National Conference on 'Advances in Engineering, Technology and Applied Sciences' - NCAETAS-2019
© 2019 IJSRSET | Volume 5 | Issue 6 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099

Solar Powered Air Compressor for Domestic Purpose

Prof. Sailesh Dhomne, Utkarsh R. Dhakate, Shivam Thambhake, Saurabh A. Wankhede, Shubham S. Nimkande , Durgesh Kurekar

Mechanical Engineering, Rashtrasant Tukdoji Maharaj Nagpur University/Dr. Babasaheb Ambedkar College of Engineering, Nagpur, Maharashtra, India

ABSTRACT

Conservation of energy and improvement of efficiency has always been the major area of concern for the engineering this days. The conventional air compressor have high power consumption factor. Such air compressor is even bulky and can't be afforded by individual. Such compressor has industrial application but can't be used for domestic purpose. By this study we are trying to make a air compressor which use renewable source of energy and the compact size of air compressor makes it useful for domestic purpose.

Keywords: Conservation, Efficiency, Compressor, Renewable, Domestic.

I. INTRODUCTION

According to the first law of thermodynamics, "energy can neither be created nor be destroyed; it can only be converted from one form of energy into another form of energy". Solar panel used for running the air compressor works on the same principle, solar radiation would be absorbed by solar panel and would convert it into another form i.e. electrical energy. Such electrical energy would power the air compressor. The electrical energy generated from this panel would be stored in battery.

II. METHODS AND MATERIAL

Designing a compressor which had a compact size was important. Hence we have designed such compressor using a aluminum alloy which is light in weight and easy to machine for smooth internal finish. Using a light weight motor with high rpm has been used further the speed has been enhanced by using gear arrangement between motor and compressor.

High rpm would lead in more liter per minute output. Solar panel used was of 100 watt which is sufficient for charging the battery in a good time. The panel was connected to a switch mode power supply, then battery. The entire setup runs with a power consumption of 48 watt.

Figure 1

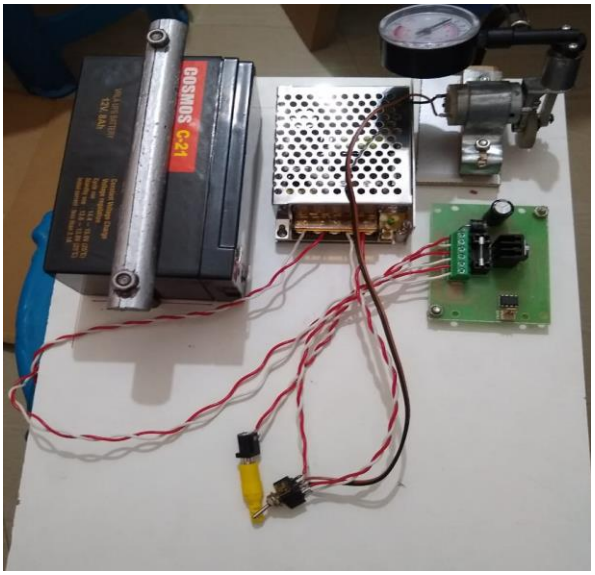

Figure 2

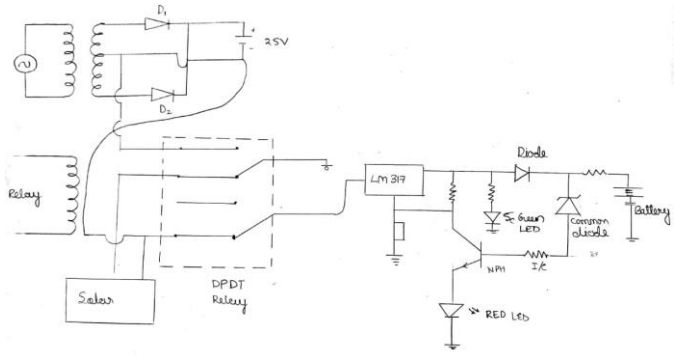

Figure 3

Calculations for compressor:-

Sut of material from pg 44(db).

Material- Aluminum Alloy

SAE No 39 Ni 2mg 1.5 sut= 253

Taking FOS=2

σt =sut=253=126N/mm^2

D=30mm (inner diameter of cylinder)

C= reboring allowance=0.8

The thickness of cylinder-

T= pmax×D+c/2σc.

Pmax=1.10N/mm^2 (160psi)

(1.1×30/2×126)+0.8

≈1mm.

Take stroke =1.15D

=34.5mm

≈35mm

Swept volume-

Vs=π/4×D^2×L=0.0243

Piston Pin

do=0.04×30

=1.2mm

≈1.5 to 2 mm (according to availability)

Displacement-

=π/4×D^2×N×L×n. (N=250Rpm, n=1)

=6185010.537mm^3/min

=6.18 l/min.

Time required filling up of tyre

= 10/6.18

=1.6 min/per tyre.

Practical time taken = 3 min/per tyre

III. RESULTS AND DISCUSSION

The solar compressor designed by us has a efficiency of 6 litres/min and 0.0243m^3 swept volume. The current rating for the compressor has been rated as 4 ampere and battery rating has 12 volts.

As the power rating is less than the industrial power compressor hence this compressor can be used by every individual. This compressor can be installed along the road side and hence air station can be installed as similar to petrol station. As this compressor doesn't need large power supply this can be used at any remote places by using solar panel. As this setup has a less fabrication cost the entire setup can be purchased.

A. Title and Author Details

VARGHESE has examined the effect of low tire pressure in vehicle. According to him low tire pressure can result in high fuel consumption and poor handling of vehicle. His system is designed to regulate the pressure in each tire without compromising the safety and driving comfort. Now days CO_2 emission is a major environmental issue. Fuel consumption is directly associated with the tyre inflated pressure and .hence more the fuel consumption more the CO_2 emission. According to a survey released in 2001 by the Department of Transportation's NHTSA a reduction in

fuel economy of 3.3% mile per gallon was recorded for a decrease of 0.55 bar in tyre pressure. [1]

Nader Jalili and **Prakash Venkataraman** studied the possibility of using nitrogen in tire inflation to improve safety and performance of vehicle. During low inflation pressure in tire the contact patch area between the tire and road increases as a result more rolling resistance is experienced by the tire lower tire pressure causes irregular wear and tear of tire. According to him using nitrogen in passenger car can improve driving safety and also improve tire life and fuel economy. His study concludes that nitrogen can maintain the tire pressure 74% better than shop air and hence produces 70% less rolling resistance than air inflated tire. [2]

Loya Chandreshkumar ,Joshi Pranav ,Chaudhri Hemraj ,Prof. Gaytri Bokade has designed tyre pressure monitoring system with fuel leak detection .Their TPMS doesn't requires a pressure sensor as it has an observer coded in software. An under inflated tire can cause higher friction in tire and road which decreases fuel economy and tire life. They have studied that an under inflated tire can reduction in tyre life fuel economy 305 and 3% respectively. Research has concluded that for better tyre life the tyre pressure should be maintained near STD value.[3]

T.J.S. Anand, M.Warikh study presents that air pressure in the car tyre falls from 10 to 20 kPa per month in which this is equal of adding a 70 kg person into the car. The facts suggest that, tyres with proper inflation pressure save their life up to 20% which sums nine months additional to its life span. It can also save fuel from 4% to 10%, improving braking efficiency up to 20%, makes the steering system easy and enables self steer. Inflating optimum tyre pressure can save tyres from overheating, explosion; nonetheless it can cushion motoring and cut maintenance cost. The desired tyre pressure values need not be noted by the consumer. This device is not only restricted to be used with kiosk for speedy inflation, but also it can also be used along with industrial air compressor or other air pressure resources. This device is designated Automatic Tyre Pressure Controller (ATPC). ATPC was discovered to be very promising in giving the preset pressure values with the minimum error of less than 1% with subject to dynamic loading and fatigue cyclic test. The test assures that the entire operating system can function up to seven years without any major variation in pre-set values.[4]

Sadda Mahendra1, N. Amara Nageswara Rao2 analysed the effect of tyre over force and inflation pressure on the rolling loss and fuel utilisation is studied. The sidewalls of the tyre contract and relax over and over, nearing to 500 times per minute at highway speeds. And, the tread deforms from a circular to a flat shape and back to circular again there being certain practical factors that can abate flex and heat. Inflation pressure has effects as follows; underinflated tyres lose their shape at a faster pace, develop high heat, and hampers fuel economy. Perfectly inflated tyres conserve fuel by mitigating rolling resistance. The stresses developed are lesser than the yield strength of rubber even when the tyre is overloaded. The rolling loss will be increased for overloading and in turn will elevate the fuel consumption rate. A possible solution for controlling fuel consumption by varying tyre operating load/pressure conditions is given. Incrementing tyre pressure is a feasible and cost effective method of fully or partially nullifying for increased rolling resistance. Some fuel conservation can be accomplished by this method.[5]

Prof. P.M. Borade, Gopinath Keskar, Yash Girme, Digambar Ghevade, Akshay Shelke.

Explained the basic workings of a CTI system study, the different aspects in which CTI systems give benefits are analysed and the cost benefit of installing a CTI system is studied. The system which possesses sensors feed the information to a display panel which can be handled manually. The electronic unit keeps in hand all the information. The source of air is obtained

from the vehicles' air braking system and pneumatic systems. Hence it aids re-inflation of the tyres to optimum pressure conditions. The transportability requirements in the former Soviet Union and Warsaw pact countries were highly consuming due to poor roadways and highway quality. As a result, a major step was taken by these countries to develop systems to enhance mobility, which included primary suspensions and central tyre inflation systems (Kaczmarek, 1984). Kaczmarek (1984) believed that "One of the most effective and well proven systems that have been adapted to wheeled tactical vehicles to improve the overall vehicle mobility is CTI". [6]

Sagar Adakmol, Tushar Shende, Dikshit Poriya, Sanjot Fotedar, Prof. S.P.Shinde.

Studied to develop a self-inflating tire system. It ensures that tires are properly inflated at all times. The design of project is successfully tested and installed with the help of centralized compressor. This innovation leads to provide fuel savings of 1-4% and increase tyre life by up to 10%. The system uses reciprocating compressor to get the air from atmosphere & to compress it to a required pressure. It is perfect for inflators, cars and bikes. When the pressure drops below required level, the sensors sense the change in pressure and start compressor to recover the pressure drop inside the tyre. It does not require any special attention from driver side after the system being installed. It eliminates the need of checking tyre pressure manually, thus saving time and labor.[7]

Ambarish G. Mohapatra. develop the automobile Tire Pressure Monitoring System (TPMS) helps the driver to be alert about the change in tire pressure. The pressure sensor was made using a self temperature regaining diaphragm type strain gauge. It was designed to measure maximum tyre pressure of 2.5kg/cm2 or 35.55psi. The system was continuously transmitting the tire pressure value to a central receiver. The output of central receiver system is displayed on the LCD receiver. Whenever the pressure will go above 2.5kg/cm2 and below 2.2kg/cm2, the feedback was displayed on the LCD display and additional warning sounds using buzzer. Various output sensors with different input pressure are noted at room temperature. Same as further an elevated temperature to determine different static character of sensors. By using different pressure levels and analysing the sensors output, different sensors characteristics were studied. To maximize the life of transmitted battery and minimize the consumption of power, the pressure data successfully transmitted.[8]

T Pletts. Studied the workings of a CTI system. This technology offers perks such as saving in road maintenances cost and mobility improvement, but it also reduces the two main components. A CTI system permits a vehicle operator to optimize tyre and vehicle performance by varying inflation pressures in response to changing operating conditions (load, road and vehicle speed) while the vehicle is moving (Foltz and Elliot, 1996). It is largely recognized that the installation of a CTI system results in increased traction, improved vehicle mobility and utilization, higher off-highway travel speeds, improved driver comfort, reduced road surface damage, reduced fuel consumption and extended tyre life (USDA,1993). Central tyre inflation systems have many advantageous benefits in the transportation industry. These benefits include, improved vehicle mobility due to the increase in traction when tyre pressures are lowered, improved ride quality and cargo safety due to the reduction in vehicle vibrations when the correct tyre pressure is used for a particular road condition, reduced road maintenance because sediment production is limited and lowered road construction costs, increased fuel efficiency and a massive increase in the life of vehicle tyres. All these benefits contribute to a considerable cost saving in the overall operation of a transportation vehicle. [9]

P.Y. Andoh, F. Davis, Y.A.K. Fiagbe, T. Alhassan presents the effect the tyre pressures of vehicles on

fuel consumption and ways to optimize running cost due to tyre pressure. The effects of tyre pressure on vehicle performance are the main issues to look after and cannot be overlooked as research shows that it has effect on tyre wear, fuel consumption, and rolling resistance. Required tyre pressures are generally recommended by vehicle manufacturer and going by the manufacturer recommendation will result in the optimum performance by the vehicle. The results of the research shows that less than 10% of vehicle have their tyre pressure as that recommended, the remaining more than 90% had tyre pressures deviated. Therefore we can infer that performances of other 90% are optimum and may be consuming more fuel. Hence the developed model can be used to anticipate the consumption of fuel consumed by a vehicle on hilly roads.[10]

Julien Brondex studied on constantly and automatically adapting the tire pressure to the driving conditions that a car encounters is an ambitious task. However it is probably an innovation that could contribute to more environmentally friendly road vehicles when one knows the impact of tire pressure on fuel consumption. It is almost impossible to get a reliable estimation by simulations alone of the extent to which such a system will allow to reduce and save fuel. This is because of the fact that the correlation between tire pressure, rolling resistance and fuel consumption is not fully understood. Therefore, the only way to quantify the benefit of the adaptive tire pressure is to make a prototype and to perform measurements. That was the purpose of the project and this is why all the components selected are listed in Appendix C with their reference number and manufacturer. [11]

Mrs. O. Hema Latha, Mr. S. Irfan Sadaq, Mr. Md. Abdul Raheem Junaidi present the work to prove solar photo voltaic is used to generate the power to run the air compressor used for inflating tyres. A solar powered air compressor does exactly as a regular compressor, but it's powered by the sun. Air compressors are often used to inflate tyres, power drills used by oil and gas companies because there is no power available, solar powered air compressors make powering these inflation system and drills very easy. The radiations in the form of energy received from sun is collected by the solar photovoltaic cell, the energy is stored and collected in battery and, from battery it is brought to the compressor if the compressor is DC motor operated. The voltage regulator or charge controller, microcontroller are used to control the fluctuation in the voltage. From batteries using inverter the energy is converted for AC motors air compressor or in many cases SMPSs are also used. Once the battery is charged the energy is transferred to air compressor and it starts working. The purpose for the research work had been successfully performed and it had been noted that the actual operation of an Air compressor can be performed using solar panel voltage which is used to drive the air compressor effectively without any external supply that will eliminate the usage of using non conventional source of energy. [12]

Anirudh Addala & Srinivasu Gangada aims to examine the performance of a car which takes air as the working medium. Air car is currently being developed which is still in progress and is under R&D stage all over the world. Reviews and feedbacks on the availability and the impact of the fossil fuels in the present and future generations led us to design a vehicle which runs by renewable energy sources. The technology of compressed air vehicles is turned out to not new, in fact, it has been around for years. Compressed air technology allows engines/ motors that are both non-polluting and economical. After months of research and development, the compressed air car is brought into existence. Unlike electric or hydrogen powered vehicles, compressed air car is not expensive. [13]

Priyadi, M. Pujiantara, and M. H. Purnomo focuses on the work done on the size of tank required to store the potential energy of the compressed air that provides

the mechanical power needed by DC generator that supplies a fixed power DC load for 12 hours. The design of the rest of system (upstream of the storage tank) will be discussed in future reports. In the paper they discuss about an application of small scale CAES to replace chemical battery storage in solar home systems (SHS). SHS is a government electrification project for non powered rural areas where it is difficult to use power source other than solar power. The project is set up by distributing small solar photovoltaic (PV) systems with capacity to cover even the minimal electrical power requirements needed for lighting in areas like rural communities. More research of the efficiency related to the regulator setting show that, if it is possible to use a boost converter with a wider input voltage range. More work is required to evaluate the components upstream of the storage tank and to complete this assessment of the possibility of this system replacing conventional SHS arrangements. [14]

Harendra Kumar Yadav, Vijay Kumar and Vinay Kumar Yadav, pivot their study on the multifarious use and necessity of solar energy in India. Country like India is very unbalanced in electricity production. Production is less when compared to consumption. Requirement consumption is around 5000 trillion kWh per year. There is prolific amount of solar radiation incident over India ranging from 1200-2300 kWh per square meter. The government of India is trying to improve the solar energy consumption and launched Jawaharlal Nehru National Solar Mission (JNNSM) on 31st March 2013. Solar power is very great option in country like India to increase power production. This is also very good for our environment protection and our economic development. Solar energy is unlimited source of energy, and our country also provide suitable climate for this energy, but we need some better ideas and source to increase efficiency and decrease production cost [63,64,66]. [15]

For many decades, utilizing the energy from the sun has always had great potential but large scale utilization has faced many bottlenecks. Amongst the many bottle necks are cost of Technology, energy storage, distribution of solar power and daily/seasonal variability of solar resource. R.S. **Anand, M.K. Das, S.S.K. Iyer, S. K. Mishra, P.S. Sensarma, A. Singh** address these challenges under three broad research themes of solar energy capture, distribution, and also the storage.

We are proposing to use multicrystalline Si solar cells, amorphous silicon solar cells, and 2D-concentrators using micro morph Ge/GaAs/GaInP Solar Cell Technology. This will also encourage the entrepreneurs of our country to invest more in solar energy technologies. The projects are serving as test platforms for large scale solar energy utilization technologies, providing more energy source. These projects are making their way in the academic institutions in long-term solar energy research, development, and pedagogical teaching activities. The project have increased the awareness of green technologies amongst the public.[16]

IV. CONCLUSION

After reading and analyzing the data collected from various papers we can conclude that a proper tyre pressure is necessary for optimum fuel consumption and less wear tear of tyre. Such solar powered air compressor can be used for refilling tyre and air station can be created along road or also can be used for household purpose.

V. REFERENCES

[1]. ALEXANDER VARGHESE,"Influence of Tyre Inflation Pressure on Fuel Consumption, Vehicle Handling and Ride Quality Simulation and Modelling".2013.

[2]. Loya Chandreshkumar, Joshi Pranav,et al. / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 3, May-Jun 2013, pp.345-348.

[3]. Nader Jalili, Ph.D., Prakash Venkataraman," TIRE NITROGEN FILLING SYSTEM, A FINAL REPORT TO: Industrial Technologies Sector of Ingersoll Rand Corporation."

[4]. T.J.S. Anand, M.Warikh."Engineering of Tire Pressure Controlling device: An Invention Towards Successful Product Development Sivarao", International Journal of Basic & Applied Sciences IJBAS Vol: 9 No: 9-261-1952091 IJBAS-IJENS @ International Journals of Engineering and Sciences IJENS.

[5]. Sadda. Mahendra1, N. Amara Nageswara Rao2. "Effect of Tyre Overload and Inflation Pressure on Rolling Loss (resistance) and Fuel Consumption of Automobile Cars" ISSN (e): International Journal of Computational Engineering Research (IJCER) 2250 – 3005 Vol, 04, Issue-10, October– 2014, pp36-42.

[6]. Prof. P.M. Borade, Gopinath Keskar,et al."CENTRAL TIRE I NFLATION SYSTEM". ISSN: 2455-2631 June 2017 IJSDR | Volume 2, Issue 6 IJSDR1706005 International Journal of Scientific Development and Research (IJSDR) www.ijsdr.org 66 CENTRAL TYRE INFLATION SYSTEM .

[7]. Sagar Adakmol, Tushar Shende, et al."Central tire inflation system" IJSRD-International Journal for Scientific Research & Development| Vol. 4, Issue 03, 2016 | ISSN (online): 2321-0613

[8]. Ambarish G. Mohapatra. "Design and Implementation of diaphragm Type Pressure Sensor in a Direct Tire Pressure Monitoring System (TPMS) for Automotive Safety Applications". International Journal of Engineering Science and Technology (IJEST). Vol. 3,No. 8,August 2011

[9]. T Pletts."A LITERATURE OVERVIEW OF CENTRAL TYRE INFLATION SYSTEMS", School of Bioresearches Engineering and Environmental Hydrology University of KwaZulu-Natal Pietermaritzburg,July 2006 .

[10]. P.Y. Andoh, F. Davis, Y.A.K. Fiagbe,et al." Tyre Pressure Model For Predicting fuel Consumption of Vehicles On Ghana Roads". INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 2, ISSUE 9, SEPTEMBER 2013 ISSN 2277-8616 120 IJSTR 2013

[11]. Julien Brondex. Design of a prototype of an adaptive tire pressure system.

[12]. Mrs. O.Hema Latha, Mr. S.Irfan Sadaq et al." Solar Based Air Compressor for Inflating Tyres", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 5 Ver. IV (Sep- Oct. 2014), PP 29-33 29

[13]. Anirudh Addala & Srinivasu Gangada," Fabrication and Testing of Compressed Air Car Viswanadha Institute of Technology and Management", Global Journal of Researches in Engineering Mechanical and Mechanics Engineering Volume 13 Issue 1 Version 1.0 Year 2013 Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 2249-4596 Print ISSN:0975-5861.

[14]. A. Priyadi, M. Pujiantara, and M. H.," . Sizing Compressed-Air Energy Storage Tanks for Solar Home Systems.", Conference Paper · June 2015 DOI:10.1109/CIVEMSA.2015.7158620

[15]. Science, Engineering and Technology (IARJSET) National Conference (NCREE-2015) IMS Engineering College, Ghaziabad Vol. 2, Special Issue 1, May 2015, page 63.[

[16]. R.S. Anand,M.K.Das,et al." SOLAR ENERGY RESEARCH ENCLAVE ",submitted to Indian Institute of Technology Kanpur, August 2009.