Design and Manufacturing of Liquid Carbon-Dioxide Filling Machine for INS-Shikra

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Abstract: CO_2 Cylinder filling system is a Universal unit, specifically designed for rapid filling of cylinders with gas. The filling system is designed to avoid high temperature excursions while filling high pressure CO2 cylinders. Accuracy and Continuity are the two features that make CO2 filling systems high in demand in market. One of the Major advantages of this system is that it doesn't require lubricating oils for gears as it is done by liquid CO2 only. This Project aims on Manufacturing CO2 gas filling machine by SHREE SYSTEMS PVT. LTD. The machine is built for Naval Air Station-INS Shikra. INS shikra is an Indian Naval Air Station located at Coloba in Mumbai, Maharashtra

I. INTRODUCTION

Nowadays due to improving technology, interdisciplinary principles of machine design and its automation are to be taken under consideration to deliver a high-end machine which is necessary for competence. Machine design and automation is a comprehensive technology discipline that studies the design, operation control and production process of all kinds of industrial machinery equipment and mechanical-electrical products.

Machine design has evolved over a long period of time. Its importance has increased over the last two decades since it has helped simplify human tasks and rectify man-made error. Machine design has simplified numerous complex operational tasks into a simplified operating machine. The advantage of these machines is reduction in wastage of time. Further, automation of machines came into consideration.

CO_2 is a colourless gas with a density about 60% higher than that of dry air. It occurs naturally on Earth's atmosphere as trace gas. Since it is available naturally, it is cheap gas and can be used for various applications. CO_2 can be stored in liquified form within the range of 10 degrees Celsius to 30 degrees Celsius of temperature in a closed container. CO2 is workable at different temperature and pressure range, according to the requirement. Liquified CO2 expands when exposed to atmospheric pressure which is used to inflate nylon tubes, nylon boats and can also be used as fire extinguisher. Therefore, due to its properties and ease of availability it can be used but has to be taken into consideration, its harmful sides.

The project is based on the making of a filling machine which fills CO2 in liquified form with accuracy using automated circuit. This machine works on the principle of Hydraulics and Pneumatics and is driven by various hydraulic and pneumatic flow components. These components are guided by PLC circuit. PLC based automated systems are easily programable and can be programmed according to the working of the machine. PLC is flexible in nature, easily installable and if easy for trouble shooting and controlling the system

I.1 Problem statement: To fill CO_2 in the pre-provided canisters from the commercially available cylinder at prescribed pressure. The previous method of CO2 filling was using traditional method of filling with bottle filling method. Which was time consuming and cost was more and it was less safety measures. The huge amount of components was used in these method which led to consumption of more energy for automated filling and need skilled worker.

I.2 Objectives: To Design and Manufacture CO2 filling Machine in Industry. To Take CO2 gas from Master cylinder and Fill the same into smaller CO2 cylinder of different sizes. To make secure & mitigate human effort. To make the machine capable so that it gives increased rate of productivity in less time. Reduce the components of the machine and use the essential components having better power efficiency. Automatic control of input pressure to get maximum output in the form of CO2 gas filled in the cylinders.

- To design the liquefied CO_2 charging system for various applications
- To achieve maximum accuracy.
- To fill the canisters with liquefied CO_2 at optimum temperatures and pressures

II. LITERATURE REVIEW

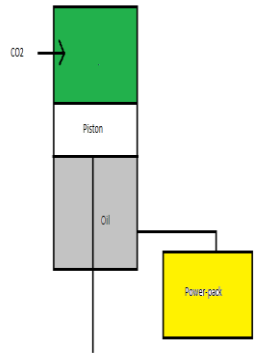
1) Title : Automated Bottel Filling System[IRJET]
Author : Vivek Dabhade
In this research paper, we found idea about its found that its efficiently works with the help of solar power approximate amount of water to irrigate field using this saves the water and less electricity is been used, its cost consumption is less.
2) Title: Survey of Semi Automatic Viscous Fluid Filling Machine

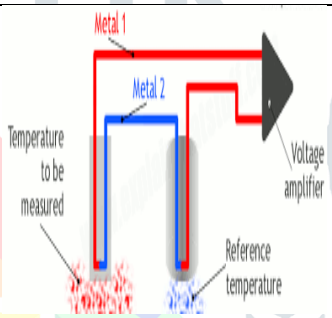
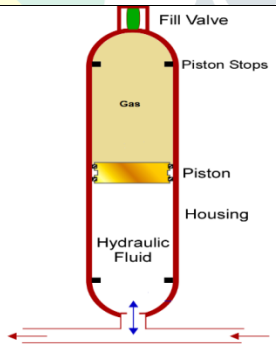
Author: Chavan Pranav A.
Through this paper, the design machine will be able to control and vary the speed as per requirement. Time required for this machine is less and Production is high.
3) Title: Automatic oil Packing Machine Using Pneumatic Machine
Author: Gurubalan.R.
In this project we have design automatic oil packing machine it is improved one from compared to old one. size is compact because pneumatic system has been used. The main advantage is it can recognize and correct the fault and increase the productivity of machine.
4) Title: Pressure testing: Pneumatic and Hydrotests
Author: Ramesh Singh
This Article explains the concept of pressure testing for both pneumatic and hydraulic systems. Also it discusses the application of hydro testing
5) Title: Automatic Liquid filling machine.
Author: Nisarg A. Solanki.
This Research paper illustrates the Liquid Filling machine working on Gear pump.
6) Title: Modelling of accidental releases from high pressure CO2 pipelines
Author: MensoMolaga,b, Corina Damb
In this research paper,the Modelling of Accidental releases of CO2 gas from high pressure pipelines has been studied and also it illustrates how to control high pressure Co2 gas in pipelines.

III. DESIGN & CALCULATION

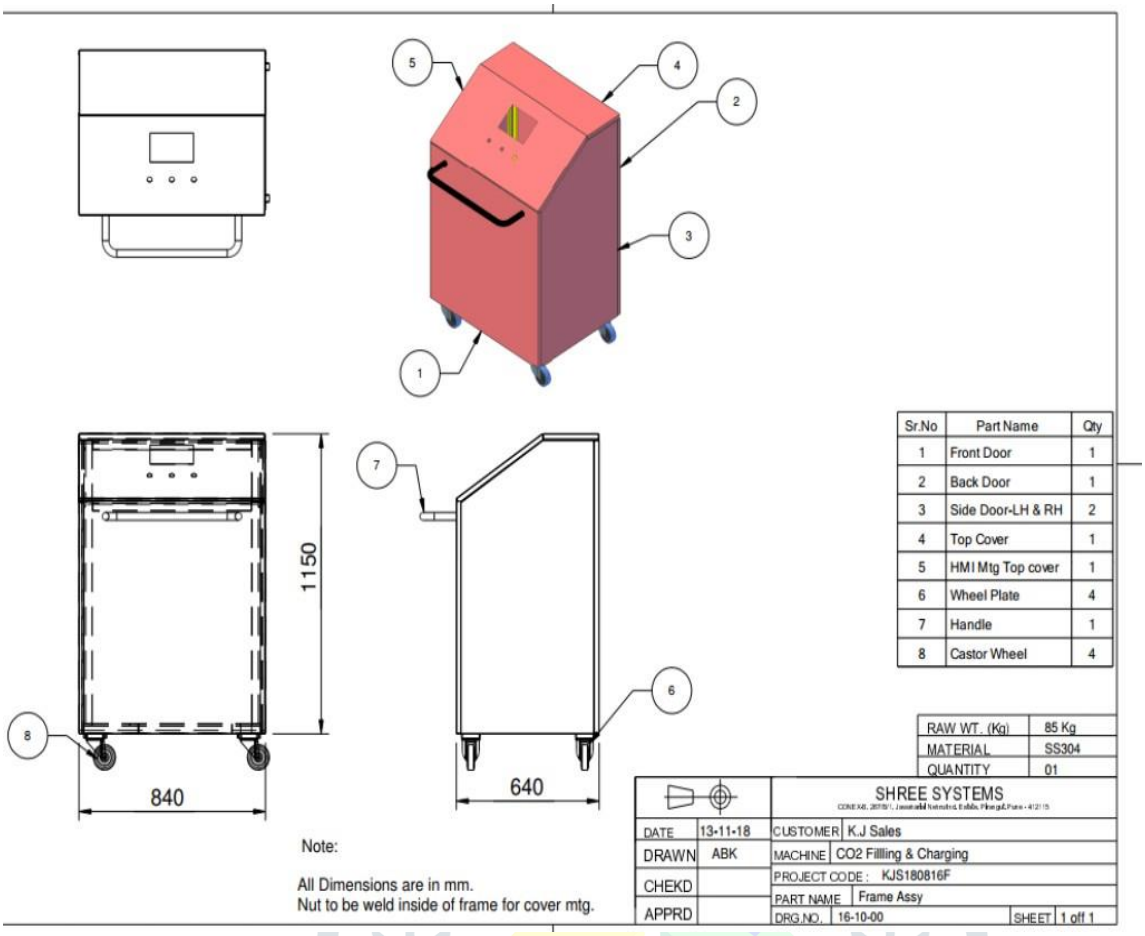
We have,
Volume, $V = 40\ litres$ =0.04 m^3 and Base length, $l = \pi r^2$l = 0.5 m. and Height, h = 0.4m.
Volume of cuboid =$V = l * b * h$ (b = breadth/width)
b = 0.04 /(0.5*0.4) = 0.25m
There are additional components viz. level gauge, air breather, suction strainer, drain valve, bell housing and coupling, hydraulic pump, flange mounted electric motor, pressure relief valve, check valve and direction control valve which will help in regulating the oil flow for efficient piston performance in the hydro-charger.

III.1 Detailing of Component

Component	Description	Image	Quantity
Hydro Charger	Hydro charger consists of a piston-cylinder arrangement where CO_2 will be adequately pressurized and will be sent for further process of filling the cannister		1-
Display	Digital display is the sub-segment of electronic signage. Digital display uses technologies such as LCD, LED, Projection and e-paper. Most commonly 7-segment, 9- segment, 14-segment and 16- segment displays are used.		1

Load Cell	Load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured.		1
Pressure Sensor	Pressure sensor is a device used for measurement of pressure of gases or liquids. A pressure sensor usually acts as a transducer, it generates a signal as a function of the pressure imposed.		2
Temperature sensor	A temperature sensor is used to measure and detect the coolness or hotness and converts it into electrical signals.		3
Gas Accumulator	Gas accumulator is a pressure storage reservoir in which a non-compressible hydraulic fluid is held under pressure that is applied by an external source.		2

IV. Cad-Cam Design



Sr.No	Part Name	Qty
1	Front Door	1
2	Back Door	1
3	Side Door-LH & RH	2
4	Top Cover	1
5	HMI Mtg Top cover	1
6	Wheel Plate	4
7	Handle	1
8	Castor Wheel	4

Fig 1 : Frame Assembly

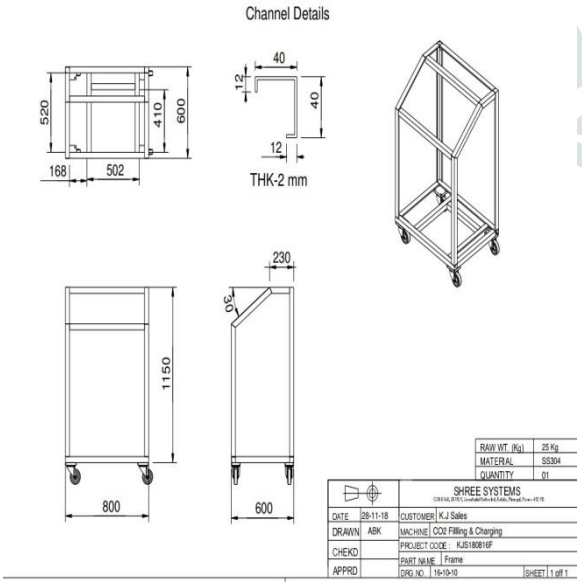


Fig 2 : Channel Details

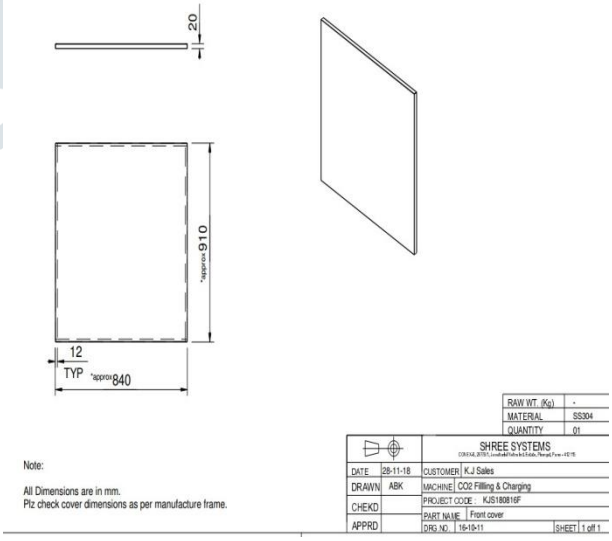


Fig 3 : Front Cover

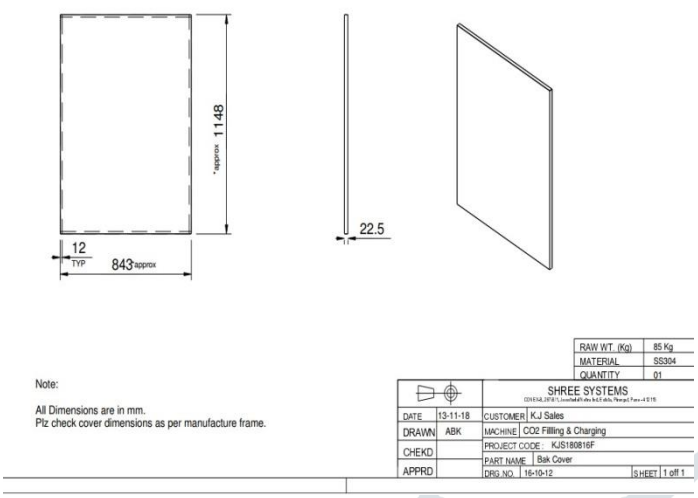


Fig 4 : Back Cover

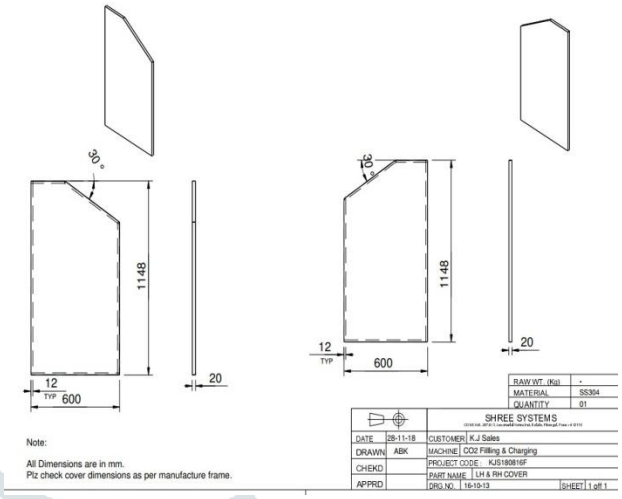


Fig 5 : LH and RH cover

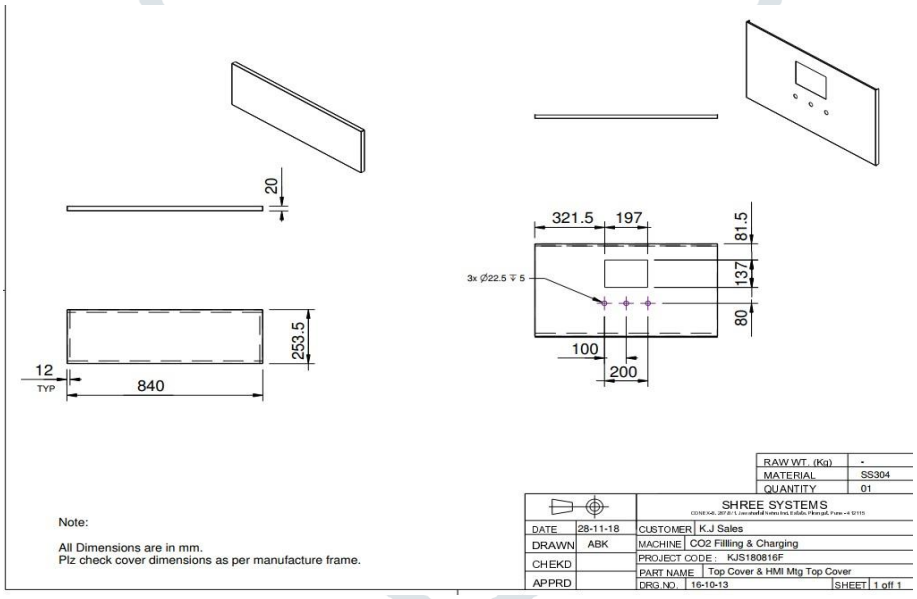


Fig 6: Top Cover

WORKING :

The CO2 gas filling Machine is Designed and Manufactured in Industry. The equipment takes CO2 gas from Commercial Master Cylinder at Pressure ranging from 450 – 850 psi and fill in the same in to smaller CO2 bottles of different sizes at approximately 1500psi.The machine is supplied along with 3 special adaptors one each for 34 gms, 300 gms, & one common for 1.5 kg & 3 kg. The adaptor is fitted to the bottle. Then, Gas bottle along with the filling adaptor attached to it is kept on the weight feedback module platform. After that, predefined quantity of CO2 is filled in the gas bottle. Once the required amount of CO2 is filled in bottle, supply of CO2 to the bottle is cut-off.

Advantage

- Human efforts are reduced.
- Machine saves the time.
- Easy to operate.
- High Efficiency and Reliability.

Limitations

- Cannot Fill more than one bottles at a Time.
- Less capacity of container.
- Complicated Design
- Skilled Personnel required.

Future scope

Can be used for Naval Operations in Sea, as a hybrid system in conjunction with other gas filling machine for Efficient running applications and for Automotive applications.

IV. CONCLUSION

This machine is supplied along with 3 special adaptors each for different bottles. The filling Machine consists of different sub-assemblies that are integrated together as a unit. Hence we are studying on this machine & we are manufacturing and designing Tank and Cylinder. Like this, the performance analysis by analytical method is under process for the design of CO_2 filling machine and, after it has been completed, it will be validated using software (Solidworks and Alibre)for optimum performance.

Acknowledgement

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