Productivity Improvement of Lathe Machine By Using Hydrualic Tailstock in ABC Industry

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Abstract- *In small industries where profit is only base to challenge future challenges we have to update our methods, operations and techniques. For conventional drilling operation carried out in small scale industry, operation takes human efforts and time. For this problem we suggest a hydraulic system which results in less human efforts and time.*

Pascal's law is the key idea behind using hydraulic system for carrying out drilling operation. In hydraulic system, pressure applied on hydraulic oil at one point is equal to pressure at every point. With the help of assembly of power pack carrying various components like motor, pump, direction control valve, flow control valve, pressure switch, 3-way electrical switch we are giving power of hydraulic fluid to drill bit to carry drilling operation. In this project hydraulic cylinder is attached with tailstock spindle with the help of clamping plate and extension device.

Hydraulic tailstock concept will lead small scale industries to sustain their increasing production rate and very relax environment in lab ours. There are also alternative systems for drilling but hydraulic system dominates them in case of continuous pressure, low maintenance and no noise criterion. So hydraulic tailstocks have bright future in small as well as profit demanding industries.

Keywords- Drilling operation, Hydraulic system, Productivity improvement

I. INTRODUCTION

In this profit demanding industrial world we just have to put efforts in developing new handy tools, processes and operations. In ABC Company machining of the gears will done on various kind of lathe machines. Drilling is also one of the operations done on the lathe machine. Conventionally movement of tool which is mounted on tailstock is done with efforts of the operators. It also consumes time a lot. It also leads to slow production rate. According to this problem we have to build something that we will succeed in overcoming above drawbacks. So let's build something awesome.

To reduce efforts of operators and to save time we will build electro-hydraulic tool. Movement of tool is controlled by pressure of oil in hydraulic cylinder. And its operation is controlled with electric switch having ON/OFF control.

We generally think of a hydraulic system as that the collection of components and conduits that is used to transfer power to do work. But that's a bit dry when said like that, so let's get dirty and build a system to do something useful.

We need a pump to pressurize the fluid, and a motor to drive the pump. The pump will have a reservoir to hold fluid, and a safety valve to allow the pressurized fluid to flow back into the reservoir when the pressure is too high (like when the system is "ON" but not doing anything). We use tubing, hoses and such to transfer the pressurized fluid to a ram or piston or hydraulic motor to do work. The ram, piston, motor or other "user" of the pressure will have return lines to take the fluid back to the reservoir. There will be valves to direct the flow of fluid, as you might have guessed, and probably a filter in there somewhere, too. By energizing the system, we can direct the fluid to operate a ram and lift a vehicle so a technician can work on it from underneath. Or we can operate the rams on a dump truck to lift a dumpster and dump it. Or we can drive hydraulic motors in the wheels of a skid steered or high lift work apparatus to move it to where we need it. There are lots of uses for hydraulic systems, and a whole industry is dedicated to the application of the ideas. It's called the fluid power industry, and we see forklifts, smaller construction equipment and all sorts of other equipment and devices that are sold and serviced under the fluid power umbrella.

II. PROBLEM DEFINITION

In ABC Company machining of the gears will done on various kinds of lathe machines. Drilling is also one of the operations done on the lathe machine. For mounting the gear on the shaft one drill hole is required. This can be carried out with the help of drilling operation which can be done on the lathe machine. This requires man power .The worker can drive the tailstock wheel, when he moves in clockwise direction then tailstock bar moves forward and operation is done .But this can require power which varies with material. So this takes more time for operation. In our industry they also use the conventional techniques for drilling operation. They are work out the 150 jobs/shift. So they face problems like lower production and also worker are not comfortable at the time of drilling so the workers get tired.

III. IDEA GENERATION

By understanding the problem statement we came to know that problem has number of solutions. As the drilling operation is done by moving the tailstock bar .This can be moved with the help of following mechanical techniques like Pneumatic operation, Rack and Pinion arrangement and Hydraulic operation. In ABC Company we use Hydraulic operation.

a. Hydralic Operation:

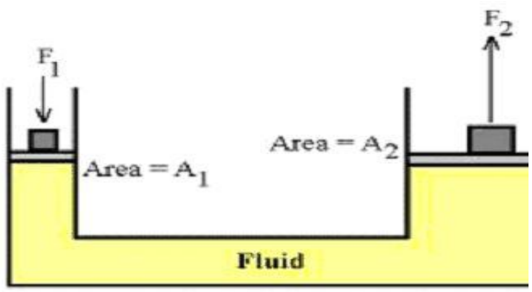

Fig. 1.Priniciple of Pascals Law

In the 1600's, the French scientist Blaise Pascal discovered a fact now known as Pascal's Law. It states that pressure at any point in a body of fluid is the same in every direction, exerting equal force on equal areas. This works for gases and liquids (both are fluids)

b. Advantages:

- Power and versatility
- Resilience
- Worker safety
- Environmental cost
- Energy efficiency

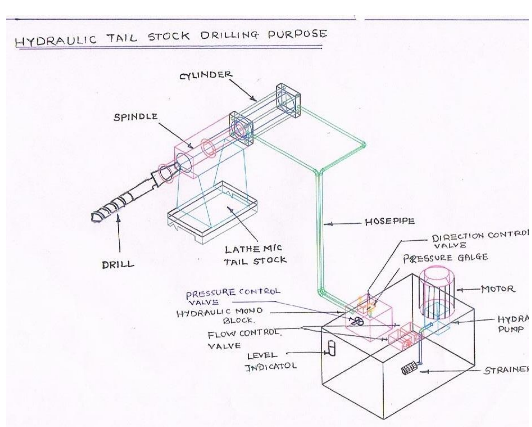

Fig. 2.Conceptual Design of Drilling operation.

c. Elemenst of Hydraulic System with their Function:

- Reservoir:-These elements include oil tanks pressure gauge, levelindicators, temperature switch, etc.
- Fluid conducting element:- These elements include pipe, connectors,hoses, etc.
- Fluid control element:-These elements include flow control valve, direction control valve, pressure control valve, control valve.
- Fluid conditioning element:- These elements include strainers, filters, etc.
- Fluid pressurized element:- These elements convert mechanical energy into hydraulic energy. These include gear, vane, and piston pump.
- Fluid power utilized element:- These elements convert hydraulic energy into mechanical energy. These elements include linear, rotary &limited rotary actuator.

IV. CIRCUIT DIAGRAM FOR DRILLING OPERATION

In the meter-out operation shown in Figure 2, the direction of the flow through the circuit is simply changed as can be made out from the diagram. It is the opposite of a meter-in operation as this change in direction will cause the fluid leaving the actuator to be metered. The advantage with the meter-out operation is that unlike in the case of meter-in operation, the cylinder here is prevented from overrunning and consequent cavitation. One major problem confronting the meter-out operation is the intensification of pressure in the circuit which can in turn occur on account of a substantial differential area ratio between the piston and the rods. Pressure intensification occurs on the rod side when the meter-out operation is carried out without a load on the rod side of the cylinder and can result in failure of the rod seals.

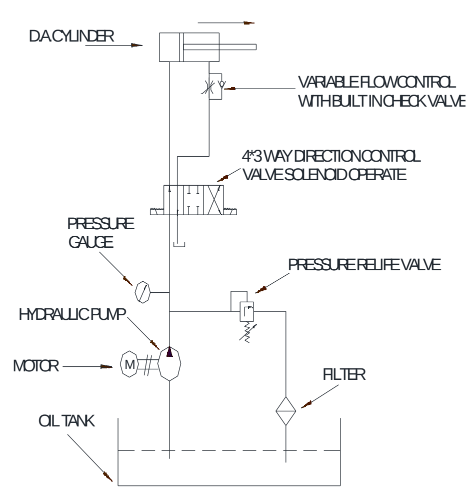

Fig. 3.Meter out circuits

V. DESIGN AND CALCULATIONS

Company data

Bore diameter of gear=20 mm

Material of gear= Cast iron

Calculations:

Diameter of drill D=20 mm ……… (Selected)

To calculate Revolution per min(n)

Cutting speed V = $\frac{\pi D\, n}{1000}$

V = $\frac{\pi \times 20 \times n}{1000}$

……… {From Table (Reference from CMTI table 277)

For Cast iron V = 20-23 m/min

Hence V = 0.5 * (20+23) = 21.5 m/ min}

n = $\frac{21.5 \times 1000}{\pi \times 20}$ = 342.183 rpm

Feed / revolution (S) = 0.2-0.3 …… (from CMTI)

= 0.3 mm/revolution …… (Selected)

Material Factor K = 1, 1.5, 2.03

= 1.51 …. (Selected average from table 272 in CMTI)

Power at spindle N (KW)= 1.25 D2Kn(0.056+1.5 S)/105

= 0.0038 KW = 3.8 W

Efficiency of transmission (E) = 85% …………. (System standard)

Power of motor (Nel) = $\frac{N}{E}$ = 0.00447 KW

Torque (Ts) = 975 $\frac{N}{n}$ = 10.828 kgf.m

=10.828 ×9.81 = 106.222 Nm

Thrust force (Th)= 1.16 K×D(100×S)0.85

=630 Kgf× 9.81

= 6189.138 N

Flow Calculations:

We know that, Pressure P = $\frac{Force}{Area} = \frac{F}{A}$

Here, Pressure (P) = 25 bar = 25× 105N/m2=250 N/mm^2

Force=thrust force= 6189.138 N

$\therefore$ A= $\frac{6189.9138}{25 \times 10^5}$ = 0.00247596 m^2

= 2475.96 mm^2

And A= $\frac{\pi}{4} \times d^2$= 2475.96

$\therefore$ Bore diameter d = 0.05527 mm ~ 60 mm ~ 6 cm

Hence new area = $\frac{\pi}{4} \times d^2 = \frac{\pi}{4} \times 6^2$= 28.2743 cm^2

By using empirical relation

Bore diameter= 1.5 × Rod diameter

$\therefore$ 60 = 1.5 × Rod diameter

$\therefore$ Rod diameter = 40 mm= 4cm

$\frac{\text{Cylinderborearea}}{\text{Annulus area}}$ = 1.5

$\therefore$ Annulus area= $\frac{\frac{\pi}{4} \times (6)^2}{1.5}$ = 18.8495 cm2

Piston rod area = Cylinder bore area – annulus area

= 28.2743 – 18.8495

= 9.4248 cm2

Flow rate requirement:

Liquid Flow rate Q= Piston speed × Area of cylinder

= 238.76× $\frac{\pi}{4}$ × (6)2

$\therefore$ Flow rate= 6750.7718 cm3/ min

= 6750.7718× 1000

= 6.75~ 7 lpm

Flow rate during advance: 7 lpm

Calculation to determine nominal sizes of houses

A = $\frac{Q}{V}$ and A = $\frac{\pi}{4}$× d2

Where d= diameter of hoses

$\therefore$ d = $\sqrt[2]{\frac{4 \times Q}{\pi \times V}} = \sqrt[2]{\frac{4 \times 6750.7781}{\pi \times 238.76 \times 60}}$

=0.7745cm= 7.745mm~ 8 mm

Motor specifications:

Electric Motor capacity Horse power = (flow rate * Maximum pressure) / 380

= 7 * 32 / 380

= 0.58947 HP

1 HP (next available)

Oil Reservoir Size:

Oil reservoir with suction filter in input side practice is used. To the same, while designing, reservoir is generally 3 times greater than pump than pump flow rate capacity / minute

(A). Oil Reservoir Size = 3 * flow rate of pump

= 3 * 7

= 21 liters

Heating of oil causes the problem related to change in fluid properties. This may change the system settings and hence the reservoir is made of extra capacity.

Capacity of oil reservoir = 2 * (A)

= 2 * 21

=42 liters (40 liters actual)

A. Lathe specification

1. Company: Annapurna
2. Lathe Motor:-
    - 3.7 - KW
    - 5 - Hp
    - 1440 - RPM
    - 440 - VOLT
    - 7.4 - AMPER
3. Chuck Type:-Three jaw chuck
4. Lathe Drive:-Belt drive

B. POWER PACK

Fig. 4.Power pack cylinder

- Clamping plate
- Extension device
- Capacity: 40 ltr
- Cost: 35000 rs.
- Ports: 2
- FUNCTION: To store the oil and supply whenever required.

Fig. 5.Attacment of Actuator on Lathe machine

VI. RESULTS AND DISCUSSIONS

TABLE I. COMPARISON OF TIME AND HOURLY PRODUCTION RATE

Parameters	Before	After
Drilling Diameter	20mm	-
Work piece	20mm	-
Time required to drill	180 Sec	54 Sec
Hourly production rate	10 Jobs	27 Jobs

In ABC Company we installed hydraulic power pack on ACME lathe machine which gives maximum pressure output of 32 bar. With this output pressure drilling operation is carried out. Before implementation the production rate was 10 jobs per hour and also more human efforts required to carry out drilling operation. Also time required for completion of drilling operation for single job of 20 mm diameter was 180 sec. After successful implementation of our project production rate increases to 25-30 jobs per hour and also time required for completion of same job is reduced to 54 seconds with less human efforts. Hence it is conclude that the production rate is increased by 2.5 times than the initial rate.

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