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(Research Article)

Case Study for Comparison of Electricity based and Gas Engine Operated AC System

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Abstract

This air conditioning system works on vapor compression refrigeration system in which compressor runs by engine which uses PNG as direct source of energy. By introducing PNG based gas engine coupled with compressor in this system, we may eliminate use of electricity. The objective behind writing this paper is to compare benefits of Gas engine operated AC system with electricity based AC system with the help of one case study and develop economical and ecofriendly air conditioning system for sustainable development and energy conservation in our country. HVAC system comprise major percentage of the energy consumed by building in India. Hence, it becomes primary focus area for energy saving. Finally, the ultimate goal of this study is to study alternatives of electric air conditioning system on basis of electricity saving techniques.

Keywords: AC system, Compressor, gas engine, CO_2 emission

1. Introduction

India needs economic growth for sustainable development, which in turn requires access to clean, convenient and reliable energy for all [1]. Electricity produced is utilized by different sectors in India. HVAC systems are becoming one of the key building blocks in modern infrastructure. These systems are found in almost all upcoming commercial as well as residential buildings. HVAC systems comprise 40 percent of the energy consumed by buildings in India; hence, HVAC remains the primary focus area for energy savings through system upgrades and optimization [2]. Air conditioning system which runs by compressor (electricity based) are generally working on VCR cycle. Following case study become useful to compare electricity base AC system with Gas engine operated AC system.

2. Electricity Based AC system

In Delta Technocast Pvt. Ltd., for coating and Press room requirement of temperature is 25-27 °C, which is obtained by air conditioning system. If temperature is not properly controlled than it affect the grain size, porosity and mechanical property of the metal. Proper control in temperature enhance the quality of the product. So temperature control become vital thing for investment casting industry [3]. Fig-1 shows capacity and required cooling load of air conditioning system which runs on electricity bases.

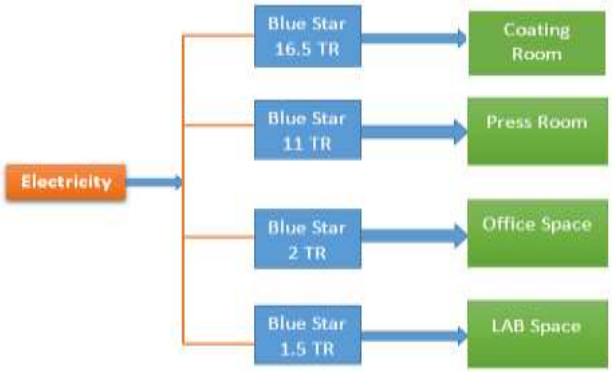

Figure 1. Cooling load

Following table shows measured power consumption by different space as discussed above.

Table 1. Cooling capacity and Measured Power

Sr. No.	Space	Cooling Capacity (TR)	Power measured (kW)
1	Coating room	16.5	56
2	Press room	11	45
3	Office	2	7.1
4	LAB	1.5	5.6
			Total = 113.7

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Consider 12 hours working time for one day and 25 working days in one month. So, monthly Power consumption becomes 34110 kW. Now electricity cost is 6.5 INR per kWh (Grid electricity cost including V.A.T). So, monthly cost of electricity consumed is 2, 21,715 INR.

3. PNG Based AC System

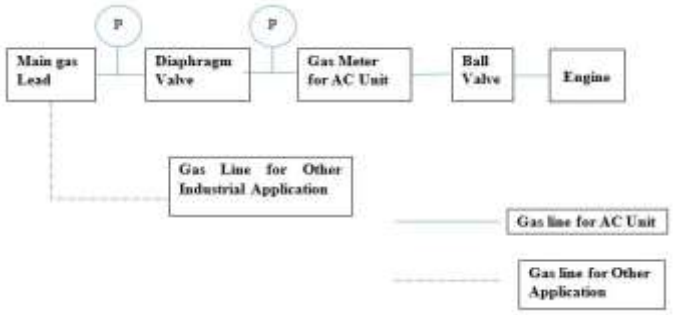

Figure 2. PNG Supply Circuit

PNG is the fuel for the engine of PNG-engine based air conditioning system. PNG is split into two ways as shown in fig 2. One path draws gas upto engine of AC system while other path shows gas line for other industrial application except AC system. Diaphragm valve allows flow of gas to enter and direct it towards engine. Diaphragm is a flexible, pressure responsive element that transmits force to open, close or control a valve. Particularly diaphragm valve is used here because it is excellent to control the flow of fluids.

There are two pressure gauges for measure pressure before and after diaphragm valve. There is separate gas meter is provided to measure the usage of gas in PNG- bases air conditioning system. Ball valve is placed which allows or stops the flow of gas to enter inside the engine. Finally engine fed with piped natural gas which is working fluid for engine of these air conditioning system. Following figure and table shows cooling load and gas consumption of Air conditioning system which runs by PNG.

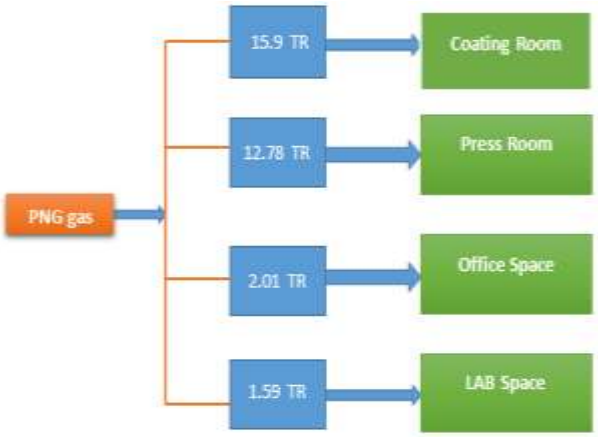

Figure 3. Cooling load for PNG base AC system

Table 2. Gas Consumption

Sr. No.	Time (hour)	Gas consumption (SCM)
1	t	70921.3
2	t+1	70938.3
		Difference = 17

Consider 12 hours working time for one day and 25 working days in one month. So, monthly Power consumption becomes 5100 SCM. Now Cost of gas is 30.43 INR per 1 SCM (including Rebate, VAT and taxes). So, total monthly cost of gas consumed is 1, 55,193 INR.

By comparing both system percentage saving in cost is 30.0033 %.

4. Carbon Dioxide Emission Comparison for Electricity Bases and PNG-Engine Bases AC Systems

Human activities since the beginning of the Industrial revolution (taken as the year 1750) has produced 40% increase in the atmospheric concentration of carbon dioxide [4]. GHG emission calculator shows that when 2.5 kWh energy produced, one kg CO_2 is emitted in atmosphere [5]. Considering 1 kg of CO_2 emission per 2.5 kW of energy generated, the annual energy consumption of 409320 KW in electric AC system will lead to 163728 kg of CO_2 emission". On other hand annual consumption of gas engine based AC system is 61,200 SCM which is equal to 2428.57 MMBTU and 24285.7 Therms. When 1 Therm gas consumed it emitted 5 kg of CO_2 in atmosphere [5]. Considering 5 kg of CO_2 emission per 1 therm, the annual gas consumption of 61,200 SCM in gas engine based AC system will lead to 121428 kg of CO_2 emission. By, comparing both system percentage reduction in gas engine based AC system is 25.84 %.

5. Transmission Losses

Electric power transmission means movement of electrons in bulk from one place to another place. Electrical energy produced in power plant reached up to different consumers by proper distribution network. This combined transmission and distribution network is known as Grid. There are two types of electricity transmission and distribution losses.

- Technical loss
- Commercial loss

Technical losses of the distribution line mostly depend upon electrical load, type and size of conductor, length of line etc. [6]. Technical losses are depends on length of line, Number of distribution transformers on Feeder, Connected load, Diversity factor, Iron loss, Copper loss, HT and LT line losses.

It is examined that generally percentage of technical losses are 4 % of the total supplied energy. By considering 4 % loss in electricity base AC system, the annual energy consumption of 409320 KW in electric AC system will lead to loss of 16372 kWh energy.

5.1 PNG Transmission: Natural gas produced from a particular well will have to travel a great distance to reach its point of use. The transportation system for natural gas consists of a complex network of pipelines, designed to quickly and efficiently transport natural gas from its origin, to areas of high natural gas demand. There are three major types of pipelines along the transportation route: the gathering system, the interstate pipeline system, and the distribution system.

Now during transportation of natural gas processing is there for reducing high Sulphur and carbon dioxide content. After processing it will distribute to location of demands. There is no any loss of natural gas except any leakage due to accident. So, 4 % transmission loss in electricity completely eliminates in natural gas transmission.

6. Waste Heat Utilization

For gas engine based air conditioning system, engine used to run compressor is water cooled engine. Output temperature of water is 85 °C. Consider atmospheric temperature equals to 35 °C for simple calculation. So water temperature increased by 50 °C. Heat required, for increase 50 °C temperature of water is 209.20 KJ/kg which saves 58.11 W of energy.

6.1 Utilization of available waste heat: Water at 85 °C is directly used as feed water of boiler. So gas engine based air conditioning system could be very appropriate for process and manufacture industries that uses boiler.

In dairy and small scale food process industry, this hot water can be used for cleaning of utensils. So gas engine base AC systems are suitable for food processing industries.

The water obtained from system doesn't content any harmful substance. So. It is also applicable for domestic purpose except drinking.

7. Comparison

Following Graph shows overall comparison for Electricity based AC system and Gas engine based AC system on the basis of Cost per month, CO_2 emission and transmission losses.

From graph we conclude that running cost per month, CO_2 emission and Transmission loss in gas engine based AC system is lower than electricity based AC system. There is 30.003 % saving in cost, 25.84% % reduction in CO_2 emission, and 100 % saving in transmission loss in gas engine based air conditioning system.

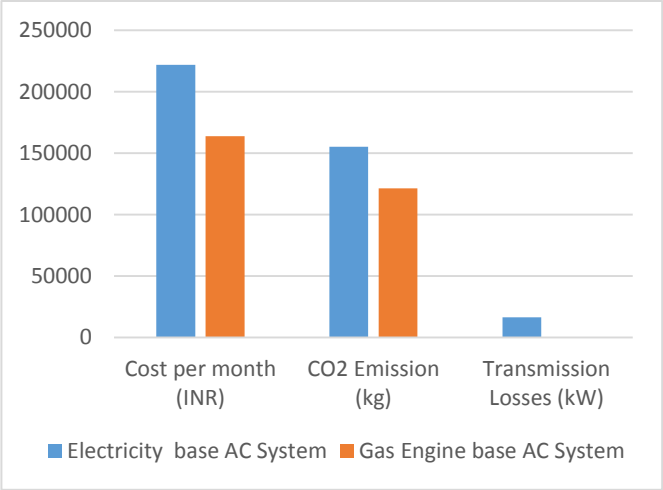

Figure 4. Comparison of both system

8. Conclusion and Future Scope

From above comparison we conclude that gas engine base AC system is batter compare to electricity base AC system by considering Cost per month, CO_2 emission and transmission losses. The main disadvantage of gas engine based AC system is its high initial cost due to engine, Energy meter, Compressor, Battery for starting of engine and pressure regulating valves. So there is a scope of cost saving in gas engine based AC system by Suitable and advanced modification.

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