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Overview of Beam Pump Operations

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Abstract

Beam pumping systems are the most commonly applied worldwide artificial lift method with 59% of all Artificial Lift in North America and 71% of 832000 wells for the rest of the world (World Oil 2000). This paper reviews many of the concerns that operators face when using the sucker rod pumping system. Operational concerns are introduced with a review of the advantages/disadvantages of the system. Automation and Pump-off Control (POC) are discussed. The most commonly automated operating parameters are examined and the technique of configuring POC set points is llustrated. To maintain efficient operation requires that pumping should be done only when the pump has a high percent of liquid fillage. Methodology for designing how to efficiently produce the well by selecting pumping speeds, stroke lengths and plunger diameters is reviewed.

Incomplete pump fillage, tagging on the downstroke, and other downhole conditions contribute to rod buckling and subsequent accelerated rod/tubing wear and possible other damage. Commonly applied solutions such are weight bars and rod guides are reviewed. Dynamometer cards, particularly calculated downhole pump cards are used for diagnostics of problems that exist in a well.

Finally simple best practices are reviewed covering POC's, use of predictive design programs, guidelines for sucker rod applications, downhole pump best practices, surface unit best practices, tubing, gas separation, use of fluid level instruments (fluid shots), effects of casing pressure, and finally some mention of solution to corrosion problems. The paper reviews older practice and suggests newer practice to assist the operator with operational concerns. In general, sucker-rod pumping is the premier method of artificial lift. Many operators will use some other lift method only after justifying why not to use beam lift.

Introduction

Beam systems, **Fig. 1** are the oldest and most widely used type of artificial lift for oil wells. There are about 2 million oil wells in the world and about 1 million wells utilize artificial lift. Over 750,000 of the lifted wells use sucker rod pumps. In the 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 and these are primarily beam lifted.

A beam pumping system is shown in **Fig. 1.** The **Prime Mover** may be either a gas engine or electric motor. If power is available, an electric motor is most often selected because of ease to start and stop when used with a POC. Also the electric motor is dependable with low maintainance cost and is good for all weather conditions. **Belts and Sheaves** are usually trouble free when properly tightened and protected with a belt guard. The selection of the motor sheave diameter is used to control the pumping speed. The **Pumping Unit** is a system of linkages that convert the circular motion of the prime mover into a linear up and down motion of the polished rod. The **Pumping Unit** structure must support the entire weight of the sucker rods in fluid, the fluid load applied to the rods by the pump, plus any additional acceleration loads resulting from moving the rods and pump. The counter weights are positioned on the **Pumping Unit** crank arm to uniformly balance the gearbox loading on both the up and down stroke in such a way that a maximum of ½ of the fluid load applied to the rods by the pump is lifted by the prime mover. The entire weight of the rods and fluid load are applied to the **Carrier Bar** and the loading is applied to the **Pumping Unit** structure by two strong large diameter wire strand cables. The **Sucker Rods** are held on the **Carrier Bar** with one or more clamps attached to the **Polished Rod**. The rubber packed **Stuffing Box** provides a seal around the **Polished Rod** to prevent fluid leakage at the well head. From the surface to the bottom of the well, a large diameter pipe called **Casing** is installed to hold the wellbore open and allows **Tubing** and **Sucker Rods** to be installed into the well from the surface to the **Producing Zone**. Part of the downhole **Pump** is attached to the **Sucker Rods** and part of the **Pump** is attached to the **Tubing**. Up and Down motion of the pumping unit causes the **Sucker Rods** to move the **Pump** and to produce fluids up the tubing and into the surface **Flow Line** during each stroke. A **Gas Anchor** should be used to prevent free gas from entering the **Pump** if setting the pump above the perforations. **Sinker Bars** are used to prevent damage to the tubing and rods, if the rods buckle. These many features of the Beam Pumping System work together to to artificially lift fluids to the surface.