Middle-East Journal of Scientific Research 20 (5): 671-673, 2014
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2014.20.05.11361

Design of Oil Field Pump

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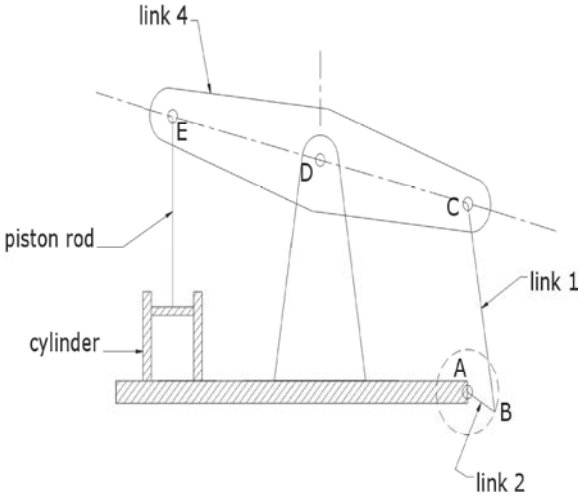
Abstract: To design and fabricate a oil field pump (sucker rod pump) used to draw oil from underground reservoirs. The four bar linkage mechanism which it employs can be found on door dampers, on automobile engine and on devices such as the lazy tong find its application. This project is aimed at to draw oil from oil well.

Key words: Fabricate a oil field · Linkage mechanism · Lazy tong find

INTRODUCTION

The oil field pump is one of the most popular machines ever invented that are used primarily to draw oil from underground reservoirs. The mechanisms it employs however are found in a wide variety of machines. The four bar linkage can be found on door dampers, on automobile engines and on devices such as the lazy tong. It is also known as SUCKER ROD PUMP. It is installed in approximately 90% of all wells in the U.S. and has been widely used for decades. Its construction is simple and robust with just few processes involved [1].

The Oil Field Pump Basically Involves GRASHOF CONDITION and MOBILITY:



Grashof Condition: The grashof condition is used when analyzing KINEMATIC CHAINS for a four-bar linkage, the grashof condition is satisfied if S + L <= P+Q where S is the shortest link, L is the longest and P and Q are the other links [2]. When the grash of condition is satisfied, at least one link will be completely rotatable.

The spur gears supply power to turn the power shaft. there is a counterweight at the end of the crank. A pitman arm is attached to the crank and it moves upward when the crank moves counterclockwise. The Samson arm support the walking beam. The walking beam pivots and lowers or raises the plunger. The rod attaches the plunger to the horsehead. The horsehead allows the joint (where rod is attached)to move in a vertical path instead of following an arc. Every time the plunger rises, oil is pumped out through a spout. The pump consists of a four bar linkage is comprised of the crank, the pitman arm and the ground [3].

The whole pump can be assembled and connected to the lower end of the sucker rod pump on the ground, run into the well as a unit and fixed in the tubing at the required depth. The work over operation time for a rod pump wells much shorter than a tubing pump well by at least 50%.

Rod Pumps Have Three Types:

Stationary Barrel Bottom Anchor Rod Pump: It is suitable for deep well since the barrel only bears pressure from outside and does not bear tensile load and its clearance change is small. But it is not recommended for

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sandy wells since there is no circulation for the well fluid around the outside of the barrel so pump may become stuck in the tubing by packed sand [4].

Stationary Barrel Top Anchor Rod Pump: The top anchored pump with stationary barrel is suitable for sand production well since the fluid discharged from the guide cage washes away sand between the tubing and top of the pump. But the pump barrel is more subject to inside pressure and tensile load caused by the fluid column and the plunger clearance will intend to increase during up strikes so the top anchored pumps are not recommended in deep wells [5].

Traveling Barrel Bottom Anchor Rod Pump: Travelling barrel pump is recommended for sandy well since the movement of the travelling barrel keeps the fluid in motion and sand washes down, which minimizes the possibility of sand setting around the pump and sticking it. The travelling barrel is particularly recommended for well being intermittently since the ball in the top cage will seat when the well is shut down, sand cannot settle inside of the pump. The travelling barrel pump is not suitable for gassy wells and viscous fluid wells. It is not recommended for the pumps with long stroke in deep wells.

Machine Used in Operation

The Lathe: The lathe is one of the oldest machine tools and came into existence from the early tree lathe which was then a novel device for rotating and machining a piece of work held between two adjacent trees. A rope wound round the work with its one end attached to a flexible branch of a tree and the other end being pulled by a man caused the job to rotate intermittently. Hand tools were then used. With its further development a strip of wood called "lathe" was used to support the rope and that is how the machine came to be known as lathe.

Drilling Machine: The second important machine tool after the lathe is the drilling machine. Drilling operation can be performed in a lathe also, but when performed in a drilling machine the operation is faster and is done at a low cost. In drilling operation a large thrust is expected on the job clamp on the table and hence the drilling machine is sometime called as "drill purse".

Operation on a Drilling Machine:

- Drilling
- Remaining
- Boring
- Counter boring
- Counter sinking
- Spot

Grinding Machines: Grinding is a metal cutting operation performed by means of a rotating abrasive wheel that acts as a tool. This is used to finish work pieces which must show a high surface quality accuracy of shape and dimension. The art of grinding goes back many centuries.

Mostly grinding is the finishing operation because it removes comparatively little metal, 0.25 to 0.50mm in most operation and the accuracy in dimension is in the order of 0.025 mm. Grinding is also done to machine material which are too hard for other machining methods that use cutting tools.

Kinds of Grinding: Grinding is done on surface of almost all conceivable shapes and materials of all kinds. Grinding may be classified broadly into two groups.

- Rough or non precision grinding
- Precision grinding

Milling Machines: A milling machine is a machine tool that removes metal as the work is fed against a rotating multipoint cutter. The cutter rotates at a high speed and because of the multiple cutting edges it removes metal at a very fast rate. The machine can also hold one or more number of cutters at a time this is superior to other machines as regards accuracy and better surface finish and is designed for machining a variety of tool room work.

The first milling machine came into existence in about 1770 and was of French origin. The milling machine cutter was first developed by Jacques de vaucanson in the year 1782. The first successful plain milling machine was designed by Eli Whitney in the year 1818.

Calculation

Preliminary design data:

Stroke	45mm
Ultimate tensile strength	200N/mm^2
Design surface stress	500N/mm^2
Bending stress	50N/mm^2
Endurance limit stress min	100N/mm^2
Nut strength in shear	80N/mm^2
Bearing pressure	18N/mm^2

Design Calculation for Gear:

Gear Material: Cast iron grade 20

$\sigma u = 200 N/mm^2$

$\sigma_{-1} = 10 N/mm^2$

Design stress [σb] N/mm^2 = 50N/mm^2
Factor of safety =2.5

$$Speed\ ratio = \frac{N1}{N2} = \frac{T1}{T2} = \frac{85}{90} = 0.9$$

Data:

$T_1 = 85$
$T_2 = 90$

Centre distance x = 145mm
$d_1 = 130$mm
$d_2 = 140$mm

$$m = \frac{2x}{z1 + z2}$$

$$= \frac{2 \times 145}{85 + 90}$$

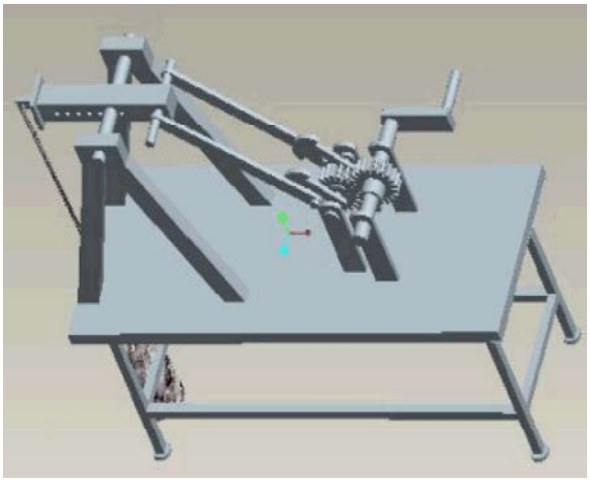
= 1.65mm

Adopt m = 2 (standard)

Where,

T_1 = no. of teeth for driver
T_2 = no. of teeth for driven gear
X = centre distance
d_1 = pitch diameter of driver gear
d_2 = pitch diameter of driven gear

Assembled Three Dimensional View Of Oil Field Pump



CONCLUSION

The oil field pump is designed and fabricated keeping view to draw oil from well. Its principle is based on four bar linkage mechanism. The four bar linkage mechanism which it employs can be found on door dampers, on automobile engine and on devices such as the lazy tong find its application. This project is aimed at to draw oil from oil well.

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