Practical Methods for Reducing Pump Repair Cost

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INTRODUCTION

Due to present economic conditions, all oil companies are trying to reduce operating costs. With this objective in mind, early in 1968 a comprehensive study was begun in a West Texas area to determine what, if anything, could be done to reduce insert pump repair cost and obtain longer pump runs. Factors examined were: causes of pump failure, pump design, materials used for each pump part, and operation of repair shops.

The first step that must be taken to reduce or eliminate equipment failure, obviously, is to determine the cause of failure. In order to do this, good reliable records must be kept in a form that is readily available for analysis. The system presently in use consists of three parts:

1. Pump Repair—Pump Record
   A set of 5-in. x 8-in. cards filed by pump number
2. Pump Repair—Well Record
   A set of 5-in. x 8-in. cards filed by lease and well number
3. Pump Repair Report Sheets
   Report sheets furnished by the various repair shops

Pumps are numbered so that the first digit identifies the shop in which the pump is repaired. This insures that each pump is always repaired in the same shop and thus allows comparisons between shops. It also allows comparison of pumps and parts from the different manufacturers.

The *Pump Repair—Pump Record* card (Fig. 1), provides a complete repair record of each pump from original purchase until the time it is junked. It gives a complete description of the pump, original cost, various wells in which it has run, length of run, major parts replaced, and cost of each repair.

The *Pump Repair—Well Record* card (Fig. 2), provides a complete pumping history of each well. It gives the number, size, and length of run of every pump run in the well. It also shows the reason the pump was changed, the cause of failure if the pump failed, and pump repair cost. This card is especially useful for identifying problem wells that need a special type pump or well treatment.

The *Pump Report Sheets* show the well from which the pump was pulled, the pump number, the condition of the various parts of the pump, parts replaced (Table 1), cause of failure, and cost of repair (Table 2).

PUMP DESIGN

Pump design is an important factor in repair cost. Pumps should be sized reasonably close to pumping unit size and the producing capabilities of the well. Well tests and fluid levels should be used to determine pump size and pumping cycles. Running a 16-ft pump where a 12-ft would be sufficient is not only an unnecessary initial expense, but will also increase future repair costs. Replacement of a 16-ft barrel will cost 33 per cent more than a 12-ft barrel. Too large a pump bore can cause several problems, all expensive. Oversized pumps invite gas lock and fluid pound which are damaging to pump parts and also sucker rods. When gas anchors are run below pumps they should be of maximum bore and have enough openings to allow proper filling of the pump barrel. Undersized gas anchors will choke the pump's suction, cause it to pound fluid and reduce efficiency. Plunger length is dependent upon pumping depth and fluid properties. It must be long enough to provide good efficiency after reasonable wear. However, a point is reached where increasing length has little effect on efficiency. Generally, the rule-of-thumb of one foot of plunger per 1000 feet of depth is sufficient. These are necessary requirements for proper pump aplication and reduction in cost, but this paper will deal primarily with the selection of materials and repairs of the bottomhole pumps.

A wide range of opinion exists in the industry

PUMP REPAIR - PUMP RECORD

PUMP NO. DESCRIPTION: ORIGINAL COST:

DATE		LEASE AND WELL NUMBER	REPLACED					TOTAL COST	REPAIRED BY	FROM	TO
IN	OUT		BARREL	PLUNGER	BALL & SEAT	CAGES	PULL TUBE		REMARKS:		

PUMP REPAIR – PUMP RECORD

FIGURE 1

PUMP REPAIR - WELL RECORD GAS ENGINE ________ ELEC. MOTOR ________
LEASE & WELL NO. FIELD

SPECIAL PUMP FEATURES NEEDED:

PUMP NUMBER	PUMP SIZE	DATE		REASON FOR PULLING PUMP							CAUSE IF PUMP FAILED						TOTAL COST OF PUMP REPAIR
		IN	OUT	W/O	PARAFF.	FILL UP	SURVEY	RODS	TUBING	PUMP	CORROS.	SCALE	SAND	POUND'G	JUNK	OTHER	

PUMP REPAIR – WELL RECORD

FIGURE 2

TABLE 1
PUMP PARTS REPLACED PER MONTH

	1968	1969	1970
Barrels	23	22	24
Plungers	16	11	7
Balls and Seats	42	29	20
Cages	--	16	14
Pull Tubes	5	4	4

TABLE 2
REPAIR COST PER PUMP

Pump Shop	1968	1969	1970
A	$ 53.32	$64.84	$56.55
B	77.58	76.16	71.71
C	96.42	72.88	61.81
D	86.65	78.91	Transferred to G
E	101.80	89.80	Transferred to F
F			54.65
G			64.10
Average	$ 79.35	$74.35	$63.25

on the merits of double valves in pumps. Local experience and comparative tests in each field or producing zone are the best criteria to use in making this decision. If longer runs are obtained with double valves, then of course they should be run. However, if tests show single-valve pumps give an equal run, it is an economic advantage to run them. The additional cost of double valves can run as high as $75 to $100 per pump. Repair cost will also be higher. Generally, pumps should be double-valved when sand, salt, gyp, or other "hard" materials are present in the fluid being pumped.

The two types of pump in greatest use are the thin wall, stationary barrel, bottom hold-down and the thin-wall traveling tube. The stationary tube pump is recommended unless pump sticking is a problem. In shallow wells, stationary barrel pumps with top hold-downs can be used. Travel tube pumps have some built-in characteristics that can cause problems especially when pumping low fluid level wells and gas-saturated oil. The pull tube forms a long small ID choke on the pump's suction and the standing valve is much smaller than the one used on a comparable size stationary barrel pump. This combination invites fluid pound, and/or gas lock.

Several pump types are available for combating special well problems, such as three-tube for sand, stroke-through for scale, ratio-compound, two-stagers, or special plungers for gas, etc. Most of these "special" pumps are more expensive to buy and repair and should be used only when necessary.

PARTS FAILURE ANALYSIS

In order to reduce pump repair cost, it is necessary not only to determine which parts fail, but also why they fail. A careful analysis of each part will materially help in reducing failures.

Barrels

The barrel is the most expensive pump part. Failure can be caused by wear—internal or external, corrosion, splitting, and stuck plungers. External wear can be eliminated by using oversized barrel bushings with stellite or spray metal facing. Barrels which split in the threads or long barrels where internal wear is restricted to a short section at the end can be cut off and rethreaded in a machine shop and used on shorter pumps. For example, four ft can be cut off a 16-ft barrel to make it a 12-ft. Most pump shops do not do this unless requested to do so. Corrosion control requires a combination of material selection and chemical inhibition. Stuck plungers can sometimes be pumped out with a high-pressure, low-volume pump. Safety precautions must be observed when using this method.

Plungers

The plunger is the second most costly pump part and should be one of the most durable. Causes for failure are wear, broken pins, corrosion, and sticking. The best plunger to reduce wear is a steel body with a spray metal hard facing. Originally, this type plunger had serious limitations due to the bare steel pins. Corrosion would start on pins and work under the spray metal causing failure. Several methods are being used by different manufacturers to successfully eliminate this flaw; these methods include nickel plating the pin and plunger ID or using brass or monel adapter bushings silver-soldered to the plunger to keep out corrosive fluids. A seven to eight year average plunger life is presently being obtained.

Other savings on plungers can be obtained by cutting new threads on plungers with broken pins and by machining the barrel off of badly stuck plungers. Machine shop charges for this service will be from $12-$15.

Valves

Balls and seats are the most often replaced pump parts and, therefore, are an important item in pump repair cost. Normal shop procedure for testing balls and seats is to remove the valve from the pump, clean it, and test on a vacuum tester. If the ball and seat leaks, turn over the seat and retest. If it still leaks, both ball and seat are junked. Most manufacturers will furnish balls and seats separately, but most pump shops stock them only as sets. Many times a new ball with the used seat or a new seat with the old ball will test perfectly. The cost of either a ball or a seat is approximately one-half that of a set. Some manufacturers also offer reconditioned valve sets at a reduced price. These sets usually consist of a new ball on a refaced seat and give good service.

Cages

Most cage failures other than those caused by corrosion are due to the beating action of the ball. This is especially serious in open cages where the wings can be beaten out so thin they will break. The use of the undersize or California pattern ball contributes greatly to this type failure especially in gassy wells. This ball was designed for use in thick heavy crudes where the ball has trouble falling, and its use should be limited to this type well. Several methods are used by various manufacturers to combat this problem such as lining the cage with stellite or rubber. Two companies make insert guided cages that utilize a replaceable stellite insert that protects the cage body from the ball action.

The addition of a short pony rod to each pump as a handling sub will prevent pulling crews from using pipe wrenches on cages. Brass and monel cages are easily damaged from pipe wrenches.

Pull Tubes and Pull Rods

Failures are usually in the thread area. Use of the API thread on pull tubes has greatly reduced this problem. Rod guides should be used on all pumps in large ID tubing to hold the pump straight. This will reduce bending stresses and wear.

Hardware

This includes all the other pump parts such as barrel bushings, connectors, hold downs, etc. Material used in these items should be similar to that used in the rest of the pump. These items are seldom the primary cause of pump failure.

REPAIR SHOP SELECTION

The most important factor in reducing pump costs is the selection of repair shops. A personal inspection should be made of each shop being considered. Essential equipment includes a pump vise with a complete set of inserts, a set of pump wrenches, inside micrometer or air gauge for inspecting barrels, outside micrometer for testing plungers, a ball and seat tester, and facilities for cleaning parts. Optional but preferred equipment would include a steam cleaner, a high pressure pump for removing stuck plungers, and a soaking vat for descaling purposes. A good shop will also be clean and well designed for handling pumps. It will also maintain an adequate inventory of pump parts.

The most essential item in the shop is an honest, dependable, well trained, and preferably full time pump repairman. While the physical work involved in repairing pumps is not complicated, bear in mind that this man will make the decision whether a $250 barrel and other expensive parts can be used again or must be replaced. A mistake in judgment in either direction will be costly. A good backup repairman must be available for vacation and sick time relief.

It is desirable to divide pumps among several shops for competition and comparative purposes, but do not spread them too thin. Place enough pumps with each shop selected to make you a valued customer. Maintain close communication and supervision with the repair shops. Comparative analysis between shops is a useful tool in reducing costs. For example, if one shop is replacing more plungers than the other shops, try to find the reason and remedy the situation. This will also work in reverse. If one shop is getting considerably longer ball and seat life, see what they are doing right and have the other shops do the same. When one shop's repair costs are consistently higher than the other shops, work with them to find their problem. If costs cannot be brought in line, move your pumps to another shop. (Table 2)

A complete list of repair specifications should be furnished to each shop and thoroughly explained to the repairman. These specifications should include a list of acceptable materials for each pump part, allowable clearances between plunger and barrel, and maximum end clearance. Maximum allowable repair cost for each size pump must also be specified. A good figure would be 75 per cent of replacement cost. All usable parts from junked pumps should be stored separately and used as needed on other pump repairs. Each shop should be required to return all junk brass and monel due to its premium price.

NEW PUMP PURCHASES

Many companies use a bid system for purchasing new pumps. When this is done, several precautions should be observed. Complete and detailed specifications must be furnished each bidder. No used parts should be allowed. Close supervision of pump assembly or random inspection in an outside shop should be made to insure the purchased pumps meet specifications.

A more satisfactory system is to base new pump purchases on past pump performance, repair cost, and new cost. This will allow you to get the exact materials needed at a reasonable cost.

CONCLUSION

The result of the program has been very successful. Expenditures for pump repairs and replacement decreased during a period when the cost of pump parts increased 21 per cent. From approximately 750 pumping wells, plunger replacement was reduced from 16 per month in 1968 to 7 per month in 1970. Ball and seat usage was reduced from 42 per month to 20 per month. Average pump repair cost was reduced from $79.35 in 1968 to $63.25 in 1970. Further savings are anticipated for the future. Success in cost reduction requires a continuing program of record keeping, analysis, and supervision.