Design, Modelling, Fabrication and Testing of Oil Measuring & Dispensing Machine

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Abstract

Liquid dispenser machine is commonly found in our daily life in different places like offices, bus stands, railway stations, petrol pumps. In this thesis we are going to present a pneumatic operated oil dispenser machine. Using a pneumatic system interface, we can effectively increase operator accuracy, reduce training time and improve overall efficiencies, thus keeping cost down a properly designed pneumatic system interface can improve overall accuracy. Present liquid dispenser machine available in industries are costly, complex and hard in design and fabrication. Main requirement from this machine is its metering or measuring quality. Accuracy of measuring is very less in various machines. Hence, the basic theme behind this research is to improve these disadvantages of oil dispenser machine. The oil dispenser machine presently available is based on practice and past experience of the employer in his working field and also, its efficiency declines at a greater rate after a period of time. By surveying the present machines and comparing their present limitations, new model will be fabricated so that designs data can be obtained to formulate experimental data based model for this process. The design of model will be so simple that it can be adopted easily by small industries & automobile workshop. Easy technology will help to reduce metering problem. The present work reports the design & fabrication of oil measuring & dispensing machine which is used in small industries & automobile workshop.

Keywords: oil dispenser machine, relays, solenoid valve, pneumatic actuator & air compressor

I. INTRODUCTION

Liquid dispenser machine is widely used in all industries like liquid filling machine, bottle filling machine, paint industry, etc. Liquid dispenser machine is commonly found in our daily life in different places like offices, bus stands, railway stations, petrol pump. In our day to day life, we come across the measurement of oil for our two/four wheeler. Many a times we have come a cross the situation were the quantity of Oil dispense to the Oil tank will not accurate. As the measurement of oil is done by standard oil can and oil is dispensing from the barrel by rotary hand pump which does not measure the oil. I have decided to do this project which will measure the oil and dispense the oil from the Oil barrel accurately.

As the rate of the oil in standard packing is 30-35% more than that of oil of same grade in 210 liter barrel. But in present situation use of barrel oil in garages is very less, because of hand operated rotary dispenser which dispense the oil only and it does not measure the oil. Also there is wastage of oil by using this conventional oil hand operated rotary pump. Due to this several disadvantages garages are not using the barrel oil which is 30 to 35% less in cost as compare to standard packed oil in small packing of same grade. In present situation consumer has to pay 30-35% more money of same grade oil by using the standard packing oil.

II. DESIGN OF DISPENSER MACHINE

This chapter gives the design calculation of major components of the machine.

A. General Procedure for Selection of Pneumatic Cylinders

1) Select pneumatic cylinder Single or Double acting.
2) Its dimensional standards like ISO, VDMA, CETOP, AFNOR.
3) Constructional details like – Piston rod, tie rod, square tube, Mickey mouse tube, rodless etc.
4) Force to be exerted (Bore dia)
5) Distance to be moved (stroke)
6) Surrounding medium (special material of construction / type of seals)
7) Air pressure available.
8) Cushioned / Non cushioned.
9) Ambient temperature for selection of seal material.
10) Speed of actuation

11) Position detection (Reed switch type)
12) Mountings
13) Stop tube length for long stroke cylinders.

Specification of pneumatic cylinders

1) Cylinder thrust.
2) Air consumption.
3) Piston velocity.
4) Type of mounting.
5) Couplings

Following points need to be considered while selecting a pneumatic cylinder.

1) Cylinder Thrust

The cylinder thrust is a function of:
F = Cylinder thrust in Kg.
D = Dia of piston in cm
D = Dia of piston rod in cm.
p = Operating air pressure in "bar".

Thrust exerted by various types of Cylinders:

1) Single acting push type

$$F = \{\pi/4 \times D^2 \times P\}$$

2) Single acting pull type

$$F = \{\pi/4 \times (D^2 - d^2) \times P\}$$

3) Double acting in forward stroke

$$F = \{\pi/4 \times D^2 \times P\}$$

4) Double acting in return stroke

$$F = \{\pi/4 \times (D^2 - d^2) \times P\}$$

2) Air consumption

The air consumption data for a cylinder is required to estimate the compressor capacity. The calculations include air consumption during forward as well as return stroke. The free air consumption for forward stroke is calculated as follows:

Free air consumption = piston area x (operating pressure + 1.013) x stroke

The free air consumption for return stroke is also calculated similarly and added to arrive at total free air consumption of cylinder during one complete cycle.

Theoretical air consumption calculations:

Let
D = Dia of piston in cm.
d = piston rod dia.
L = stroke in cm.
P = Air pressure in bar
$C = \{\pi \times D \times (P+1) \times L\} / 1000$

Free air consumption in litres for forward stroke:

$$C = \{\pi/4 \times D^2 \times (P+1) \times L\} / 1000$$

Free air consumption in litres for return stroke:

$$C = \{\pi/4 \times (D^2 - d^2) \times (P+1) \times L\} / 1000$$

3) Piston Velocity

Factors governing the piston velocity are: the operating pressure, opposing forces, inside diameter and length of the air line between the control valve and cylinder and the size of the control valve. The piston velocity may be increased or decreased with the help of a quick exhaust valve or flow control valve respectively. The average piston speed at no – load is between 100 – 500mm/ sec. Depending on the frequency of operation and the speed required, proper type and size of valve needs to be selected.

4) Mounting Types

1) Front plate mounting.
2) Rear plate mounting.
3) Double trunion mounting.
4) Centre trunion mounting.
5) Neck mounting.
6) Leg mounting.
7) Hinge mounting.

5) Couplings

- Fork
- Rod eye end.
- Universal coupling

6) Flow Measurement

The selection of valve for any automation, needs to be evaluated in terms of its flow rate to determine its capability to meet the final application. Flow rate is defined as the volume of air passing thro' a given cross section in a unit time.

Typical unit for measuring flow rate is Nl/m (i.e.. Nominal litres per minute) or SCFM (standard cubic feet per minute) expressed at standard conditions of pressure and temperature.

7) Flow coefficient (Cv)

Cv is a measure of flow capacity. It is measured as the flow of water thro' the cross section of the valve in US gallons (3.785 litres) per minute when the pressure differential is 1 psi.

Flow rate in litres/sec thro' a valve can be calculated to a limited accuracy by the formula:

Air flow rate (litres/sec) = 6.694 Cv(outlet pressure + 1.013) x P

8) Pneumatic Valve Selection

To select a valve, following details need to be taken onto account:

- Cylinder bore (D cm)
- Stroke of cylinder (L cm)
- Required stroke time (T sec)
- Pneumatic pressure available (P)

Compression factor can be substituted in the formula below:

$$Cv = \frac{\text{Cyl. Area x stroke x M x compression factor}}{\text{475 x stroke time in sec.}}$$

Table - 2.1
Specification for M constant

Inlet Pressure	*Compression Factor*	*"M" Constant*
1	2.0	0.092
2	3.0	0.072
3	4.0	0.062
4	5.1	0.054
5	6.0	0.049
6	7.1	0.045
7	8.0	0.042
8	9.2	0.039
9	10.3	0.038
10	11.2	0.036

B. Design Calculations

Maximum working pressure= 7 kg/cm^2
Average working pressure = 3-4 kg/cm^2
Design of dispensing cylinder for 3 litre of oil
For 125 mm

D = 125mm = 12.5 cm

Volume = area * stroke
$3000 = \pi / 4 * D^2 * L$
L = 25 cm
Design of driving cylinder (pressure cylinder)
Compressor of 3 bar pressure
The thrust developed by piston single acting push type

1) Thrust f_2 (kgs) = area * pressure
$= \pi / 4 * D_2^2 * 3$ ---- (D_2 = 5cm)
= 58.875 kgs

If D = 6.3 F_2 = 93.64 kgs

If driving cylinder is of D_2 = 5cm and dispensing cylinder of D_1 = 12.5cm the pressure on the dispensing cylinder $= \pi / 4 * (12.5)^2$, A_1 = 122.71 cm^2

F_1 (thrust) on the driven (dispensing cylinder)
F_1 = area * pressure (on dispensing cylinder)
= area of dispensing * pressure
F_2 (thrust) transmitted on dispensing cylinder
Pressure = F_1 / area of dispensing = 58.875 / 122.71
= 0.47 kg / cm^2

For D_2 = 6.3
$F_2 = \pi / 4 * (6.2)^2 * 3$
= 93.46 kg

F_2 (thrust) of the driving cylinder is 93.46 kg
Now calculating the pressure on dispensing cylinder
F_1 (thrust) on driven dispensing cylinder
F_1 area * pressure (on dispensing cylinder)
Pressure = F_1 / area of dispensing
F_1 is transformed to F_2
$F_1 = F_2$
= 93.46/122.71
= 0.761 kg/cm^2

III. MODELING OF DISPENSER MACHINE

In engineering practice different people have utilize CAD in different ways. Some utilize it to produce part drawing and part design, other may employ it as a visual tool by featuring shaded images and animated displays. Here it is used for modelling of dispenser machine, to visualize the model before actual fabrication. This CAD software give us idea about how will be the product after fabrication. This CAD software provide us with the tools needed to perform our project efficiently and free from the tedious and time consuming task, that requires little or no technical expertise further more.

A. Main Parts of Machine

1) pneumatic cylinder (driving cylinder)
2) pneumatic cylinder(dispenser cylinder)
3) solenoid valve
4) non return valve
5) Compressor
6) Relay
7) Frame

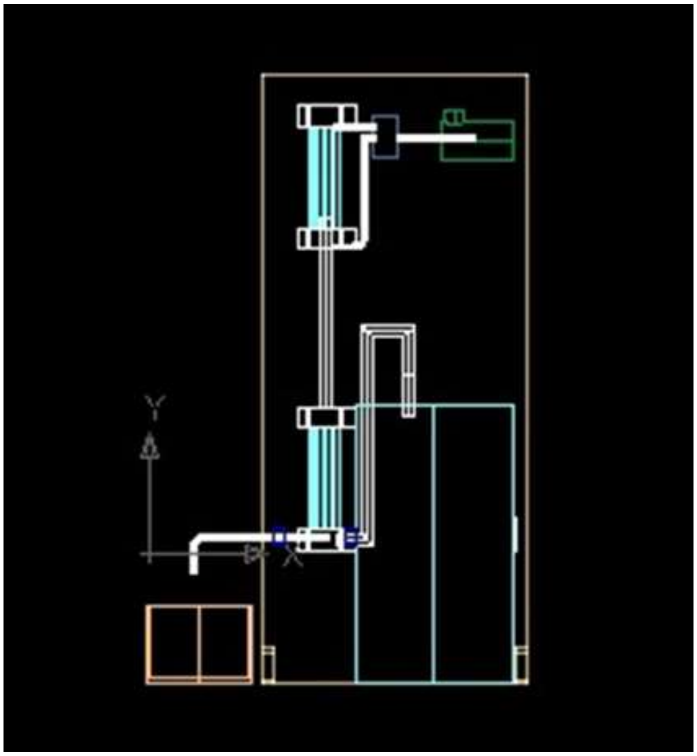

Fig. 3.1: Front View

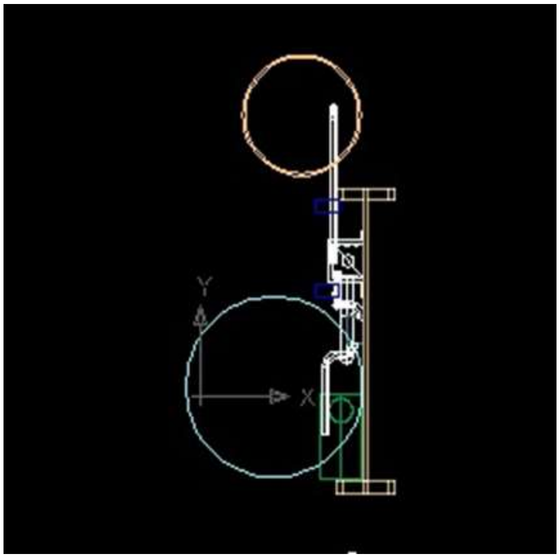

Fig. 3.2: Top View

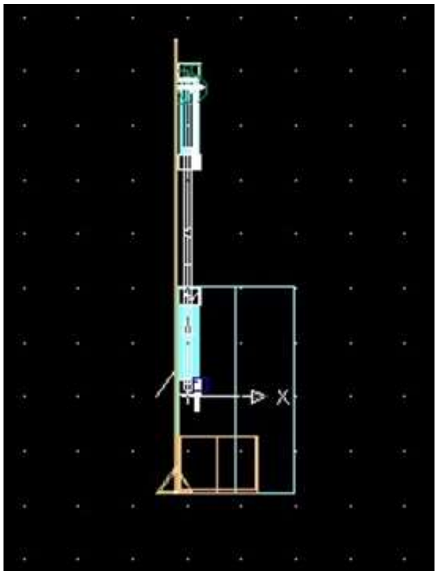

Fig. 3.3: Side View

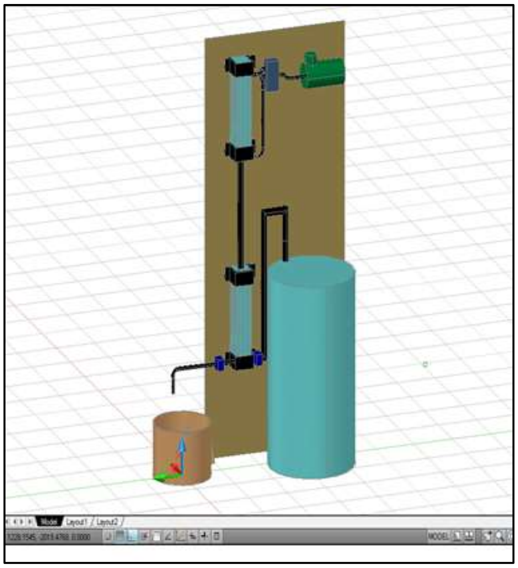

Fig. 3.4: Isometric View

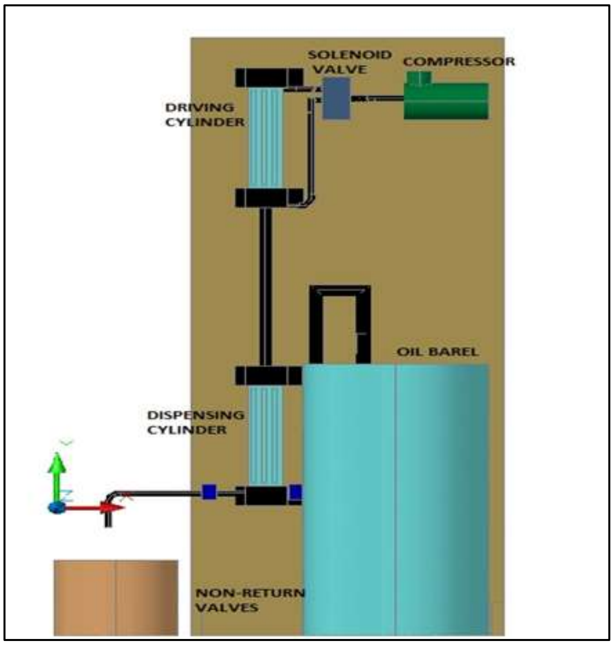

Fig. 3.5: Schematic Diagram of Cad Model

IV. FABRICATION

The following components are used for the fabrication purpose:

A. Mechanical Components

1) Pneumatic cylinder (Driving Cylinder)

Specification: working pressure
7 bar
Diameter 63mm
Stroke 280 mm


Fig. 4.1 : driving cylinder

2) Pneumatic Cylinder (Dispencing Cylinder)

Specification:

Diameter 125 mm
Stroke 250 mm


Fig. 4.2 : dispensing cylinder

3) Solenoid Valve


Fig. 4.3: Solenoid valve

4) Relay 24 Volt Coil Type

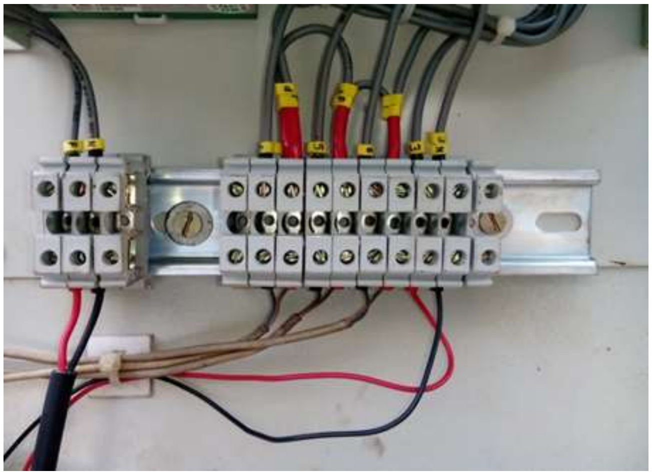
Fig. 4.4: relay

Fig. 4.5: pneumatic cylinders with frame

Fig. 4.6: Complete assembled machine

B. Working

1) The selection switches are numbered according to the quantity of oil to be dispensed say 1,2and 3 in liters.
2) For 1 liter s1 button will be pressed 1 time the 1 liter oil shall be obtained in the container by this setup.

3) When the switch is actuated sensor receives signal to make the piston do its work according to the command.
4) The length of stroke in both pneumatic and dispensing cylinders is same.
5) During suction the suction valve opens and the oil is sucked inside the dispensing cylinder.
6) After completion of the suction stroke in the beginning of discharge suction valve closes and discharge valve opens allowing the oil to enter into the oil container.
7) The operation of suction and discharge valves is electronic controlled.
8) The force required to dispense oil is very less at about 10 to 15kgf and the head of oil barrel is added so the power consumption is less making the system efficient.

V. EXPERIMENTATION

In the experimentation of an oil measuring and dispensing machine oil is considered as a material whose quantity is to be measured.

First experiment is done for 1000ml of oil and 10 readings are taken, tabulated and plotted as shown below.

Table – 5
quantity vs no. of readings

Input Quantity	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*mean*
1000ml	*960*	*1010*	*980*	*1030*	*990*	*1040*	*975*	*1035*	*1045*	*995*	*1006*

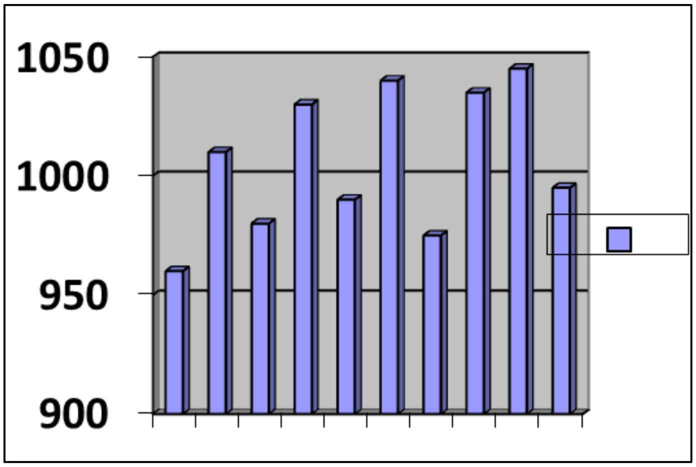

Fig. 5.1: quantity vs no. of readings

Second experiment is done for 2000ml of oil and 10 readings are taken, tabulated and plotted as shown below.

Table -5.2
Quantity vs no. of readings

Input Quantity	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*mean*
2000ml	*1980*	*1975*	*1960*	*2045*	*2035*	*2040*	*1975*	*1990*	*2030*	*1990*	*2002*

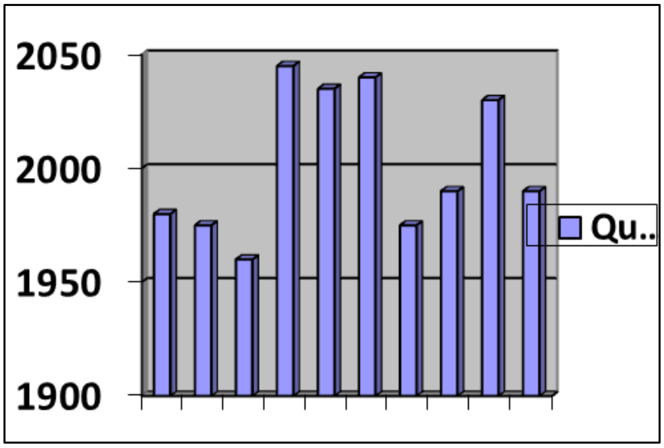

Fig. 5.2: quantity vs no. of readings

Study of above table shows that the results of experiment are acceptable .the error occoured is 0.05% of input value .

VI. CONCLUSION

Proper evaluation of the design will be performed and created something even better instead of simply manually operated operations. Finally we conclude that atomize machine is better option to use instead of manually operated. The demands of automatic oil measuring and dispensing machine for automobile garages and workshops & other customers is also considered while designing machine. Purpose of fabrication of the this machine was to determine the suitability of machine for use. Two experiments performed. First for 1 litre and second for 2 litres measurement and dispensing and 10 readings each. The values found out are acceptable to standards and desired. Since this machine is made for small businessman, small automobile garages and workshops, therefore the work carried out by this machine is less. The capital required for purchasing the bigger size oil dispensing machine is very high. In comparison this "Oil measuring and Dispensing Machine" is very cheap.

Traditional method of oil dispensing is without measurement of oil and there is waste of oil while dispensing. This problem is completely removed by " Design and Fabrication of Oil measuring and Dispensing machine".

In the process of completion of the project work our ideas and thought are development towards the mechanisms and technologies of the equipment. We also visualized that this "Design and Fabrication of Oil measuring and Dispensing machine" in the automation for the future growth and development of industrial automation sector projects.

Similarly we can say that for the purpose of oil dispensing is economical and ideal in case of industrial automation sector projects. This process is more economical and faster than manual process or any other processes. Therefore on the completion of this project, it is concluded that the "Design and Fabrication of Oil measuring and Dispensing machine" will save the tremendous time, wastage of oil energy manpower and save financial input of the project, reducing the cost and time considerably which is the backbone of the present world economy.

Also the design procedure involved in this project makes it easy to change the machine parameters according to the requirements. Design procedure adopted in this project makes the product durable for long time as well as makes it efficient also helps to understand the concept of design and gaining the knowledge of fabrication. The model so constructed is robust enough and durable. Use of automation technologies improved lifestyle of workshop owner, automobile owners having small scale holding. So with the involvement of Machine marketability can be increased, which helps in improving their income.

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