



# Experimental Set Up On Portable Refrigerator Air Compressor Used In Automobile

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## Abstract.

In today's era, automobile field is growing day by day. There is not a single place where you cannot get to see automobiles. The automobiles run on the tires which are stowed with the compressed air. Till so far, the system which provides compressed air is very huge in size, consumes large amount of electricity power & are not possible to carry with. This is noiseless air compressor as compared to Garage compressor. We can run this compressor with external battery so, we are going anywhere that time we don't need any garage or puncher shop if our vehicle's tire is low pressure. So, considering those aspects, may say which there is a drastic required of an air compressor which should be energy efficient can run on power, small in size and portable to carry with. Hence here we propose a design of a system that will provide optimum compressed air by utilizing minimum amount of power and will be able to run on device such as batteries.

**KEYWORDS:** Compressor, air tank, spray gun, nozzle.

**DOI Number:** 10.14704/Nq.2022.20.17.Nq88057

**Neuroquantology 2022; 20(17):445-454**

## 1. Introduction

Presently number of vehicles are run on the road and each vehicle has tire and that tire need to air and that air is supply from the air compressor. If we are going somewhere and between the road our tire is get low pressure of air due to run on the road that time, we need go to the garage but if garage is not near that time than what to do? When the advent in the field of science and technology, several aspects have been brought forward in order to enhance the human living exposure. Innovations in the field of science have made our life easy and comfortable.

There are several aspects that are put forward to enhance our day-to-day work ability. Currently, each & every field is in impact with the scientific growth. May can't find single industry without scientific facet. B/w all changes, revolt in the field of automobile has made our life emerging and easier. Current scenario automobile industry is at its peak. Huge amount of development done so far to nourish the industry demands. Every day we see numerous Automobiles running all over

the world. For human, automobiles play very important role in their daily life.

Automobile vehicles constitute several parts that help to run efficiently. Wheels are the basic and running basis of the automobile. Those wheels comprise of tires which are filled with the compressed air. Every day we get to see compressed air stowing points. It may be at the garage or may be near the fuels stowing station. Present scenario, the way compressed air is gained is too tedious & complicated procedure. Every time there is need of compressed air for our automobiles, we need to rush to the nearest air stuffing points, those is a headache for especially when time constrain matters. These points to a need of a well improved option for providing compressed air at our place, in such scenario, a portable air compressor can be well functional and can fulfill situation's requirements. A portable air compressor is a device which convert power (using an electric motor, diesel or gasoline engine etc....) in to latent energy stored in pressurized air. They are most commonly used

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**Relevant conflicts of interest/financial disclosures:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



to compress air and are used in a variety of industries. Compressors can be small enough to carry in your glove compartment for inflating a flat tire. They can also be larger units called turbocompressors used in large industrial facilities. The uses of compressed air can be many. Depending on the industry or facility, it may be used to power air tools, paint sprayers, and abrasive blast equipment, refrigerants for air conditioning and refrigeration, or even to shoot gas through pipelines. They work in two phases: the compression operation and the release operation.

According to search one of the first air compressors that were used for something other than fire management shows up around 1762. It was powered by a water wheel and produced only 14 psi. By comparison, today's large industrial air compressors will reach up to a maximum of 220 or so.

Through one of various process, the air compressor pushes huge amount of air into the storage tank, rising the pressure. When vessel pressure achieves its maxi. Limits the air compressor off. The energy implied in the compressed air can be used for various petition, using the actual energy of the air it is free & the vessel is pressed. When the tank pressure reaches its mini. Limit, the air compressor restarts & re-pushes the vessel.

Air compressors are used to supply compressed and compressed air for numerous uses in a variety of industries. These tools are now also used to operate power generation and production equipment and control system valves; The rear compressor was much less versatile. The advent of air compressors is thousands of years old.

By 1800, people started using air compressors to passing energy. Austrian engineer Victor Pope built the first compressor plant in Paris in 1888. In just three years, Pope's 1,500 kW compressor plant grew to 18,000 kW. Further modernness in air compression continued to improve the methods and early started to include electric and pneumatic power. If you use an air compressor in your home or business, you might assume that the industry doesn't have much more innovation to do. Air compressors in the 53212 area, regardless of

their size, are highly useful but basic machines—the bells and whistles usually come from the attachments rather than the compressors themselves. However, there's an increased emphasis on efficiency and saving energy these days—and some interesting new innovations that use air compressors for power. Here are a few of the newest air compressor technologies, and some insight into where the industry might turn next.

**Efficient air compressors:** The Atlas Copco company just released new air compressors in their GA VSD+ range. These air compressors are designed to be incredibly efficient—they can reduce energy consumption by up to 50 percent with their oil-injected rotary screw compressors. This particular model is 15 percent more efficient than previous models, and is designed to take up less space, make less noise and offer 12 percent more free air delivery. This is accomplished with a single, vertically aligned drive shaft shared by both the motor and the drive train. The drive train is completely enclosed, and uses one oil circuit to cool the motor and lubricate the bearings. The end result is a powerful, efficient rotary screw compressor that's significantly quieter than comparable air compressors.

**Compressed air energy storage:** Compressed air energy storage has been making waves when it comes to wind power, but it could have applications in other industries, too. As you may know, wind power has been unreliable, since the energy is only available while the wind is blowing. Compressed air energy storage has made it possible to store the air like a battery, so the power is available at any time. Keep an eye out for how this interesting technology may become available in your industry.

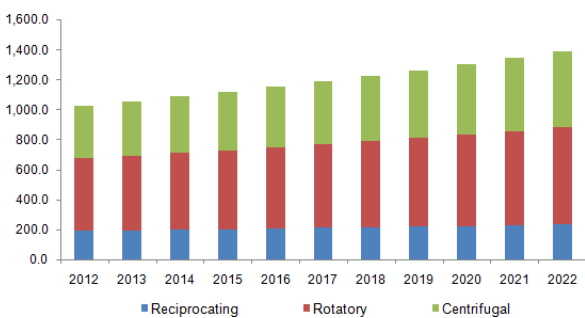
**Vehicles that can run on compressed air:** As we continue to look for energy-efficient solutions to cut down on fossil fuel use, some folks have come up with plans for vehicles that run on compressed air. The AIRPod vehicle (you may have seen it on the TV show Shark Tank) is a completely emission-free vehicle that's designed for urban centers. If air compressors can power an entire car, what could they power next?

**Air compressor braking systems:** Some



manufacturers are looking into “air hybrid” braking systems for buses, which create air pressure as soon as buses start decelerating. The compressed air is stored and then used to power the engine’s pistons when the bus takes off once again.

Currently, there are various types of recent air compressors to think. Compressed Air methods proposal a wide range of production lines including exchanges, oil-less, vehicle-mounted and other air compressors tailored to your special needs.



**Chart.1.** Portable Oil-Free Air Compressor Market Analysis

The industry can be categorized by technology into reciprocating, rotary, and centrifugal segment. Reciprocating and rotary air compressor are termed as positive displacement compressors whereas centrifugal fall under the dynamic category or negative displacement products. Rotary air compressor market accounted for over 45% of the overall demand in 2014, followed by centrifugal and reciprocating.

Positive displacement equipment works by decreasing the volume of a chamber filled with air whereas negative or dynamic types utilize centrifugal force by spinning impeller for further increase and decrease the amount of air resulting in compressed air. The Centrifugal compressor market is expected to grow at a CAGR of over 4.0% over the forecast period.

Growing demand for maintenance and replacement activities is estimated to drive demand over the forecast period. Increasing trends such as clean air technology and new-age devices including portable and noise-free compressors are expected to offer lucrative opportunities for producers of innovative equipment.

Eco-friendly features, efficient operations at

lower costs, and retrofitting of existing systems are also expected to drive demand. Rising cost of raw materials, high competition, and noisy operation can hamper the portable oil-free air compressor market. However, technological advancements, stringent government regulations, and environmental protection can reduce the impact over the next few years.

## 2. LITERATURE REVIEW

Consumption of power is affected to refrigeration compressor because the refrigeration compressor is low power consumption and get high performance that’s why author try to use refrigeration compressor in some suitable work.[1] In the development of air compressor, it depends on the increasing its performance. For this many factors are there, like clearance between piston and head, stroke length, friction losses, running time of compressor, working condition of backside, and leakage of air, this factor are affected and when it is work with proper than our performance is also

increasing. [2]

The researchers research on development of reciprocating air compressor but with the investigation author was trying to maintain the compressor and compressor will give as to high volume at a high pressure.[3]

Change in the global climate is the big problem in today’s era. So, it can be overcome to used air as a fuel. So, that can be reduce the global climate. It is need to shift to be use convention fuels to non-convention fuels.[4]

Tire is a sensible part of the vehicle and it is crucial role to drive a safe driving. Every vehicle has two or three tires and some vehicle has more than three. Reduction in pressure (PSI) is tire is reduced the mileage of the vehicle, tire life, safe driving, and vehicle performance. Most of the problem are come when the pressure of the tire is low. [5]

Air pollution is the main challenged to faced currently. The first problem is air pollution, in this our personal vehicles cause of global warming, that’s why need to change conventional fluid to non-conventional fluids. [6]

The device who converting mechanical energy to pneumatic energy is called air compressor. In the market many air compressors are available



for their different application, but all air compressor is work the same function. It is making higher pressure. For this author is try to overcome the temperature of the compressor.[7]

Global climate change due to pollution is major issues om today's era. So, compressed air is safe and clean fluid. So, compressed air is used as a gas filling in tire in two and three-wheeler it is comparatively safe. So, this compressed air is environmentally friendly. It is not harmful.[8]

In future, compressed air vehicle has developed and it is beneficial over petroleum and main is it is ecofriendly and low cost. CAV (Compressed Air Vehicle) is good as a pump to wheel and well to wheel basis as compared to petrol fuels cost. So, CAV is good framework for future design.[9] For vehicle, tire is most important parts. If air is low in tire than it can be chance to get accident on road, because air is low in tire, that's why driver is loose their balance on steering of the vehicle. So, automatic tire controlling device is currently used but it is high in cost. In survey for the road accident most of accident comes due pressure drop in tire cussed the loosing balance on the steering of the vehicles.[10]

In survey 80 % of the vehicles are run on the road with under inflated tire. Today automobile is improving the efficiency of vehicle. In survey of one year 15 % fever miles, we can drive on them for every 20% under inflated tire. We can use pressure gauge to check the pressure of the tire.[11]

For us air compressor, we can say that air compressor is quite noisy. If we can have reduced that noise little bit than it is good for the researchers, that's why author try to reduced compressor noise, and try to absorb in reduced of high frequency noise compare to using sheet metal.[12]In the past few times, conservation of energy and reduction of carbon is very important factor in the world. Scientist have research to reduced that factor by using air compressor. It can be reduced in IC engines. In future, air compressor is considered as green energy.[13]

In a garage, big air compressor is used and this air compressor takes lots of space and it is noisy. When it starts it is created noise that is affected to children. So, author try to reduce this all factors by replacing air compressor. Author uses refrigerator air compressor for that kind of

problems.[14]

Automobile play very Vittel role in the economics of all the world. The one is this tire performance. Make sure that tire pressure is in correct all the time and it is up to date on the proper condition. That's why compressed air is very crucial part of working performance of tire.[15]

All of this benefit of the compressor, in study of all the things author think about how can air generate power, where this air compressor used, benefits of this air generated power, types of compressors, author figure out all these things in their research work.[16]

### 3. Description of problem

- Currently everyone is near with the air compressor at our local garage or gas station. Compressed air is used to inflate vehicle, bicycle tires, paint sprayer, air tools etc.
- Suppose that while going on long drive if car's tire gets less air pressure and there is no garage or gas station on the road or that way. It will be very difficult to drive the car properly.
- Also, we want to paint walls of our home on very short time, spray painting is needed for this work. But the equipment cost of spray painting is very high compared to conventional brush or roller painting. What if we have a small easy to use and less costly equipment to spray paint in our house.
- Considering all this problem we are going to develop a product which is portable and also has multiple application. The product that we are going to work on portable air Compressor.
- We will try to design this portable air compressor by considering all factor and consequence.
- Hence, this paper is all about designing a Portable compressor considering all the factors so that it can be made and available at very low cost, and easy to operate. Due to its low cost and multiple application capability, it can be used by masses.

### 4. Experimental Setup

In this Experiment we need to many components for perform and this component can attach with each other to run proper experiment and we can achieve desired results



by perform step by step.

The components can we need is 1) Refrigerator compressor, 2) Pressure vessel, 3) pressure Gauge and 4) Plumbing Equipment like T-fitting, Bushes, Nipple Fitting, Regulator Valve and Outlet nipple.

### Step 1

For experiment, first aim to find old refrigerator compressor. That compressor is heart of the system and act like a pump that moves the gas upward direction in the system. After selecting the compressor, the compressor is attached to another component. That another component is Pressure vessel. In fig. we can see the hermetically shield compressor.



Figure 1: Hermetically shield Compressor

### Step 2

For storage of gas, we can need a pressure vessel. But for this experiment we can use stainless steel carbon dioxide cylinder. Compressor pass the gas we storage this gas in this cylinder. For use this cylinder because our main objective is portable air compressor that we can carry out anywhere and anytime. Carbon Dioxide cylinder see in fig.2



Figure 2: Stainless steel Carbon Dioxide cylinder

### Step 3

After and before enter the gas in storage tank we can put pressure gauge inlet and outlet of the storage tank or cylinder. Pressure gauge that can give us the actual reading of pressure of gas inlet and outlet. That's why pressure gauge is very sensible part of this experiment. The pressure gauge seen in the fig 3.



Fig. 3: Simple Pressure gauge

### Step 4

We can attach small parts that is most important like, Bushes Fig. 4, Nipple Fitting Fig. 5, T-fitting Fig. 6, Regulator valve Fig. 7 and outlet nipple Fig. 8 etc. this is most important part that can affected in experiment. This is shown in figures.



Fig. 4: Bushes



Fig. 5: Nipple fitting



Fig. 6: T-fitting



Fig. 7: Regulator Valve



Fig.8: Outlet Nipple



Fig. 9: Attachment of all component

- When we are attached these components, after this we can perform our project. First of all, start the compressor and stored the gas in steel tank. We can check pressure of gas that in pressure gauge that provide in front of inlet. When some pressure is stored in tank that time, we open outlet valve and check the pressure of outlet pressure of gas and

control the gas by regulator valve. And last, we can fill our vehicle tire.

- If we can used for paint a wall by spray paint that time only change the outlet nipple into Spray gun. So, we can paint a wall by spray gun.
- For this setup approximate cost to made portable air compressor is 5k to 6k.

## 5. PRINCIPLE OF AIR COMPRESSOR

- It is a machine that takes air at low pressure with the help of certain adjustments, such as reciprocating piston and cylinder alignment or rotary alignment and the desired pressure to that compressor is called air compressor.
- An air compressor is a device which converts electricity (usually from an electric motor, diesel engine or gasoline engine) into potential energy by pushing a small amount of air and thus increasing its pressure.
- Compressor can store energy in air when air is under pressure. Energy can be used for a variation of applications, in general using wind actual energy because it is depressurized.
- Air compressor is a powerful device which construct and transfer compressed air. Air down pressure supply excellent force, that can be used to authority a variety of instruments.[17]
- As earlier, compressor is that machine which is compressing the air and its pressure is increased. In practice, the air sucked in to cylinder of the compressor. This air is then compressed and then this air at high pressure is stored on storage vessel. Thus, in this storage vessel, compressed air is collected. This compressed air is takes to the places of use.
- Pressure air is measured in solid feet, and flow rate is measured in solid feet per minute or in CFM. Pressure is measured in psi (pounds per square inch). The normal pressure ratio for an air compressor for home or small garage use 90 psi. By comparison, a spray gun uses regarding 40 PSI for painting.
- A normal air compressor runs on electrical power. Small domestic air compressors are suitable for general jobs, but large farm or construction projects may require medium or heavy-duty compressors.

### 5.1 WORKING OF AIR COMPRESSOR

- Compressor is expert by the corresponding move of the piston inside the cylinder.
- This speed as an alternative nourishing the cylinder and which compresses the air. The joint rod converts the rotary speed of the crankshaft to the accordingly speed of the piston in the cylinder.
- It depends on the application; the whirl crank is operated at a steady momentum by a fit capital propeller (usually an electric motor).
- The fig. 9 is showing about the working of it.

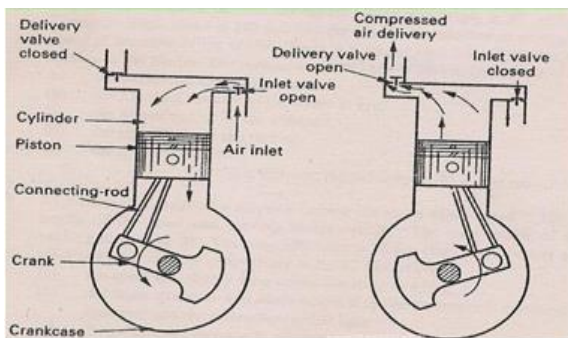


Fig. 10: Working of reciprocating compressor [18]

#### • INLET STROKE

- Suction or entry stroke animal by piston on top dead center (post given least or regression quantity).
- Through a downhill stroke, the piston speed decreases the pressure inner side of the cylinder to less than the meteorological pressure.
- The entry valve then naked opposite the pressure of its spring and allows for air to flow into the cylinder.
- Air is drawn into the cylinder up to the piston come to the maximum volume position (lower dead center).
- The release valve residue closed through the stroke.

#### • OUTLET STROKE

- The squeeze stroke transfers the piston in the adverse direction (from the lower dead center to the top dead center).
- As the piston opening to move uphill, the inner valve closes & the pressure inside the cylinder continues to increase up to it come to above the delivery side pressure attached to the obtain.

- The exit valve then opens and air is supplied to the receiver during the rest of the upward movement of the piston.

### 4.3 Complete the task of a single stage compressor bypassing regress

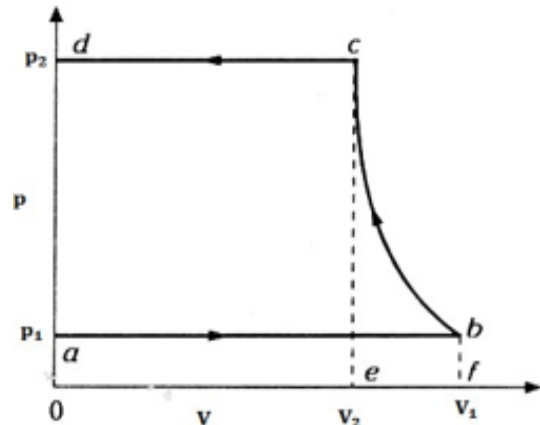


Fig. 11: PV Diagram [19]

Figure 10 shows a PV diagram of air in a cylinder of an air compressor. Steady pressure line ab deputizes suck stroke. The air is then adiabatically compressed (process line BC), and which expelled from the cylinder at steady pressure (process ladder). The area deputizes the ABCD function. There are 3 type of compression processes are possible in a compressor

**Isothermal compression.** Air compression occurs at a constant temperature.

$$\text{work done during compression} = p_1 V_1 \ln \left( \frac{p_2}{p_1} \right) \text{----- (1.1)}$$

Where  $p_1$  = inlet pressure ,  $p_2$  = outlet pressure

- **Adiabatic compression.** There is no flow of warm energy in or exit of the gas through extension or shirking.

$$\text{work done during compression} = \frac{\gamma}{\gamma-1} (p_2 V_2 - p_1 V_1) \text{----- (1.2)}$$

$$\text{workdone during compression} = \frac{\gamma p_1 V_1}{\gamma - 1} \left[ \left( \frac{p_2}{p_1} \right)^{\frac{\gamma-1}{\gamma}} - 1 \right]$$

$\gamma$  is the ratio of specific heat = 1.4 for air

$$c_p = 1.005 \frac{kJ}{kg} \text{ k, } c_v = 0.718 \frac{kJ}{kg} \text{ k}$$

- **Polytropic compression.** This method lies b\ n isothermal and adiabatic. In aerology,



major shirking / extensions are nobody adiabatic nor isothermal. It is multitrophic.

$$\text{workdone during compression} = \frac{n}{n-1} (p_2 V_2 - p_1 V_1)$$

$$\text{workdone during compression} = \frac{n p_1 V_1}{n-1} \left[ \left( \frac{p_2}{p_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

*n is the polytropic = 1.4 for air*

- **Efficiency of compressor.** In a respond of kind compressor, the work is minimal when compression come after the isothermal method. The ratio of too actual work performed to isothermal function is called isothermal efficiency.

$$\eta_{\text{isothermal}} = \frac{\text{Isothermal work}}{\text{actual work}}$$

#### 4.4 Operate in single stage compressor taking into account the clearance

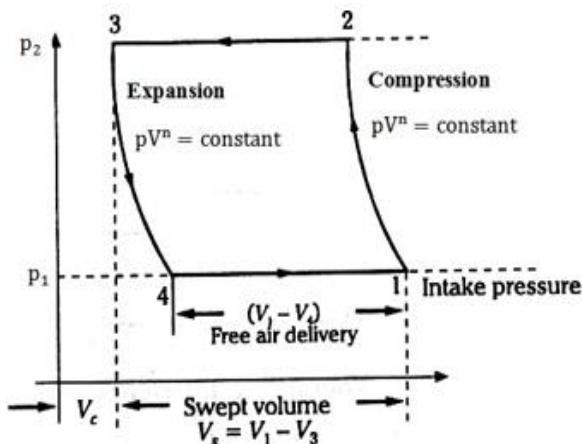


Fig. 12: PV Diagram with clearance [19]

In the experimental design of the compressor, some clearance b/w the cylinder and the piston are required to stop the piston from colliding with the cylinder crown. Figure 11 shows the PV dia. of single stage with regress.

In the PV diagram of a single-stage compressor with consent when compressed air is administered through the distribution stroke, a definite fund of air will be rescue into the cylinder at  $P_2$  pressure communicate to the evacuation volume  $V_3$ . Through the next suction stroke, this air details back to the opening pressure  $P_1$  and volume  $V_4$ . Thus, some air correlate with to volume  $V_4$  will already be in the cylinder before fresh air come

in the cylinder. The volume contained through this suck stroke will be  $V_1 - V_4$  which is less than the swept volume  $V_s$ .

The thing performed on the distributed air is not dominance by the evacuation volume because the things needed to compress the evacuation volume is in presence of moving through the detail of  $V_3$  to  $V_4$ . Thus, given by the complete the task.

$$\text{workdone during compression} = \frac{n p_1 (V_1 - V_4)}{n-1} \left[ \left( \frac{p_2}{p_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

- **Volumetric Efficiency**

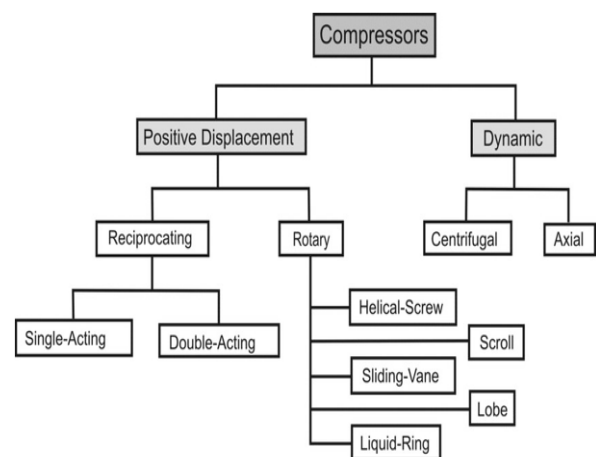
Free air delivery FAD is the quantity of meteorological air which can be sip by the compressor into the decant or entry location of the compressor on a compressor motor utilize at meteorological pressure, 20 C, 100 percent dry air and 100 percent rated value. FAD is a main buy variable and measures the size of a compressor in precondition of the air flow it can command. FAD is used to contrast unlike compressors. It is main to note that the convince mass per cycle must be same to the mass give out per cycle on the report of to the law of maintaining, even if the convince and distributed quantities will be isolated.

$$\eta_{\text{volumetric}} = \frac{\text{Actual volume of air taken referred to free air conditions}}{\text{swept volume of the compressor}}$$

$$\eta_{\text{volumetric}} = \frac{p_1 (T_a)}{p_a T_1} \left[ 1 + k - k \left( \frac{p_2}{p_1} \right)^{\frac{1}{n}} \right]$$

Where  $k = \left( \frac{V_c}{V_s} \right) = \text{clearance ratio}$

- **Classification of Air Compressor**





### 4.5 Classification of Air Compressors

### 6. RESULTS AND DISCUSSION

- We all know that, the compressor in showrooms and garage is quite big and noisy as compared to this compressor. We have comparison both compressor sound through Sound level meter and we getting low DB (Decibel) as compared to regular air compressor that used in garage and showrooms.
- When run the both compressor by 10 Bar pressure that time we have got sound difference between them. The distance between sound level meter to compressor is 2 meters.
- 1st we have start to check garage compressor and the frequency wave is high in the garage compressor and low frequency wave in refrigerator compressor.
- For experiment in refrigerator compressor, we know that the use of this portable refrigerator air compressor is low sound that means it is not affected the humans' ears and specially children's ears.
- We have check different pressure and different time interval and volume, for how much time take to filling the air tank with gas or air. That discussion is given below.

P2(Bar)	V (M <sup>3</sup> )	T(Minutes)	FAD(m <sup>3</sup> /min)
7.93	0.0248	7.55	0.0255
7.03	0.0248	6.57	0.0261
6.00	0.0248	5.50	0.0263
5.03	0.0248	4.59	0.0263
4.00	0.0248	3.59	0.0266
3.03	0.0248	2.56	0.0283

**Table 1:** Relation B/w operating pressure at various time interval

- We can fill the tire about 40 PSI to 50 PSI from this Refrigerator compressor. For small vehicles like Bikes, Bicycles, and cars and Air toys etc. Easily we can fill their tires.



**Fig. 13:** filling air in the tire

- We are paint our house and body of our vehicle in body shop by this Compressor. Attach the spray gun in nozzle of outlet air than we can easily paint our house with 100% accurate painting. So, by this we can reduce our time as compare to roller paint and brush paint. Fig. shown that how easily to do paint in our house by this compressor.



**Figure 13:** Spray Paint by Spray Gun

- We can clean the floor by this compressor. In small space that we cannot clean properly that time we can use this. We can attach nozzle in front of plastic pipe than we can easily clean that small space. If we need vacuum cleaner that time this is useful.

### ADVANTAGES OF AIR COMPRESSOR

- Low cost of air compressor
- Use less power supply
- Easy to operate at any situation.
- It is easy to move one place to another place.
- Maintenance cost is very low.

### APPLICATION OF AIR COMPRESSOR

- Gust up balloons or fill in air in products.
- Add air to tire on bikes and other automobiles.



- Use of several air tools for domestic plan.
- Painting vehicles in an auto body shop.
- Using air nail guns for roofing.
- Using air drills and hammers on structure field.
- Strength different air tools in an automotive repair shop.
- Using an air blowgun to clean machinery.
- Spraying crops.

## FUTURE SCOPE

Most people likely pass by or are in the presence of some type of air compressor regularly. Today, air compressors can be used from day-to-day activities like inflating your vehicle tires or compressors used at construction sites to power jackhammers or concrete compactors. They can also be hidden away in your refrigerator. You might also run into compressors in the HVAC systems of larger facilities like your favorite sports arena.

In the future, we can expect basic air compressors to take after the GA VSD+ range: compact, highly efficient and consistent models that still offer plenty of power. It will be interesting to watch how air compressors are used for more unusual applications going forward, like vehicles, braking systems and more.

## CONCLUSION

From this experiment we can find better way to modified approach can be suggested to gain compressed air. So, minimize to complexity of the system and to achieve portability in terms of compactness. From this experiment would say that reduced out time and easily carry with anywhere. This is small that we can carry out in anyplace. From this experiment we can colored our homes and our vehicles body by spray paint and we can clean our house or any small corner that we cannot easily do that.

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