RESEARCH ARTICLE OPEN ACCESS

Photovoltaic Based Energy Efficient Air Compressors for Ships

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ABSTRACT
Compressed air onboard ship has exhaustive applications. Hence the reliability of the compressors needs to be improved. The air compressor systems can be isolated from the ship alternators and can be connected to green energy sources like solar, This will be avoid the dependency on conventional energy sources and also reduce the carbon emission into the sea. The efficiency of the compressor system will also be improved. In this paper, a microcontroller based air compressing system is developed for ships. This system is powered using the solar panels connected to the ship.
Keywords :-Air compressor, Pressure sensor, Solar, Battery .

I. INTRODUCTION

In the recent past, marine industry has taken up several initiatives to reduce the carbon emission into the sea. However, it is a long way ahead to transform the ship energy sources into complete green energy based [1][2]. It may not be easy to propel a large cruise ship or cargo ship with solar or wind energy. But, certain equipment can be isolated from the turbine alternators and be catered from renewable energy sources like solar or wind [3][4][5].

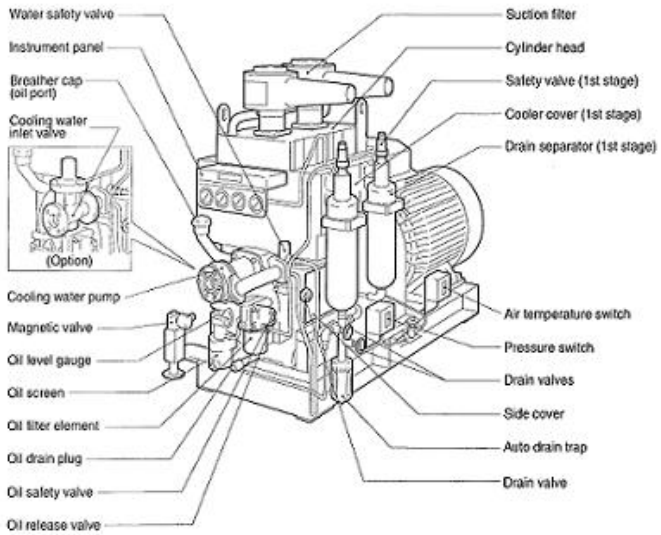

Fig. 1 Air compressor onboard ship

One crucial device that can be powered with solar energy onboard ship is the air compressors. The air compressors have huge applications and the reliability of this equipment is highly expected. The compressed air onboard ship is used to start the diesel generators, for automation control of machinery, for maintenance and for deck services. The construction of an air compressor is shown in Fig. 1 [6][7].

To be more precise, the compressed air is used for start of every generator i.e., main, auxiliary and energy generator onboard ship, for blowing the soot out of boiler and economiser, for machinery repair, maintenance and testing using pneumatic and hydraulic tools, for fog horn, for heaving up the life boat, for supplying water in the required places, for cleaning the deck etc [8][9][10].

Since, the applications of air compressor are numerous, it is important to improve the reliability of the system[11][12]. Isolating the compressor system from the main supply and connecting to a solar energy can unburden the traditional energy source and also improve the efficiency of the overall system [13][14][15].

In this paper, a microcontroller based solar energy system is connected to the air compressor. It is also connected with pressure sensor to make it energy efficient. The air compressor is connected with solar panel through a battery to maintain the continuity in all weather conditions [16].

The subsequent sections of this paper are organised as follows. In the section II of this paper, the working principle of the solar based air compressor system is explained. In the section III, the hardware implementation and the components involved in the system are explained.

II. WORKING PRINCIPLE

The system architecture to power the air compressor through the microcontroller is as shown in the Fig. 2. The compressor is supplied from a battery source connected by a switching circuit. This switching circuit is operated from the microcontroller based on the logical conclusion of the program fed into the microcontroller and from the pressure sensors connected to it. The battery is charged from the solar panels so as to maintain the continuity of the supply [17][18].

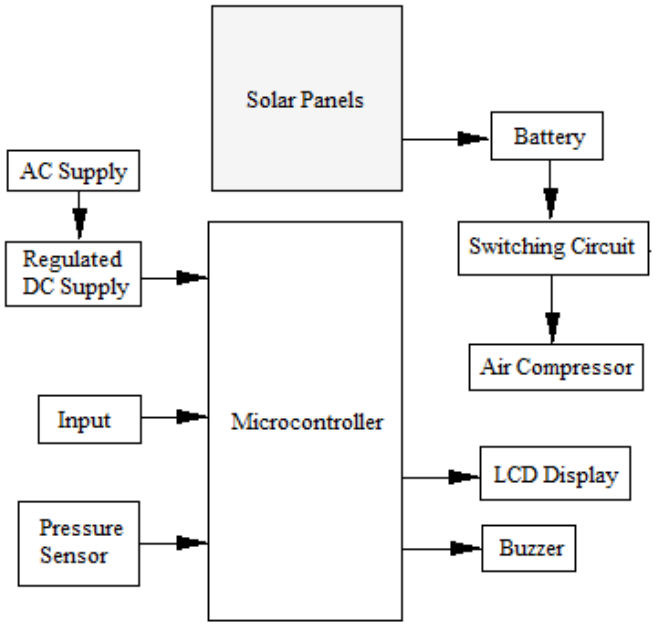

Fig. 2 Block diagram

The supply to the microcontroller is from a DC regulated power supply connected to a step-down transformer. The microcontroller is also connected with a LCD display and Buzzer to indicate if any variation with the pressure.

The air compressor can be operated with the specified limits fed into the microcontroller or with the input interface connected to it.

III. HARDWARE IMPLEMENTATION

The key parameters to be decided prior to the implementation of this system are [19]

- Rating of the solar panel
- Battery capacity
- Power of the air compressor

The components used in the photovoltaic based compressor system are enumerated below.

A. PIC16F72 microcontroller

In this system, to the inputs and output are coordinated using the PIC16F72 microcontroller is used. The features of this microcontroller are [20]

- Compatible with other 28 pin or 40/44 pin
- 8K Bytes of in-system reprogrammable flash memory
- Endurance: 1,000 Write/Erase Cycles
- Fully Static Operation: 0 Hz to 24 Mhz
- Three-level program memory lock
- 128 x 8-bit Internal RAM
- 35 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

For this system, Proteus 7 is used to write the code and FLASH MAGIC is used to burn the program into microcontroller. Proteus is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proteus. Proteus is a programmer which itself contains a microcontroller in it other than the one which is to be programmed.

The following steps are followed before programming the microcontroller:

- The memory location on address lines is given
- The suitable data byte is given.
- The appropriate combination of control signals is fed.
- The VPP is raised to 5V.

B. Air Compressor

Fig. 3 Air Comperssor

The air compressor converts the power into kinetic energy by compressing and pressurising the air in the form of bursts. The most commonly used is a reciprocating compressor [21]. The compressor used in this system as shown in Fig. 3 is supplied for 12V for the sake of simplicity and as a maximum pressure of 300 PSI.

C. Photovoltaic cell

A solar cell or photovoltaic cell is a device that converts solar energy into electricity by the photovoltaic effect [22]. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the source is unspecified. In this system the solar panel used to supply the battery is of 12 V and 5 watt capacity.

D. Regulated DC power supply

The 5V DC power regulated before supplying to the Microcontroller. This DC supply is originated from the regular AC supply of 230 V and is steop down using a transformer. The full bridge rectifier connected to the transformer converts it into DC supply and filters out the ripples in it.

Since, the transformer used is a 230/12 V, It consist of a voltage regulator (IC 7805) to lower the voltage from 12V to 5V. Another advantage of this IC is that no additional components are required to regulate the power supply.

E. Pressure Sensor

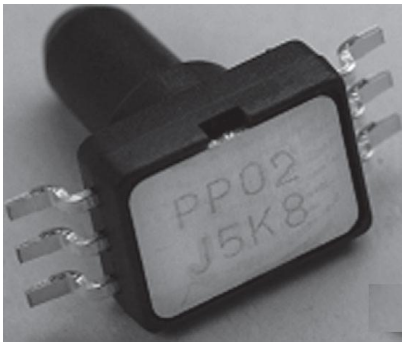

Fig. 4 Pressure Sensor

A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this system, such a signal will be electrical. The pressure sensor used in this system is a MEMS based Guage pressure sensor. It has a range of 0 to 37 kPa pressure range with a low power consumption of 0.2 mW. The drive current is 100 µA DC and maximum allowable pressure of 53 kPa.

F. Buzzer

A buzzer is an audio signalling device, typical type of buzzers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. A buzzer is used to give alert driver to awake from the sleep. As soon as any idle state discovered the Micro-controller switch on the Buzzer to inform the driver.

G. LCD Display

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x8 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

IV. CONCLUSIONS

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REFERENCES

[1] Babysen R, Manikandan P and G.K.D.Prasanna Venkatesan, "Various Indoor OFDM Optical Wireless Communication Systems and Performance Characteristics," Vol. 3, No. 5, 2014.

[2] Krishnapriya, Shashidhar kasthala, "Identification of Cable Faults Onboard Ship using Power Line Communication.," International Journal of Advanced Research in Computer Science, Vol. 8, No.3, pp. 70-73.

[3] S. Saranya, A.Vijay, G.K.D.Prasanna Venkatesan. ,"A Hybrid Communication Infrastructure Power System Using Effective Sensor Network", International Journal of Research in Engineering and Advanced Technology, Volume 2, Issue 2, Apr-May, 2014.

[4] Shashidhar Kasthala, GKD Prasanna Venkatesan, "Estimation of MIMO Power Line Communication Channel Capacity using Multi-Conductor Transmission Line Theory," IEEE International Conference on Applied and Theoretical Computing and Communication Technology.

[5] Shashidhar Kasthala, GKD Prasanna Venkatesan, A Amudha, "MIMO PLC Channel Modelling on Indian Residential Networks" International Journal of Applied Engineering Research, Vol. 12, No. 14, 2017.

[6] S. Ramya, GKD Prasanna Venkatesan, "Study of various transmission schemes of MIMO systems," International Journal of Emerging Trends in Engineering and Development, Vol. 2, No. 3, 2013.

[7] Banupriya.R, R.R.Jegan and G.K.D.Prasanna Venkatesan,"Disseminating For Concurrent Wireless Data And Power Transfer Using MIMO",International Journal of Research in Engineering & Advanced Technology, Vol. 2, No.2, 2014.

[8] V Ravichandran, GKD PrasannaVenkatesan, R Rani, "CDMA coding techniques for interconnect between ip cores," IOSR Journal of Engineering, Vol. 2, No. 9, 2012, pp. 84-90.

[9] GKD Prasanna Venkatesan, VC Ravichandran, "Performance Analysis of Dynamic Sub-Carrier Allocation Technique for Adaptive Modulation based MC-CDMA System", International Journal of Computer Science and Network Security, VOL.7 No.2, February 2007, pp. 201-204.

[10] GKD Prasanna Venkatesan, VC Ravichandran, "Performance analysis of MC-CDMA for wide band channels," Information technology journal, VOl 6. No. 2, 2007, pp. 267-270.

[11] J Kirubakaran, GKD Prasanna Venkatesan, "Performance Analysis of MIMO based ASTM-OFDM System for Indoor Communication," International Journal of Advanced Engineering Technology, Vol. 8, No. 2, 2016, pp. 662-666.

[12] V Ravichandran, GKD Prasanna Venkatesan, "CDMA Technique with Inter-process Communication," Research Journal of Applied Sciences, Engineering and Technology, Vol. 7, No. 8, 2014.

[13] G.K.D.Prasanna Venkatesan J.Kirubakaran, "Performance analysis of MIMO systems using CDMA for 4G Wireless Communication," International Journal of Applied Engineering Research, Vol 10, No. 41, 2015.

[14] Shashidhar Kasthala, GKD Prasanna Venkatesan, "Evaluation of Channel Modeling Techniques for Indoor Power Line Communication", International Conference

on Advanced Computing and Intelligent Engineering, Bubhaneshwar, Dec 2016.

[15] Shashidhar Kasthala, GKD Prasanna Venkatesan, Experimental Verification of Distributed Parameters on Indian Residential Networks for Power Line Communication," International Journal of Engineering & Technology, Vol. 8, No. 6, 2012.

[16] Shashidhar Kasthala, GKD Prasanna Venkatesan, A Amudha, "Design and Development of Protective Coupling Interface for Characterizing the Residential Broadband PLC Channel," Journal of Advanced Research in Dynamical and Control Systems, 9(2), 2017

[17] Shashidhar Kasthala, Krishnapriya and Saka Rajitha, "An Efficient Photo Voltaic System for Onboard Ship Applications," International Journal of Engineering Research and Applications, Vol 6. No. 2, pp 75-81, 2016.

[18] Shashidhar Kasthala, "Reactive Power Management in Industries: An analysis," International Journal of Emerging Technology and Advanced Engineering, Vol. 3, No. 11, 2013.

[19] Shashidhar Kasthala and Saka Rajitha, "Power Consumption Pattern in Residential Buildings: A Case Study," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, No. 4, 2015.

[20] Shashidhar Kasthala and Saka Rajitha, "Ethernet based Monitoring and Controlling of Real time Security Parameters," International Conference on Innovations in Electrical & Electronics Engineering, Hyderabad, 2015

[21] Shashidhar Kasthala and Saka Rajitha,"Non Intrusive Monitoring of Electrical Cables in Ship Power Systems," The Journl of CPRI, Vol 12. N0. 4, 2016.

[22] V Ravichandran and GKD Prasanna Venkatesan, "Performance analysis of MC-CDMA for wide band channels," Information technology journal, VOl 6. No. 2, 2007, pp. 267-270.