Compressed Air Power Plant

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Abstract--- India currently suffers from a major shortage of electricity generation capacity, even though it is the world's fourth largest energy consumer after United States, China and Russia. Shortages of fuel: despite abundant reserves of coal, India is facing a severe shortage of coal. The country isn't producing enough to feed its power plants. Some plants do not have reserve coal supplies to last a day of operations. India's monopoly coal producer, state-controlled Coal India, is constrained by primitive mining techniques and is rife with theft and corruption; Coal India has consistently missed production targets and growth targets. Poor coal transport infrastructure has worsened these problems. Many villages also suffer due to their locations where transmission of electricity is the major problem such as villages present at hilly areas. Improper transmission lines decreases the efficiency and also increases the cost of maintenance. The effect of improper transmission lines could be dangerous to the life of peoples. Air Compressed power plant includes use of atmospheric air to produce power which is easily available everywhere. The method of power production is conventional that is using turbine and generator.
Keywords: Compressor, Turbine, Generator.

I. Introduction

We live in a world where electricity is of prime importance, without electricity we cannot imagine one day also. But the bitter truth of our country, more than 25% of our population lives without electricity. Hence there is a severe need of producing and supplying electricity.

Air compressed power plant is the compact of all power plant units. As there is a risk in using heavy duty compressors hence, the compact power plant with the production capacity to fulfil the needs of a village with 1000 citizens or less. Rural areas or villages at remote locations suffer the prime problem of power transmission because of their location. Air compressed power plant can be installed to such places such that it powers the village only so the problem of transmission does not arise.

The raw material used is only air which is easily available and free. The only thing needed is to power up the compressor initially.

II. Block Diagram

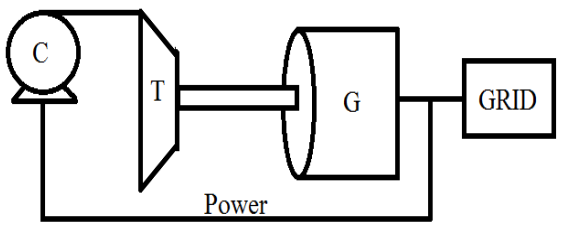

Fig. 1: Block Diagram

A. Description of Block Diagram

The first part is the compressor; it compresses the air from the atmosphere through air filter. The filtered air is compressed and stored in a tank at the maximum pressure of 250psig. The stored air is ejected through a pipe on the blades of the turbine. The high pressure jet of compressed air forces the blades of turbine to rotate at the maximum speed of 1500 rpm at maximum pressure. The energy of air is converted into mechanical energy of turbine. The rpm of turbine reduces with the reduction in pressure of air. Turbine fixed on the low weight shaft with the bearing mechanism such that the friction force is the minimum and the movement is smooth. Generator rotates with the rpm delivered by the turbine and produces the predefined power. The maximum power production capacity calculated is 1000W.

Nowadays the solar energy and wind energy are the emerging sources of energy. The main problem with these sources is their load factor. Load factor is the availability of power anytime; thermal power plant has the highest load factor. Solar and Wind energy are not available everywhere and any moment, for example solar power plant is useless at night. The air compressed power plant has good load factor compared to wind and solar energy as this can be operated 24 hours.

III. Components of Power Plant

A. Compressor

The compressor is operated by motor. The air from the atmosphere is compressed by the compressor and is supplied to the turbine.

An air compressor is a device that converts power (usually from an electric motor, a diesel engine or a gasoline engine) into kinetic energy by compressing and pressurizing air, which, on command, can be released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or negative-displacement types.

Compressor requires some power source to operate itself. Here we use 0.5kW motor on demo basis but in industrial application we can use the wind energy to rotate the compressor and solar energy to heat the compressed air. The output pressure and volume can be increased by cascading the compressors, but cascading requires more power and efficiency decreases so it is not preferred.

Due to adiabatic heating air compressors require some method of disposing of waste heat. Generally this is some form of air- or water-cooling, although some (particularly rotary type) compressors may be cooled by oil (that is then in turn air- or water-cooled).

B. Turbine

This is the main mechanical part of the system which converts pressure of the compreesed air into the rotation of blades.

C. Generator

It is the only part which converts the mechanical rotation of turbine blades into electricity.

In electricity generation, Electric Generator is the device which converts the mechanical form of energy into electrical energy. A Generator forces Electric current to flow through the external circuit. In our project the source of mechanical energy is our TURBINE which rotates due to the falling of high compressed air on its wings. Generator is based on the electromagnetic induction which can be stated as the production of a potential difference (voltage) across a conductor when it is exposed to a varying magnetic field.

In the simplest, The EMF generated by ELECTROMAGNETIC INDUCTION due to the relative movement of circuit and magnetic field is the phenomena underlying electric generators. When a permanent magnet moves relative with respect to conductor or vice versa an electro motive force is created. If the wire is connected to the external load the current will flow, converting the mechanical energy into electrical energy.

Michael Faraday is generally credited with the discovery of induction in 1831 and then this discovery was known by the "FARADAYS LAW OF ELECTROMAGNETIC INDUCTION".

The stator coils are excited using a 12V battery, which converts coils into electromagnets and generate magnetic field. The moving rotor with coils of conducting material produces emf because of mutual inductance. The emf produced depends on intensity of magnetic field, the rpm of rotor, number of coils and magnetic flux linked with the coil.

IV. Application

Air compressed power plant, as it is compact in nature has wide range of applications. Small remote villages at remote locations can be powered up and become independent. Similarly, industries who face the cost problems and power cuts which affect their production can use this power plant in their primises to fulfil their power demands.

Multi-storeyed business houses and even residential buildings can also install and can reduce their power consumption from electricity suppliers.

V. Results And Conclusion

Fig. 2: Model

The above figure shows the turbine and generator assembly. We can see the compact nature of power plant. The compressor and motor assembly is as we see in petrol pumps.
The motor used is of 0.5hp which is equal to 372.84 Watts. The compact generator shown above gives 12V and 40A current.
The output power, i.e. power produced is,

P = V x I
= 12 x 40
= 480W

Hence, the power obtained is greater than the power used. Once after start-up, the power plant is capable of supplying to its own motor. Larger turbine and generator assemblies are capable of generating more power and hence the more power to use.

VI. Future Aspects

The motor can be operated using wind mills also when the wind flow is capable of rotating the windmills.

The second most important thing after power production is farming. In small village green house farming can be done smartly. The power produced from Air Compressed Power Plant can be used to operate the windows of green house. The temperature can be controlled by opening and closing the windows using Microcontroller, Analog to Digital Converter and small D.C. motor, fans can also be operated.

VII. Some Safety Measures

The safety is of prime importance. The innovation without any safety measures is useless as without safety it cannot be applied for domestic or industrial use. This power plant as used also for domestic purpose hence some safety measures are necessary.

- Pressure of the compressed air in compressor
- Alternative Compressor should be connected
- Volume of gas enters into the turbine
- Moisture of gas should be removed to prevent corrosion effect.
- The RPM of turbine should be constant.

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