations within a few miles of this site it was assumed that the group present would be generally familiar with the Hydraulic system. If this assumption is in error it might be construed as being somewhat presumptuous. To correct this implication, and enlarge on the rather broad statements made here-to-fore, we have prepared a series of slides showing both the complete system and its functional portions. These will be described and discussed as the slides are shown.