PUMPING UNIT PREVENTIVE MAINTENANCE

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INTRODUCTION

It is the hope of every operator to receive a long and faithful life from the pumping units in his or her area of responsibility. Merely driving by to make sure a unit is still going up and down and periodically pumping a little grease in the structural bearings is simply not enough. As tough as these units appear, considerable care and attention is required to maintain top performance and prevent the headaches caused when a unit does crater. Such care and attention will also enable your people to recognize early warning signs that will result in lower repair cost and less downtime. Preventive maintenance, by definition, strongly implies decisive counteraction to keep equipment in an existing state or to preserve it from failure. It is therefore desirable, from a dollar standpoint, to have some type of preventive maintenance program established in your area.

We will show, by example, cases where repair costs and downtime could have been greatly reduced simply by paying more attention to the pumping unit or by working together to get potential problems taken care of before catastrophic failure occurred. But, who in your organization can best detect these potential problems, and what are the tell tell signs. The purpose of this paper is to help you realize the possible cost savings of a preventive maintenance program, establish who can best prevent failures, and what they need to look for.

THE WHY OF PREVENTIVE MAINTENANCE

We said that we were going to show you some examples of why you need preventive maintenance. First, let's set some ground rules. Each example happened during 1987 and was repaired by our shop and field crews. The lost production cost is figured on $16.00/bbl oil and reported production. It is a gross figure and does not include the overhead cost of production. The repair cost is either actual or estimated (for the lesser repair) and does not include any damage to the polish rod, rods, pumping tee, etc. Okay, you're saying to yourself, "These guys are going to give the worst cases they can think of to try and scare me." That's right, we are; fright can open your eyes and make you change your ways. So let's look at some worse case scenarios, see what happened, and what could have prevented or lessened the damage.

Example One

Our first example is one with shared responsibilities. It involves a

cantankerous rancher and a timid lease operator. The rancher gave the pumper a hard time about closing and locking gates, staying on the road, and raising a dust cloud whenever he checked a certain well. To avoid the confrontations, the timid operator stopped going into the rancher's fenced area for over five months. After all, the unit was less than a quarter mile off the road; where he could see it, and his tank battery and guages were outside the fence so he could make his production reports; he was doing his job. Let's see what doing his job cost his employer. On the second day of no production, he decided he had better go in and see what was the matter. What he found was a unique crater. The profile of the unit looked normal from a distance, but; as he got closer he could see the extent of the damage. The left hand crank pin had seized up and started to turn in the crank. The movement ruined the crank pin hole, the crank pin nut finally gave way and the pin came out of the crank. The flexing caused by the crank pin moving around in an oversize hole and finally the unit only moving on the right hand side stressed the structure beyond it's limits. Both pitman arms were damaged beyond repair, the equalizer was torn on the right hand side, the walking beam was torn at the tail bearing lugs, both crank pin assemblies were ruined, the wireline was frayed, and the tail and center bearing assemblies required repair.

This unit was a 228-213-86 operating within it's torque and beam limits. It was balanced reasonably well, had an electric motor on a percentage timer, and was producing an average of fifty-four BPD of oil. It took eight days after the unit went down to get the replacement parts built and the other parts repaired so the unit could produce again. The original crank pin failure could have been delayed with regular lubrication. When the crank pin did require repair it could have been done with only a few hours of production lost and at a much lower cost. From the amount of material worn out of the crank we estimate that thirty to forty-five days had elapsed from an obvious crank pin failure to the complete collapse of the unit, detection at any time during this period could have greatly reduced the expense of repair. Please see figure one for a cost comparison between repair of one crank pin and repairs necessitated by neglect.

Example Two

Our second horror story involves a gearbox failure on a 320-256-120. Figure two has the scary dollar signs. The unit is about eight years old and is driven by an Ajax DP60. It runs twenty-four hours a day and produces an oil cut average of 40 BPD. The pumper says that he thought he heard a rumbling in the gearbox last week but didn't pay too much attention to it, everything seemed to be okay. He went on days off and came back to find the engine running but the unit standing still. The belts were off and badly worn so he had the roustabout crew put on a new set. When he restarted the unit he heard a horrible grinding and thumping coming from the gearbox. What we found inside the gearbox was an intermediate bearing that had completely come apart, the rollers were gone and both inner and outer races were broken. That was the good news. The bad news is that every gear and pinion had teeth broken off or deformed in such a way as to make them useless. When the bearing came apart this allowed the intermediate assembly to bounce on each load reversal and ruin the rest of the gears. What caused this to happen? Could the pumper or his

relief have saved XYZ oil company some money? You already know the answer to both these questions. The bearing was going out last week and should have been replaced when the pumper heard it rumbling over the slow-speed engine. New bearings and oil are expensive but not as much as a new gearbox. Now that we've mentioned gearbox oil, let's spend a minute talking about it. All major manufacturers of pumping units state that for optimum gearbox life the oil must be maintained properly. They may differ in some details but they agree that the oil must be of the proper viscosity, at the proper level, and free of contamination and sludge. Had this been done on our example? The pumper took over this lease about two years ago. He had checked the level a couple of times but had never really looked at the oil. In fact, the usual practice was to change the oil only when a major repair was done to the gearbox.

In this case, an exchange gearbox was available from the manufacturer in the same time as replacement gears. It was decided that the additional cost of the exchange gearbox was offset by labor charges to repair the original box and downtime would be one day less. Assuming that the unit went down the night before the pumper came back to work, six days of production were lost. One day was lost while belts were being put on, four days for the replacement box to be delivered, and one day to put it on the unit.

Example Three

Our third case illustrates the damage that can occur when counterbalance is ignored. Many people in the field hold the false conviction that a pumping unit cannot be overloaded by having too much counterbalance. They will swear that too little is bad but too much causes no problem at all. This would only be true if the gearbox were intelligent enough to know which load it was trying to pick up, the rods or the weights. It doesn't, cast iron has a very low I.Q. In this case we're dealing with a 57-109-48. It is running with a 15 hp. electric motor on a time clock. It produces 20 BPD of oil, has 6800 pounds of CBE, and has been on this location six or seven months. When the unit was first put into operation the pumper had a problem with the overloads tripping after thirty or forty-five minutes. He called the electricians back out and had them install larger heaters. The motor seemed to be straining but it would run the unit now. The gearbox started making a thumping noise after a few months but it was still running. A few more months passed and the noise had gotten so bad that the pumper was afraid that something might be going bad. He was right, all the gear teeth had worn so badly that they were now sharp pointed triangles. So much metal flake had gotten into the oil that all the oil ports were clogged; which ruined the bearings, bushings, and slow-speed shaft. We brought the gearbox into our shop, replaced all the gears, bearings, bushings, and shaft, and had the unit back together in four days. When we started the unit we saw how badly weight heavy it was. Analysis showed that with the current CBE (6800 lbs.) the gearbox torque was 194% of rating. With the unit in balance (4160 lbs.) the torque dropped to 89% of rating. The electric motor no longer strained and energy cost should have decreased.

What should the pumper have done when his overloads tripped repeatedly? Instead of masking the symptom, he should have found the cause.

If the sound of the motor straining or the weights going straight down when the unit stopped didn't tell him that the unit was weight heavy, then a quick check with an ammeter would have. The saddest part of this example is that it could have been avoided so easily. The weights could have been properly placed when the unit was installed or the pumper could have moved them himself in less than an hour. Figure three shows only the cost of his repair and lost production because the cost to prevent this failure is so small as to be insignificant.

Example Four

Figure four also shows the cost of repair and lost production. This costly failure could have been prevented if the pumper had spent thirty minutes talking with his foreman and five minutes resetting a dial. We are dealing with a LUFKIN Mark II 912-305-192 running with an electric motor controlled by a time clock. The time clock was set for one hour on and one-half hour off. The well had initially produced almost 1000 BPD but production had slowly dropped off to an average of 400 BPD with a 90 BPD oil cut. The time clock setting was never changed. As production dropped the unit started to pound fluid, the time it pounded getting longer and longer during each run cycle. The pumper noticed the noise and the unit shaking all over but did not report it, he assumed that the foreman knew what was going on. For those of you who don't know what pounding fluid is we'll give you a quick explanation. A fluid pound is caused when the pump plunger rises above the fluid in the hole and then has to re-enter the fluid on the downstroke. This occurs when you try to draw fluid out faster than the reservoir can supply it. The resulting shock caused by this condition travels up the rods and must be absorbed by the equipment. Mark II units are especially sensitive to this because of their accelerated downstroke although any unit will be damaged. In this example the slow-speed gear was the weakest link and failed first. The continued hammering caused the gear to shear its key and crack at the keyway. The gear eventually turned on the shaft which ruined it and forced metal particles into the slow-speed bushings, ruining them. The remaining gears were also replaced because of the wear caused by undue stress.

Could this have been prevented? Of course it could. If the time clock had been reset to allow a longer fill time the unit would not have failed. Production would not have been reduced because the unit can only produce the fluid that is available. There are other ways to obtain the same production on this well. The existing unit could have its stroke shortened or been slowed down and still have produced the same fluid. Perhaps a smaller unit could be put on the well and maintain the same production. While all of these are viable solutions, the resetting of the time clock would have prevented this failure, at no cost, while the final decision was made.

THE WHO, WHAT, AND WHEN OF PREVENTIVE MAINTENANCE

If you've read this far you have a pretty good idea of who. The pumper, or lease operator, is your first line of defense. He is backed up

by every employee you have. The what is simpler than you could have ever imagined. The real backbone of preventive maintenance is just looking and listening. If something is seen or heard that is unusual it must be reported and investigated. The when is just as simple, every time any employee is on the job they are in a position to notice a change. Any change is a signal that something may be wrong.

Let's expand on the generalities above. If you succeed in getting the following suggestions to become second nature, to become automatic to your employees, your long term maintenance costs will go down and you will have the beginnings of the best preventive maintenance program in the oil patch. The first is to pay attention to what is going on around them, even if it does not directly affect them. The pumper is the person who should best be able to tell when a pumping unit is developing a problem, he is the person who can best prevent the problem from escalating. He should be the one responsible for following the manufacturers recommendations on types of lubrication and lubrication intervals. This will make him familiar with the pumping unit, so he better understands how it works. He will also know how it looks and sounds when it is operating properly. Then when he sees or hears something different he should find out what is causing it; if he can't, he must get the help he needs to find out. He might find this expertise within the company or he may have to go to an outside source. The differences he may notice can be as varied as a new rust stain which is caused by a loose bolt to a low crackling noise coming from the gearbox which could be a broken gear about to shatter the gearbox housing. You may be thinking, "How do we educate all the people who come in contact with our units on proper maintenance and what to look for as far as alignment, levelness, etc." A good place to start is with the major pumping unit manufacturers. Most of these companies offer short (1-2 hrs.) maintenance talks that are very informative and cover, in detail, recommended maintenance schedules. Also, if your people have any questions concerning peculiarities of a particular unit they can have those questions answered. These talks are very helpful and can open some eyes to details often overlooked or taken for granted.

The second thing that should happen is to create a maintenance schedule that will help establish your company's guidelines for preventive maintenance. This could be accomplished by providing your employees with a list of what should be inspected, how often to inspect, and then insisting that this be done. The following will give some idea of what the minimum requirements for the check lists should be.

Daily

(1). LOOK - Inspect unit for abnormal leaking at structural bearings and reducer. Look for any misalignment, abnormalities, or changes in the gearbox, structural bearings, wire rope, any working components of your unit. As an example, a rust stain evident at a metal joint would indicate that there is a working or fretting at that joint; that is, the joint is loose, and the attaching bolts

need to be tightened.

(2). LISTEN - Really listen for any abnormalities or changes in sounds of gear reducer, structural bearing or working components of your unit. An analysis of an abnormal noise could save expensive repairs or even a wreck to your pumping unit.

(3). APPLY - Apply the brake slowly but firmly when stopping the pumping unit. Maintain the brake and all its components in proper working order. Also, check "V" belt tightness.

Monthly

(1). Check items in LOOK, LISTEN and APPLY. (above)

(2). Check oil level in gearbox. Level should be between low and high marks on the dipstick when the reducer is inoperative.

(3). Check structural bearings for lubricant leakage; center bearing, tail bearing and crank pin bearings.

(4). Bronze (journal type) structural bearings should be relubricated as required to maintain oil level by removing fill plug and adding oil until reservoir is full.

Every Six Months

(1). Make all monthly checks listed above and items listed under LOOK, LIsten and APPLY.

(2). Pump several ounces of grease into each roller bearing assembly. This can be done conveniently and safely through the ground lubrication system.

(3). Collect a typical sample of the gear reducer oil in a glass jar. A visual inspection will expose possible dirt, sludge, water emulsion or other forms of contamination. If lubricant has an abnormal appearance or smell, check with your oil supplier for possible replacement, or send to your lab for a report.

(4). Recheck tightness of all structural bolts.

It should be noted that no special tools are required to perform these checks. In time, all of these items will become automatic and enable your employees to become very acquainted with each of their pumping units. Any change will then become surprisingly easy to detect. The important thing is that changes be recognized, investigated, and reported to get things back to normal. The sooner a problem is found and corrected, the cheaper the repair will be.

The third thing that has to happen is the one most often ignored. It depends on you. Everyone in your company has to be made aware that they play an important part in preventive maintenance, just as they do in safety. The roustabout crew that notices a strange noise, the clerk who

logs production and notices a drastic drop from one well, both need to be encouraged to pass this information along and not assume that someone else will notice it. The idea that maintenance is not their job has to be changed. You must be the one to change it. You have to encourage each worker, especially pumpers, to make preventive maintenance an every day job. The best way to do this is to praise and support those who detect problems while they are still small and to not accept excuses when major, expensive failures occur. The attitude that equipment just tears up and nothing can be done about it is no more valid than accidents just happen and you can't do anything about it.

CONCLUSION

We set out to convince you that preventive maintenance can save you money. We certainly showed you four examples where that was the case. We told you that no special or expensive tools are needed for a good program. With the right attitude and encouragement, your employee's eyes and ears can save you money. Yes, some added effort is required of you and your employees and some extra time will have to be found. More small expenses may crop up that you do not now have. Please don't be discouraged by these expenses, one catastrophic failure prevented will more than offset them. The final objective of all our jobs is to produce the most product at the lowest cost. Preventive maintenance, getting the most out of what we have, is the only way to meet this objective.

ACKNOWLEDGEMENT

We would like to thank our customers who provided us the information and history necessary for our examples to be as complete and accurate as possible.

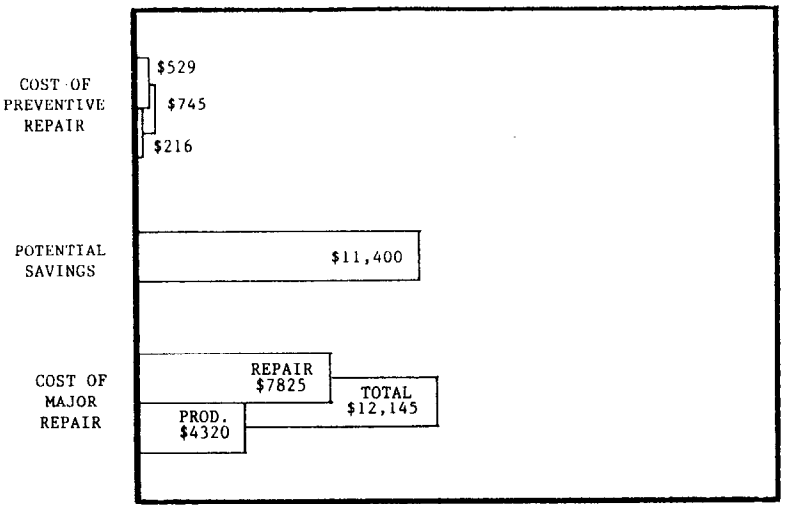
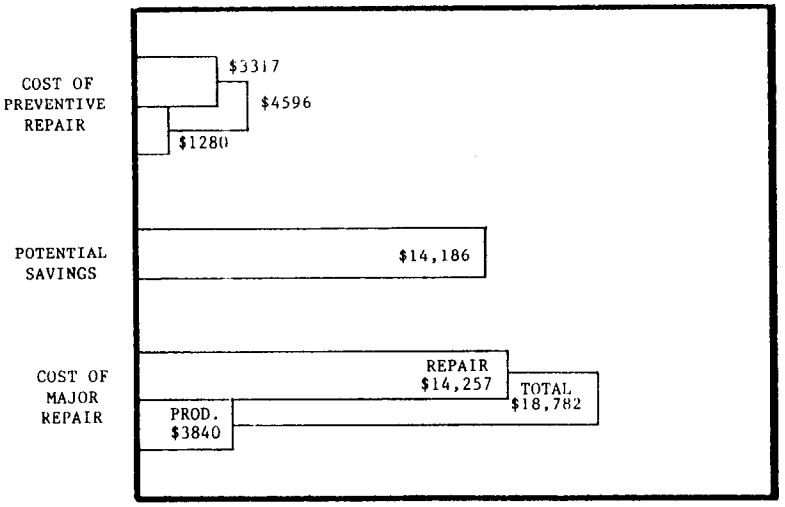


Figure 1



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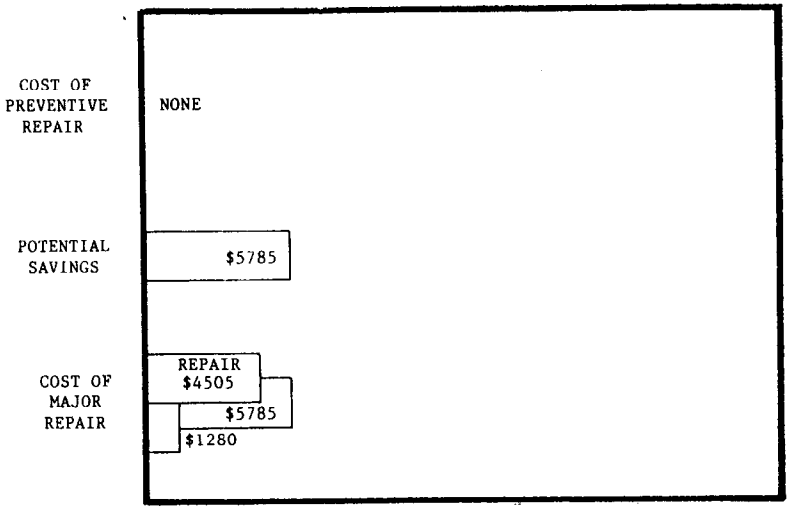

Figure 3

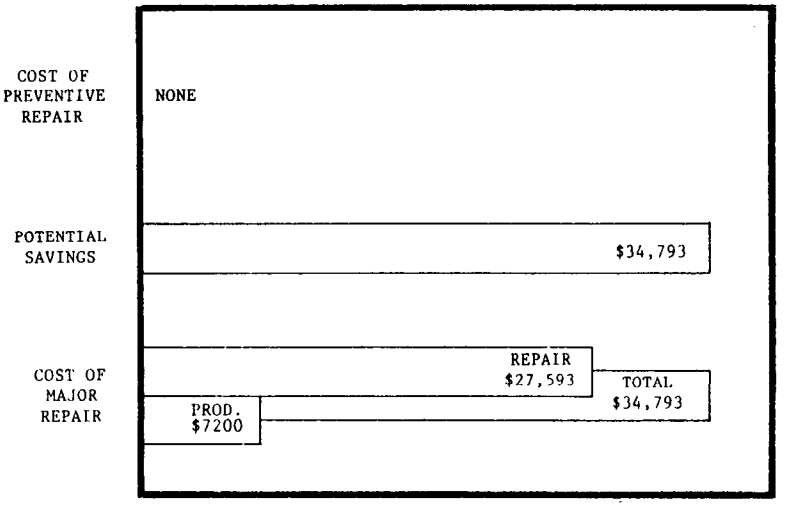

Figure 4