BASIC RECOMMENDED PRACTICES FOR HANDLING, INSTALLATION, AND OPERATIONS OF SUBMERGIBLE PUMPING EQUIPMENT

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ABSTRACT

The handling, installation, and after-operations are all very important factors to ensure successful submergible pumping operations. This paper recommends the basic practices to follow for each of these subjects. It is felt that if these practices are followed, it will result in successful submergible operations for the user. The bottom line is that the producing company must be the major contributor who enforces good working practices that are pertinent to their operations and result in economical results.

The following list itemizes the responsibilities and precautions related to the handling, installation, and operations of a submergible pump. Details of these general practices will be covered in the context of this paper under each individual category.

GENERAL PRACTICE

1. Do not hurry operations.

2. Ensure that equipment is not handled in a rough manner.

3. Ensure rig is aligned over the well.

4. Ensure hole is properly prepared.

5. Ensure that excessive strain is kept off the cable.

6. Be certain that the proper equipment, such as slips, backup, etc. are of the type that prevents the cable from being damaged or wrapped around the tubing. A backup should always be used when tightening tubing.

7. Run or pull the tubing slowly to ensure that the cable is not damaged.

8. Be certain that the pulling unit crew is banding the cable to the tubing correctly and that care is taken not to damage the cable with the slips.

9. Ensure switchboard is located a safe distance from wellhead (50 ft minimum) and that the cable is vented between the wellhead and switchboard on installation.

10. It is recommended that the cable sheave be no higher than 30 ft above wellhead (45 ft maximum).

11. A pickup nipple should always be used in the pump discharge head when suspending the total assembled unit.

12. The installation should be completely checked out prior to leaving the well site with all data logged correctly.

13. Have test procedure set up immediately after installation to ensure unit is performing as sized.

14. Set up proper data gathering and monitoring system.

15. Ensure that a good line of communications exists between the pump representative and company representative.

EQUIPMENT HANDLING

The following instructions should be relayed to the truck hauler and the individual in charge of setting up the equipment prior to installation or pulling operations. These instructions should be insisted on and enforced.

1. Submergible pumping units are precision units and should be handled with care. All equipment must be handled utilizing a spreader to prevent damage to equipment. The use of a chain bridle or sling is not recommended!

2. All boxed equipment should be placed as near to the wellhead as practical. Place the colored end of the shipping box toward the wellhead. If the equipment is unboxed, place the end of unit which has all of the bolts on shipping cap toward the wellhead, or the end of equipment which has the nameplate attached. (The other end will have the shipping cap held on with two or three bolts.)

3. The cable reel must be handled with an axle (customer provided) and a spreader bar. It should be set up 75 to 100 ft from the wellhead and in the rig operator's direct line of sight. A short spacer should be placed between the reel and the stand on each side. (A thread protector, collar, Vic clamp, or hammer union wing are some examples.) The cable must feed off to the wellhead from the top of the reel.

4. The switchboard and transformer(s) should be unloaded in an area at the site where they will not be damaged. Directions for the spacing of the junction box and switchboard are located inside the switchboard. These directions should be followed to ensure the safety of all personnel. It is recommended that the transformers not be placed directly over the switchboard.

5. A 4 or 6 ft tubing sub will be needed to run the unit. It should be of the same size and thread as the production string.

6. Please check the wellhead. A threaded spool, casing nipple, swedge, or other hardware may be required to make up to the casing.

By following this guideline, equipment will be handled properly, and costly time will be saved during all operations.

In addition, the following practices on handling of equipment and cables are recommended.

1. The pump, motor, and cable must be handled during installation or removal according to the manufacturer's instructions. The field representative should be on all jobs, and his experience fully utilized. He must be allowed ample time to use special tools and instruments to check out the equipment.

2. The field representative should be given the authority to stop the job at any time where he feels the practices being used are not correct.

3. An assembled unit should never be stood back in the rig.

4. At all times, there should be slack between the cable reel and the cable guide wheel. Tension applied to the cable can result in a slight elongation which in turn can result in additional heat buildup in the cable. Proper procedures in the care of the cable can and does reduce cable failures. Carelessness with the cable during installation creates difficulty later which might be diagnosed as cable failure or misapplication when in actuality it is, in fact, handling damage during installation. Careful handling is imperative if cable life is to be prolonged.

5. Flexure must be kept to a minimum, and downhole equipment must be run with care to minimize any damage resulting from the cable rubbing against the well casing.

   Note: It is extremely important that there is no obstruction in the wellhead or casing that will result in damage to the cable during running operations.

   If the hole that will receive the pumping equipment has been produced by other means, then the following steps should be considered. Running a bit and scraper will clean the casing walls making sure foreign material will not hamper the installation. Following this with a gauge ring or impression block will make sure the casing is of adequate size to allow the Reda equipment to safely reach the producing area. Another preventive

measure would be to pressure test the casing for possible holes. A hole in the casing above the pumping equipment can cause premature failure due to insufficient fluid passing the motor for cooling purposes. If these procedures fail to find any problems, the well should be ready for the pumping equipment.

Taking for granted that a problem does not exist is an open invitation for costly trouble. It is more economical to take the time for these tests than it is to repeatedly replace damaged equipment, or try to fish stuck equipment. Even in a new well, a gauge ring or impression block should be run to assure that no burrs or damaged collars protrude enough to damage the power cable and equipment.

6. When pulling a pump out of the well, remember this unit is still valuable equipment and should be treated as such. Avoid dropping the unit or rough handling.

7. If the possibility exists that the equipment is to be reused, or stored for future use, the equipment should be drained and refilled with new oil. The pump should be flushed out, preferably with fresh water, then oiled and the caps put on. If the oil in the motor contains water, or is badly contaminated, it should be flushed out with clean oil and capped.

8. Shipping caps should be secured on both ends of each piece of equipment to prevent the leakage of oil or the entry of moisture or dirt.

9. The cable should be properly spooled onto a reel, sprayed with oil, and stored away from the sun.

10. The switchboard should be kept upright unless the oil has been removed from the dashpots.

11. A minor item is the check valve. A coat of oil here may preserve it in good working condition.

Note: If equipment is to be returned to the factory for repairs, try not to disturb any evidence which may be helpful in explaining the cause of operational outage.

THE SAME PRECAUTIONS USED IN HANDLING NEW EQUIPMENT APPLIES TO USED EQUIPMENT. TO AVOID HIGHER REPAIR COSTS DUE TO MISHANDLING, ALL PRECAUTIONS IN HANDLING THE EQUIPMENT MUST BE OBSERVED.

INSTALLATION

The following practices on installation and pulling operations are recommended.

1. The rig must be aligned over the well prior to running or pulling operations. If the well is not aligned, the results will be extreme cable damage.

2. Proper slips must be used for submergible operations. The slips must have an open space or guide slot for the cable to feed through. A backup should always be used when tightening tubing. If the tubing is allowed to turn, this will result in the cable being wrapped around the tubing and damaged. Slips should be kept in good condition with sharp dies of the non-rotating type.

3. Be certain that the cable is being banded to the tubing correctly and that care is being taken not to damage the cable with the slips. Any damage should be reported immediately and corrected on the spot.

4. Field service representative must be allowed to stay on site to supervise the entire installation and should not be asked to perform other functions in an area away from the installation.

5. Check cable with ohmmeter for closed circuit (balance) between phases and resistance to ground. Cable checks should be made regularly while unit is being run in. The recommended policy is to check the cable and motor approximately every 2000 feet.

6. Weather conditions are unpredictable, but a serious threat to all electrical equipment including submergibles. A major problem for obvious reasons is moisture in the form of rain, snow, or even high humidity. There is no faster way to create an electrical short than to add moisture, even in small amounts. The results are very expensive and unnecessary. If the unit can not be sheltered in such a way as to keep the moisture out of the electrical connections and motor oil, it would be more economical to delay the assembly until the weather clears enough to safely make the connections. Another problem is wind. Not only does the wind create the problem of swaying the equipment from side to side during assembly procedures (with the danger of bending or breaking the shaft), but also there is the danger of foreign material entering the motor or protector. Remembering that submergible equipment is built to exact tolerances, the introduction of sand and dirt could cause premature failure thus adding to the cost of the produced fluid. Any added care that can be taken in assemblying the equipment will result in longer runs and less operating expense.

   Taking proper precautions during installation result in a longer period of time before getting a well back on production, but experience indicates that the added time prior to installation results in more economical final results.

7. Winter seems to be the worst season of all, but all problems have solutions. Cold weather procedures have been developed that will greatly reduce the risks.

   All petroleum products tend to stiffen in cold weather. Special oil used in submergibles is no exception. If at all possible, the oil should be heated, as well as the motor and protector, to allow trapped air to escape. This is very important as trapped air will create hot spots resulting in early failures. However, if the unit is assembled as far as possible and then oiled and set a joint or two into the hole overnight, the oil will warm enough to allow the trapped air to flow out of the oil. Final oiling will be much easier. This delay will more than pay for itself in the form of longer runs and less cost to the customer due to equipment failure.

8. Power cable should fall in the extreme care category. All electrical cables are affected by cold temperatures. To get the most life from the power cable, heating of the cable should be provided at temperatures below zero. Running the cable at speeds not to exceed 1200 to 1500 ft per hour will help keep the cable useful for a longer period of time. Another measure that will increase cable life is suspending the cable sheave 30-35 ft above the ground. This will take the excess weight off of the cable, thus eliminating dangerous stretching of the insulation. This stretch weakens the dielectric qualities of the insulation and will cause the cable to fail.

9. Electric power that will best service individual installations is important. Whether the decision is generated power or a line source, certain precautions should be taken. If a generator is to be used, one of a good quality should be selected. The fuel supply should be adequate to allow the equipment to run on a continuous basis. Due to the inconsistent characteristics of the generator, operation on the hand position of the selector should be considered. This will eliminate the repeated attempts to restart if the exciter circuit fails to react. The most common means of power supply in the domestic U.S. is using a bank of three single phase transformers, which provide a stable power supply. Two basic connections are used to obtain the desired voltage. They are delta- delta and Y (star) delta and are considered the most dependable. Some rural co-ops use the practice of grounding the secondary bushing commonly known as a grounded delta. This can cause problems as a three phase motor requires a balanced power source to achieve a long life. This grounded delta will create an imbalance of various degrees depending on the power supply that can seriously impair performance. Another point is that three phase equipment requires at least two phases to operate. At times, a power cable

may be grounded on one phase and still the unit can run. However, a grounded delta has already taken one phase out of service, thus eliminating the possibility of the unit running if the cable becomes grounded on one phase. It should be noted that if a three phase autotransformer is to be used in a system where grounded deltas are used, the XO terminal or ground terminal should not be grounded. The XO terminal, not a hot line, will produce a significant amount of voltage that could be harmful to unsuspecting persons. Another connection sometimes used is a Y-Y connection. This can create unfavorable imbalances and is not recommended.

10. The installation of the switchboard should be made a short distance from the transformer bank. This prevents the switchboard from being directly under the transformers where a dangerous situation could develop. If for any reason the transformer should fail, the switchboard operator would be directly underneath the falling sparks and hot oil.

11. A junction box should be used to vent gas from the power cable before it reaches the switchboard. It also provides a means of easily disconnecting the downhole cable prior to pulling the equipment. The junction box should be mounted about 15-25 ft from the wellhead in such a way as not to be in the way of the service rig or any other work to be done in that area.

12. After the transformers, switchboard, and junction box are installed, the housings should be grounded to provide adequate safety measures against electrical shock.

13. All flow lines should be checked to ensure they are in proper sequence for startup, etc.

14. A final checkout of the installation should be made before leaving the well site. The recommended checks are as follows:

    A. Switchboard properly grounded.

    B. Recording ammeter drive wound and fitted with properly filled out, correct new chart.

    C. Ammeter pin inked.

    D. Overload and underload properly calibrated.

    E. Ensure that no-load and load voltages have been observed and noted on run ticket.

    F. Run ticket complete with proper data.

    G. Nametags been tied together and left in a safe place inside switchboard.

H. Shipping caps properly assembled and stored under or close by switchboard.

I. Purchase order number and field signatures obtained as required.

J. Make sure there have not been any tools and/or instruments left on location.

K. Legible copy of run ticket left in switchboard.

OPERATION OF SUBMERGIBLE EQUIPMENT

Testing

A careful study should be undertaken on any pump installation that does not produce as originally designed since the problems may be either with the pump and motor assembly or may be a well bore deficiency. As much information as possible should be collected to ensure that subsequent installations will be satisfactory and sized correctly.

A means of gauging should be provided on start-up. The unit should be closely observed for the next couple of days, and good initial start-up data obtained. Periodic tests and equipment analysis are required to obtain the most efficient service from any artificial lift system.

Data Gathering

The importance of collecting good production and operating data on an installation cannot be overstressed. This data will be used as follows:

1. To check the installed design.

2. For resizing, if necessary.

3. Catching and preventing possible problems that could cause failures.

4. Economical evaluation.

5. As an aid in analyzing and determining the reason for any failures.

It is bad operating practice to replace an existing pump assembly that is missized with the same size merely because one is available from the manufacturer's warehouse. Whenever it is determined that the well is equipped with an improper pump, the pump company should be contacted so a properly sized unit can be built and put into stock.

Communications

A good line of communication should exist between the field representative and company representatives. The job of data gathering and well monitoring should be a combined effort. Once a submergible pump is correctly sized and its operation is properly monitored, the installation becomes a relatively trouble-free operation.