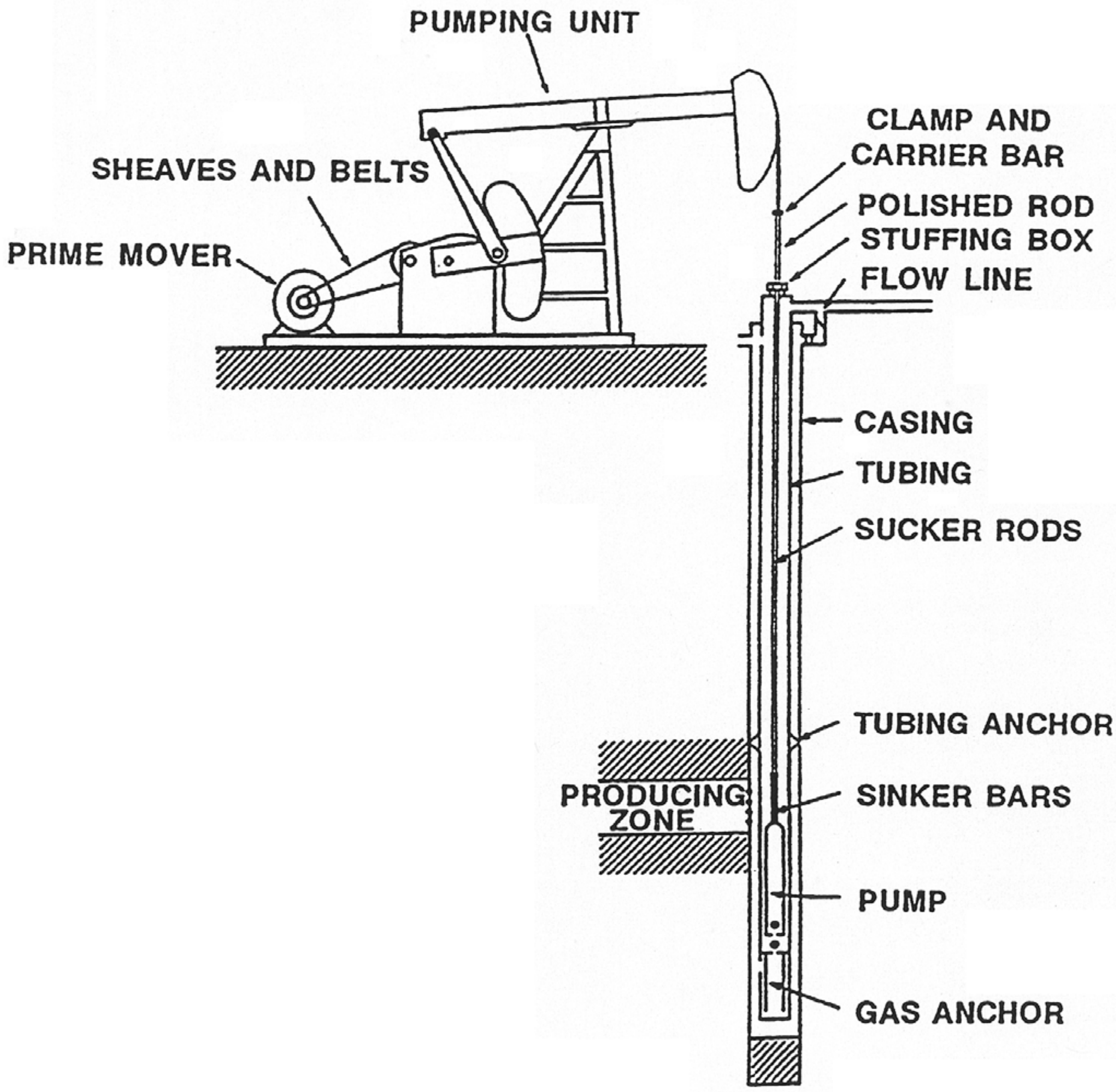
Overview of Beam Pump Operations

Beam Pump System



Beam Pumping Systems The Most Commonly Applied Worldwide Artificial Lift Method

- 59% of All Artificial Lift In North America And 71% of 832000 Wells For The Rest Of The World
- 2 Million Oil Wells In The World And About 1 Million Wells Utilize Artificial Lift and 750,000 of the lifted wells use sucker rod pumps
- U.S. beam lift systems lift about 350,000 wells. About 80 percent of U.S. oil wells are stripper wells, making less than 10 bpd
- We will discuss the concerns that operators face when using the sucker rod pumping system

Beam Pump System Considerations and Advantages/Disadvantages:

1. **Beam systems should be considered for lower volume stripper wells**
2. **Proven to be cost effective.**
3. **Operating personnel are usually familiar with these mechanically simple systems.**
4. **Less experienced personnel can operate rod pumps more effectively than other types of Artificial Lift .**
5. **Beam systems can operate efficiently over a wide range of production rates and depths.**
6. **Systems have a high salvage value.**
7. **Surface units and gearboxes can last in excess of 30 years if not loaded in excess of 100%.**

Beam Pump System Considerations and Advantages/Disadvantages:

1. **Beam systems should be considered for lifting moderate volumes from shallow depths and small volumes from intermediate depths.**

2. **Possible to lift up to 1,000 BPD from about 7,000 feet and 200 barrels from approximately 14,000 feet (special rods may be required and resultant rates depend on conditions present).**

3. **More commonly lower rates are lifted from 7,000 feet and few wells are lifted by Beam below 10,000 ft.**

Beam Pump System Considerations and Advantages/Disadvantages:

1. Many parts of the Beam system are manufactured to meet existing standards, which have been established by the American Petroleum Institute (API).

2. Numerous manufacturers can supply compatible interconnecting parts.

3. many components available that are not API certified, such as larger/smaller diameter downhole pumps (SRP's) extending beyond API sizes.

Beam Pump System Considerations and Advantages/Disadvantages:

1. Sucker rod string from the surface to the downhole pump is continuously subjected to cyclic fatigue loads.

2. Rods must be protected against corrosion and from damage from running/pulling more than any other AL system, since corrosion introduces stress concentrations and lead to early failures.

3. Special high strength (HS) and fiberglass (FG) rods are available.

Beam Pump System Considerations and Advantages/Disadvantages:

1. Often incompatible with deviated (doglegged) wells, even with rod protectors, and rod and/or tubing rotators.
2. Deviated wells with low dogleg severity may allow satisfactory performance, even if the angle is large (~30-40 Deg and some up to 80 Deg).
3. Some high angle hole systems employ rod protectors and “roller-rod protectors”
4. High glass content in protector increases abrasiveness and will rod cut tubing.
5. Plastic lined tubing is effective in reducing rod/tubing wear.

Beam Pump System Considerations and Advantages/Disadvantages:

1. Sand causes problems. Some pumps are designed to either exclude the sand or operate as the sand travels through the barrel-plunger clearance. Special metallurgies are employed for fine sand wear.

2. Paraffin and scale can interfere with the operation of Beam systems. Special wiper systems on the rods, and hot water/oil treatments are used to combat paraffin. Hard scales can cause early failures.

Beam Pump System Considerations and Advantages/Disadvantages:

1. Free gas entering the downhole pump reduces production.
2. Use proper down hole gas separation techniques to restrict free gas from entering the sucker rod pump
3. Most effective method of down hole gas separation is to set the pump intake below all gas and fluid entry zones.
4. Gas interference is one of the most common reason for low producing efficiencies
5. Operate with the pump filled with liquid

Beam Pump System Considerations and Advantages/Disadvantages:

1. One of the disadvantages of a beam pumping system is that the Polished Rod (PR) stuffing box (which is where the PR enter the well at the surface through a rubber packing element) can leak.

2. Special pollution free stuffing boxes that collect any leakage are available.

3. Good practice such as “don’t over tighten”, and “insure unit alignment”, are also important.

Beam Pump System Considerations and Advantages/Disadvantages:

1. **Pump Capacity greater than maximum liquid inflow from the reservoir leads to:**
   - **Incomplete pump fillage, "fluid pound"**
   - **Mechanical damage**
   - **Low energy efficiency.**
2. **Simple changes in pumping speed and stroke length can be made to match withdrawals to inflow.**
3. **POC (pump-off controller) systems are designed to produce 20-50% more than reservoir inflow.**
4. **Percentage timer is low cost method to control run time.**
5. ***Pumping with full pump barrel each stroke*** **is the primary requirement for trouble free efficient operations of the Beam Pump system.**

Best Practice for Rod Design:

1. Use well's inflow performance to determine if additional production is available.
2. Determine the overall efficiency to identify wells that are candidates for improvement.
3. Analyze the performance of the pump.
4. Analyze the performance of the downhole gas separator.
5. Analyze mechanical loading of rods and beam pumping unit.
6. Analyze performance of prime mover.
7. Design modifications to existing system.

Best Practice for Rod Design:

1. Design with no additional load on pump
2. Use default dampening factors
3. A low pumped off level of about 50’ should be used for a conservative maximum load on the pump.
4. 100 % pump load should be input.
5. Use motor option for speed variation and use defaults for inertial values.
6. Before accepting a High Strength Rod design, evaluate design of D Rod using a Service Factor of 1.

Best Practice for Rods:

1. **Use Grade D rods with T couplings ~ Use Spray Metal couplings if wear and economics dictate.**
2. **High Strength rods should only be used when absolutely necessary.**
   - **EL HS rods do not have HS pins.**
   - **Use HS couplings with HS rods.**
   - **Be cautious of slim hole couplings with HS rods.**
   - **Be cautious of HS rods when H2S is present.**
3. **All rods should be designed with loadings using your field established service factor. If field established Service Factor is not available, then use 1.0 for service factor. Do run HS rods until rod loading on D rods exceed 100% when using a 1.0 service factor.**

Best Practice for Rods (continued) :

4. Use steel as opposed to FG unless economical to do otherwise.
5. Use lighter % loading with FG (~ 80%) using lowest temperature rating, usually shown in predictive program input/output.
6. FG is used for deep wells when rod loading is a problem. Use FG rods for perhaps 50-70% of the top of the string and steel rods for the bottom of the string to keep the FG out of compression.
7. With FG, a shear tools should be run on all wells that have shown any tendency to stick pumps.

Best Practice for Rods (continued) :

1. Inspect both new and used rods for:
   – manufacturing damage
   – meet specification
   – handling damage
2. When running rods in well use proper handling
3. Use Make-up with displacement card will reduce early failures and increase run life.

Best Practice for Pumps:

1. **Use larger pumps without overloading the unit and rods.**
2. **Use a simple design. More complicated pumps fail more and cost more.**
3. **Use heavy wall pumps. Thin wall pumps have less corrosion and pressure resistance.**
4. **All pumps should be designed and built where the TV is within 1” of the SV when pump bottoms out on the clutch at the top.**

Best Practice for Pump Leakage:

1. **Pump leakage should about 2-5% of production.**

2. **High water cut wells should have more pump leakage.**

3. **Deep wells can have pumps with smaller clearances.**

4. **Use new leakage equation to calculate downhole clearances.**

Tubing Best Practice:

1. Use J55 tubing on producing wells with depths no greater than 8500'. For deeper wells, calculations must be made. Use couplings of same grade as the tubing.

2. Run the seating nipple as deep as possible.

3. Minimize the distance between the tubing anchor and the seating nipple. In open hole, the tubing anchor should be as close to the casing shoe as possible. In cased hole, the tubing anchor should be out of the perforated zones. Use caution when setting the anchor below any perforations, because fill may stick the anchor.

Tubing Best Practice (continued):

4. In wells deeper than 3000 feet justify why not to use a tubing anchor. Corroded casing or small diameter pumps are reasons not to use tubing anchor.
5. Use API modified no lead thread sealant spread over complete thread area.
6. Tubing below the anchor should be inspected for excessive wear on each pull and replaced if worn.
7. Use thread protectors until tubing in derrick.
8. No wrench marks are acceptable on tubing anchors. Use only ISO 9000 replacement parts.
9. A non API seating nipple should be used only on 2 7/8's tubing strings. The API nipple can cause the pump to stick.

Gas Separators:

1. Set pump intake below the gas entry point into the well.
2. If not possible, consider the collar size gas separator instead of the poor boy separator.
3. An improperly sized gas separator is worse than no separator
   - it can trap gas into the pump
   - the separator can becomes gas locked.

Beam Pumping Unit - General:

1. Unit should have the concrete base set on 5/8's river stock. Sand can wash out.
2. Unit and wellhead must be aligned correctly so the polish rod pulls out straight.
3. Daily Check stuffing box. Don't over tighten causing wear on polish rod and increased output horsepower from motor.
4. Weekly the unit should be inspected for abnormal sounds, grease or oil leaks, or rust stains at metal joints.
5. Every six months, grease all bushings, inspect unit and GB oil for contamination, check tightness of all bolts, follow check list and keep records.

Beam Pumping Unit (continued) :

1. GB and unit structure load should be below 100%.
2. Perform Yearly Maintenance on Surface Equipment.
3. Use a predictive program to help size the motor. If program says a 32 HP is needed and the next bigger available size is 50 HP, then use it. In general you loose significant energy only when the motor size exceeds about 2X the correct motor size. Use only NEMA D motors.
4. Polish Rods: Spray metal polish rods without liners should be used in all CO2 flood beam lifted wells and corrosive wells. Water flood and primary wells can use either a liner on the polish rod or a spray metal polish rod.

Fluid Level Detection:

1. Shoot fluid levels regularly, including wells that are on POC.
2. Dynamometer cards can indicate if a well is pumped off or has other problems.
3. Shoot fluid levels when the well is being tested for production rate.
4. Consider a lift revision to increase the pumping capacity if additional potential is indicated.

Perform Complete Acoustic, Dynamometer And Motor Power Survey of Well

1. Analyze the Performance of the Well and the Equipment
2. Determine the well's productivity, the downhole pump performance, the down hole gas separator performance, the rod and beam unit loading and the motor performance.
3. Take steps to maximize the well's production rate
4. Make Recommendations to fix any problems discovered in the analysis of the collected data
5. When the recommended changes to the well are completed, new data should be collected in a few weeks once the well is operating under stabilized conditions.
6. Notice if the well performance has changes as planned.
7. Evaluation of the recommended changes is called the follow-up process.
8. Following-up on recommendations is how experience is gained and the analyst role changes from a data collector to a knowledgeable well analyst and problem solver.

Perform Complete Acoustic, Dynamometer And Motor Power Survey of Well

1. **Maintain high volumetric efficiency:**
   - **Match pumping requirements to well inflow.**
   - **Eliminate Gas interference**
   - **Use Full Pump Capacity by controlling run time with a POC or Timer**
2. **When System Efficiency is low, find and fix problem.**
3. **Verify power meter calibration.**
4. **Mechanically / electrically balance pumping unit.**
5. **Properly size pumping unit to match well loads.**
6. **On severely over sized motors where average surface efficiency falls below 50% change motor.**

Conclusions

1. Periodically monitor with dynamometer surveys and the diagnostic pump card shapes should be used to insure that the pump has no mechanical problems and efficient operations are maintained.

2. Fluid level surveys should be used to confirm all the available liquid is produced from the well.

3. Percentage timers and POC operate the Beam Pump system only when the downhole pump is filled with fluid else low efficiencies and equipment damage usually result from gas interference and fluid pound.

4. Applying the simple best practices to beam pumped systems will result in lower operating cost and longer equipment life, but some of the practices may not be best for all fields.

5. Any time the operator makes changes to his normal practices, then follow-up analysis should made to confirm that the new best practice is working as desired.

Questions?