International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Automation of Drum Washing Machine by using Hydraulic Cylinder

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Accepted 12 March 2017, Available online16 March 2017, **Special Issue-7 (March 2017)**

Abstract

In pharmaceutical industry, a lot of importance is given to hygiene. It is necessary to maintain hygiene in the industry for the welfare of the workers. Hence, to maintain hygiene in the industry it is necessary to make operations such as cleaning of drums, which are used for bulk production, automatic. This is done by using steam washing system. This is where hydraulic system comes in. The hydraulic system helps to make the whole process automatic as no workers are needed to manually lift the drums for cleaning.

Keywords: *Hygiene, Hydraulic Cylinder etc.*

1. Introduction

Hydraulic systems have played a vital role in various applications for various industries. The first practical hydraulically operated machine waste hydraulic press, invented by Joseph Bramah in 1796.Bramah's press embodied the principle originally demonstrated by Pascal in 1647, where-in fluid pressure created by applying a force to a small area plunger in a closed cylinder can be used to act on a larger area plunger to produce a correspondingly larger force if the fluid spaces in the two plunger cylinders are connected by a pipe.

Today there are many different forms of hydraulic power and water power that are currently being used or developed. The majority of them generate electricity but there are a few that are mechanical. We see examples of hydraulic power in use all around us today.

Hydraulic cylinders are basic components of hydraulic control and actuation of mechano-hydraulic systems. The hydraulic cylinders convert the hydrostatic energy into mechanical energy, by achieving, within a certain time, a certain force, with a certain speed in a straight stroke. The continuous development of the field of hydraulic acting systems, their penetration in the most unexpected industrial applications, caused that each component to be investigated very carefully, in terms of ensuring the technical performance claimed.

Problem Statement

Development of hydraulic system for automation of drum washing machine.

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Objective

With the increasing demand for hygiene in pharmaceutical industry, it is important to develop a automatic system for cleaning to meet the needs of the industry. As in case of this project the automation is done using a hydraulic system for lifting the drum which is to be cleaned. The main objective of this project are as follows:

To develop a low cost hydraulic system.
To develop power pack to take the load of the system.
To develop a hydraulic cylinder which can be used for a long period of time.

Scope

Scope of this project is to develop an automated system for cleaning of the drum which are used for producing drugs. Overall scopes of this project are stated below:

- Designing of hydraulic system.
- Fabrication of the hydraulic system.
- Assembly of hydraulic power pack and cylinder.
- Testing of the hydraulic system for the given application.

Methodology

Design

- Designing of the sealing system for the cylinder.
- Designing of the power pack for the cylinder.
- Designing of the hydraulic cylinder that is to be used.

Fabrication

- Fabrication of piping for the system.

Assembly

- Assembly of the power pack.

Testing

- Testing of the power pack at pressure higher than the working pressure of the application.

2. Literature Review

Dynamic behaviour of the hydraulic cylinders from hydraulic driving installations of the machines and technological equipments is strongly influenced by the performance of their sealing systems. That is why, in recent times, it pays special attention to sealing systems used in the construction of hydraulic cylinders. Bruus, H. (2007). Theoretical Microfluidics - The mobile/dynamic translational sealing of the hydraulic cylinders, which realize the sealing of the rods or of the pistons, are in alternative translation motion on the working stroke. Kirby, B.J.(2010).Micro and Nanoscale Fluid Mechanics: Transport in Microfludic Devices: Chapter3 Hydraulic Circuit Analysis, Cambridge University Press. ISBN 978-0-521-119-03-0- The fluid lubricant adheres to the component parts motion. Smith Edger C.(2013)[1938]. A short History of Naval and Marine Engineering ,Cambridge University Press,pp,334-6,ISBN 97811076629232- research of the tribological behavior of sealing systems of the hydraulic cylinder seals was made both by theoretical mathematical modeling and numerical simulation and, also, experimentally.

Remnants of Early Hydraulic Power System; JW Gibson MA (SYD), MIE Aust. & MC Pierce BE (Elec.)- A hydraulic system employs enclosed fluid to transfer energy from one source to another, and subsequently create rotary motion, linear motion, or force.

Armstrong WG 1858, ON Water Pressure Machinery, Proceedings of the institution of mechanical engineers, London-When a hydraulic power unit begins functioning, the gear pump pulls hydraulic fluid out of the tank and moves it into an accumulator. Armstrong WG 1877, The history of the Modern Development of Water pressure Machinery Proceedings of the institution of Civil Engineers, VOL.50, MAY 1887- A special one-way valve keeps fluid from flowing out of the accumulator, but if the pressure drops by a significant amount, the charging valve reactivates and the accumulator is refilled with fluid.

C. Cristescu, P. Drumea, D.I. Guta, S. Anghel, M. Crudu: Experimental measurements for determination of frictional forces within the rod seals of hydraulic cylinders in: Proceedings of the rod the 7th International Conference Tribology: pp.163-170- If the accumulator is equipped with a fast-stroking device, it can be connected to other accumulators to allow them to charge pressure as well. Often, an automatic thermostat or fan will be included to help alleviate rising temperatures.

3. Hydraulic Power Pack

Theory

Hydraulic powerpacks have been designed based on Pascal's law of physics, power from ratios of area and pressure. A hydraulic system enclosed fluid to transfer energy from one source to another and create rotary and linear motion. Hydraulic power units applies the pressure that drives motors, cylinders, and other parts of a hydraulic system. Unlike standard pumps, these power units use multi-stage pressurization networks to move fluid, and often include temperature control devices. The mechanical characteristics and specifications of hydraulic power unit stated the type of projects for which it can be effective.

Some of the important factors that persuade a hydraulic power unit's performance are pressure limits, power capacity, and reservoir volume. In addition, its physical characteristics, including size, power supply, and pumping strength also significant considerations.

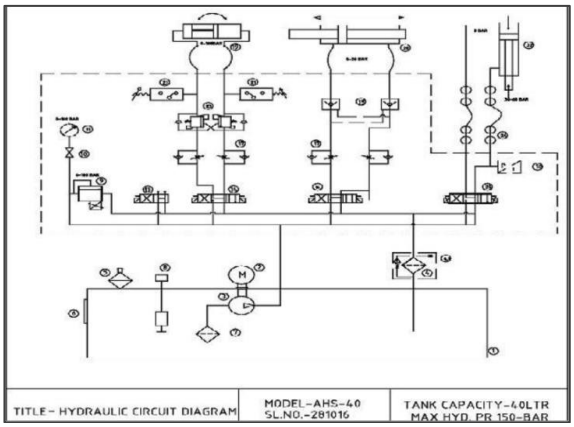


Fig.1 Hydraulic Power Pack Circuit Diagram

Calculations

The calculation of the hydraulic power pack can be given as follows :
Power pack Calculations –
Given Pump Capacity = 1.7cc/rev
Hydraulic Pressure (max) = 140 kg/cm^2
Motor Speed = 1440 rpm
Power required to drive the pump $= \frac{Pump\ discharge\ per\ \min\ .X\ Pressure}{600\ X\ N}$
N = Motor Efficiency = 90%
Power $= (\frac{1.7X1440'}{1000}\ X140)$ / (600 x 0.9)
=0.635 kW
Next higher size standard capacity is 0.75 kW
Therefore, Motor kW= 0.75

Tank capacity = $\frac{Pump\ discharge}{minute}\ X\ 10$
=2.45 X 10 = 24.5 Litres
Since tank size is too small to accommodate hydraulic pump and components, size increased to 40 litres.
Tank size= 260W x 270H x 600L
= 42 litres

4. Cylinders

Coupling cylinders

Description of use

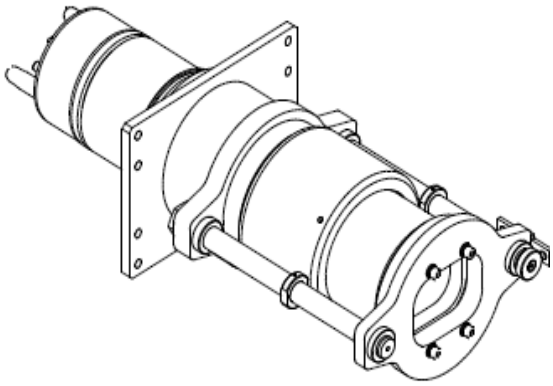
Application

The Hydraulic Cylinder is suited for Pharmaceutical Industry.

Technical Data

Material Specifications

- Tube Material : Stainless Steel Gr.304
- Piston Rod Material: Stainless Steel Gr.304.
- Rod Housing : Stainless Steel Gr.304

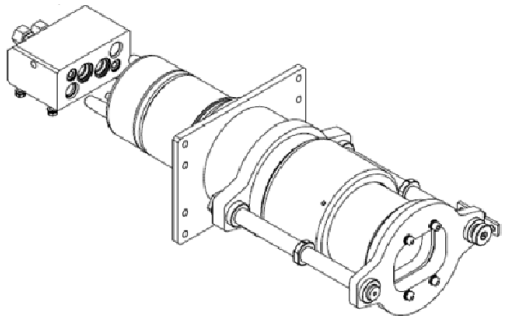


Cylinder Details:

- Bore : Ø 150 mm
- Rod : Ø 140 mm
- Stroke : 95 mm
- Working Pressure : 100 Bar
- Test Pressure : 150 Bar
- Total Gross Weight : 50 kg

Machining

- Cylinder tube : Stainless Steel Gr.304
- Surfaces precision honed
- Ra = 0.1 – 0.4µm (R max.2.5 µm)
- Piston rod: Stainless Steel Gr.304
- Surface grinded and polished
- Ra = 0.1 - 0.4 µm (R max.2.5 µm)
- This cylinders are going to be used for listing four vessels of 400 kg each.



Lifting Cylinders

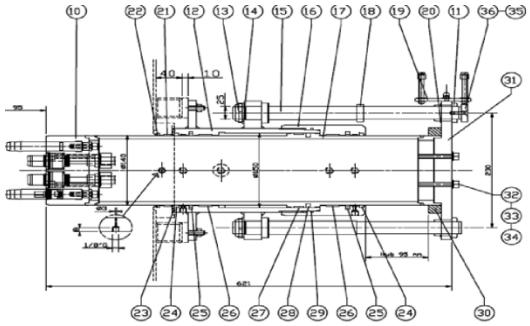
Description Of Use-
a. Configuration of Parts:
The Hydraulic Cylinder consists of following parts:
- Cylinder Barrel.
- Piston Rod.
- Piston.
- Seal Set.
- Mounting Clevis.

b. Application:
- The Hydraulic Cylinder is suited for Drum Washing System.

c. Technical Data:
Material Specifications :
- Tube Material : SS304
- Piston Rod Material : SS 304
- Piston : SS304
- Rod Housing : SS304

Dimensions :
- Bore : 40 mm diameter
- Rod : 30 mm diameter
- Stroke : 600 mm

Machining:
- Cylinder tube : Surfaces precision honed
- Ra = 0.1 – 0.4 µm (R max.2.5 µm)
- Piston rod : Hard Chrome Plated.
- Surface grinded and polished
- Ra = 0.1 - 0.4 µm (R max.2.5 µm).



Future Scope

This system that we have designed can be incorporated in various pharmaceutical plants for the purpose mentioned above. This will help them maintain better hygiene at the plant and help them increase productivity in minimal expenditure.

The above system developed can also be modified for various other purposes which will help in smooth running of an industry.

Conclusions

The authors can write the conclusion as a whole in a paragraph or by making points. An example is given as under.

1) This report describes the design of a hydraulic power pack at a low cost and in an efficient way. Low cost was achieved by designing and manufacturing a compact power pack for the system.
2) The new sealing system designed for the cylinder should help us to get better sealing and help the working of the cylinder in the long run.
3) We are able to lift and clean 4 vessels, instead of 1, at the same time by using hydraulic cylinder. This has helped us to reduce the time required for cleaning and achieve better efficiency for production.

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