International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 11 | Nov 2018 www.irjet.net p-ISSN: 2395-0072

A REVIEW ON GREEN TECHNOLOGY IN HVAC

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Abstract - *Twenty First Century was the century of innovations and the main aim of the innovations where reduce the energy consumption of components that is useful to people all around the world. The main consumer of energy in the world is by buildings around 40% due to Heating, Ventilation and Air Conditioning (HVAC) systems. HVAC system is used to maintain optimal temperature, air circulation and air filtration for comfortable indoor environment. Due to high energy consumption, HVAC systems calls for a green technology. The main objective is to minimize the energy consumption by shifting towards natural renewable source while maintaining the required comfort level of a building. This will help the earth to achieve sustainable development.*

Key Words: Solar, Water, Geothermal, Retrofits etc.

1. INTRODUCTION

HVAC is an acronym stands for "Heating, Ventilation and Air Conditioning". Often installed into a single system, these three functions of HVAC system are closely interrelated to provide thermal comfort and to maintain good indoor air quality. HVAC is sometimes referred to as climate control because it provides heating, cooling, humidity control, filtration, fresh air, building pressure control and comfort control.

HVAC is one of the largest consumers of energy around 40% of the world. HVAC systems account for much of electric energy use. Almost every facility has the potential to achieve significant savings by improving its control of HVAC operations. To improve the efficiency of the system it uses innovative technology, proper design, installation and scheduled maintenance. How to improve the energy efficiency has gained much attention as the reduction of energy use can effectively contribute to the environment sustainability. There are many ways to improve the building design and to select more energy efficient devices at the design stage itself through renewable resources for HVAC systems.

Green Technology is an environmental friendly technology which is used to achieve sustainable development of our earth. We had many renewable and non renewable resources for the usage, but we didn't use the resources in proper way for ourselves and future generation. We use our non renewable resources mainly for power generation, but the limited amount of resources don't fulfill our needs. So we want to find more innovative technology in power generation with our renewable source of energy. We want innovative technology in the field of HVAC with our renewable source of energy like solar, water, geothermal energy etc. The direct usage of renewable energy for the HVAC will reduce the power usage and we can improve the efficiency of our natural resources and also our HVAC components. By this way we can conserve our natural resources and our earth for the future generation and this will lead the earth to achieve sustainable development.

2. SOLAR POWERED AIR CONDITIONING

The demand of air conditioning is increasing due to the effect of climate change and global warming. If we still rely on the conventional electric air conditioning which consume electricity and is generated from mainly fossil fuels, the greenhouse gas emission would increase. To produce the air conditioning, it requires energy where the source is electricity. With increasing electric tariffs, solar energy becomes attractive once the system has been installed. As one of the sources of renewable energy, solar energy is likely the most suitable system for installation. Utilizing solar energy to run the air conditioning system is a practical technique to replace conventional electricity.

In solar air conditioning system, the air conditioner mainly consists of five key components which are compressor, refrigerant, expansion device, evaporator and condenser and the supporting components are Photo voltaic (PV) module, battery and charge controllers. Compressor is electrically operated can be described as the heart of air conditioning system as it pump refrigerant throughout the system. The main function of a compressor is to compress refrigerant vapour to a high pressure, making it hot for the circulation process of the refrigerant.

PV system is known as, Photo voltaic system which is combination of two words, photo for light and voltaic for electricity, converts the energy of sunlight directly into electricity. The conversion from the sunlight into electricity is occurred because of the PV effect. A complete PV system comprises two subsystems. First subsystem is the PV modules that convert sunlight into electricity. In between the first subsystem and air conditioner, there will be second subsystem which is a set of devices and structures that enables the PV electricity to be properly applied to the load. The next subsystem is known as "Balance of System" or the BOS PV module.

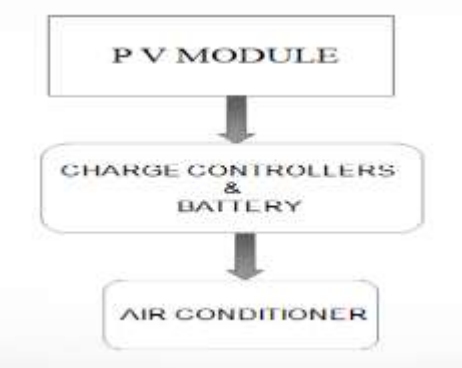

Fig 1: Block Diagram of P V system & Air Conditioning System

The BOS in this system consists of inverter, charge controller and battery. The function of charger is to regulate the voltage and current coming from the solar panel going to the battery. The battery is the key components in PV systems as it act as energy back-up for the renewable energy systems. It also functions as storage devices for storing PV generated electricity during cloudy days and at night. In order to apply this system in AC load, the inverter is needed to convert the DC electricity generated by the PV panel into AC.

The purpose of charge controller is to regulate the current from the PV module to prevent the batteries from overcharging. A charge controller is used to sense when the batteries are fully charged and to stop, or decrease, the amount of current flowing to the battery. Charge controller as in rated by the amount of current they can receive from the solar panels.

The working of solar powered air conditioning includes, the solar energy is received by the PV module and transform into electrical energy. The electrical energy is then being regulated by charge controller either by supplies it directly into the load or charges the batteries. As the electrical energy coming from the PV module is in DC, inverter will convert it into AC as the compressor needs AC to operate. The most common type of air conditioning is technically referred to as direct expansion, mechanical, vapour compression refrigeration system.

4. ICE POWERED AIR CONDITIONING

Ice powered air conditioning is more and more popular and continues to be applied and developed. Ice storage air conditioning technology is a kind of phase change energy storage. The system follows green technology by the usage of renewable energy source with working fluid as water. It makes use of the valley load electricity to make ice to storage to cool at night and melt ice into water during daytime peak hours. It can release the quantity of coolness stored in the ice and supply cooling capacity to the load end with refrigeration unit.

Ice-ball type ice-storage air-conditioning system is the earliest developed static ice-storage technology. In ice storage air conditioning system, the water is sealed in a coils, and the coils are arranged in certain order to form a cool-storage device. While making ice, the secondary refrigerant with low temperature flow from the bottom of the ice-storage tank and flow in the gap of each coil, and then make heat exchange with the water in the coil, the water temperature decreases constantly. As the time of cool-storage goes on, ice crystals form and grow rapidly in super cooled water, the water in the coil gradually freezes, the ice grows from the inner wall of the coil to the center, finally the water in the coil is completely frozen into ice. While melting ice, warm ethylene glycol flow again in the gap of coil, make heat exchange with ice ball, making the ice melting from the inner wall of the coil to the center gradually. The temperature of secondary refrigerant decreases constantly and then it is pumped to the refrigeration system to meet cooling capacity which air conditioning needs.

While making ice, secondary refrigerant ethylene glycol flows into the coils stayed in the ice-storage tank and cycles continuously, makes heat exchange with the water outside of the tube. The water out of the tube completely frozen from inside to outside along tube after repeated cycling of secondary refrigerant with low temperature. For external melting ice-on coil type, while melting ice, the backwater with a higher temperature of air-conditioner flows into ice-storage tank and gets heat transfer with the ice in it by direct contact, making the ice melt from outside to inside. For internal melting ice-on-coil type, the secondary refrigerant with a higher temperature in the tube get heat transfer for the second time with the ice outside to melt it.

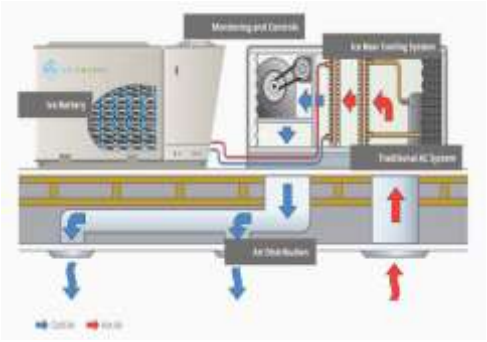

Fig 2: Ice Powered Air Conditioning System

Super cooling method is a method of making ice crystals by using the phenomenon super cooling of water. Because of its simple device and low cost, it has been used in many commercial fields. There are three parts in the process of making ice crystals, which are the sub cooler, the super cooling removed device and the ice-storage tank. In the process of making ice crystals, the refrigerator cools secondary refrigerant ethylene glycol to below 0 centigrade and then it is pumped to sub cooler. The water at 0 centigrade is also pumped from ice storage tank to sub cooler after filtration and makes heat transfer with it. Thus the water is cooled under 0 centigrade to become super cooled water. The water is removed from the super cooled state by the super cooling removed device and the ice crystals are generated. The ice crystals are sent to the ice-storage tank with water, and the ethylene glycol after heating is pumped to the refrigerator to continue the ice-making cycle. During the day time, the mixture of ice crystals and ethylene glycol is used to replace the chilled water in the traditional air-conditioning system. Then it is sent back to the ice-storage tank to participate in the ice-making cycle again.

For ice crystal cool storage air conditioning system, because the ice crystal which produced in the ice-storage tank is very small and uniform with the diameter of about 100 u m and can be directly pumped to participate in the refrigeration cycle at the load end, the system eliminates the need for secondary cooling medium and heat exchanger .So that the system is simple and the initial investment and operation and maintenance costs are low. Besides, the total heat transfer area is big, so it has high efficiency of work cycle and low energy consumption. Due to the uniform mixing of ice crystal and ethylene glycol, it is not easy to produce ice bridge and dead space in the ice storage tank. This makes it have a rapid speed of icing and ice-melting and have a stable process. In the case of the same diameter of the delivery pipes, it can transfer a large amount of cooling capacity. It can be found that the payback period of ice-crystal cool-storage system is within acceptable range, and its life cycle cost is relatively small. Besides, it has certain economic advantages than conventional air-conditioning system. In addition to the advantages mentioned above, the ice crystal cool-storage air-conditioning system has the advantages of large energy-storage density and strong adaptability.

5. GEOTHERMAL HEATING AND COOLING

Geothermal Heating and Cooling systems provide space conditioning heating, cooling and humidity control. Geothermal heating and cooling systems work by moving heat, rather than by converting chemical energy to heat.Every geothermal heating and cooling systems has three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between its fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building.

Fig 3: Geothermal Heating and Cooling

The geothermal heat pump is packaged in a single cabinet, and includes the compressor, loop-to refrigerant heat exchanger, and controls. Systems that distribute heat using ducted air also contain the air handler duct fan, filter, refrigerant-to-air heat exchanger, and condensate removal system for air conditioning. For home installations, the geothermal heat pump cabinet is usually located in a basement.

Most residential geothermal systems use conventional duct work to distribute hot or cold air and to provide humidity control. Properly sized, constructed, and sealed ducts are essential to maintain system efficiency. Ducts must be well insulated and, whenever possible, located inside of the building's thermal envelope (conditioned space).Geothermal heating and cooling

systems for large commercial buildings, such as schools and offices, often use a different arrangement. Multiple heat pumps (perhaps one for each classroom or office) are attached to the same earth connection by a loop inside the building. This way, each area of the building can be individually controlled. The heat pumps on the sunny side of the building may provide cooling while those on the shady side are providing heat. This arrangement is very economical, as heat is merely being transferred from one area of the building to another, with the earth connection serving as the heat source or heat sink only for the difference between the building's heating and cooling needs.

6. SUSTAINABLE RETROFITS

Replacing old HVAC equipment is expensive and time consuming but outdated technology is costly and wasteful. To avoid this, a sustainable retrofits is introduced with economizers, smart controls, demand response ventilation by the company "Transformation Wave". It will help to reduce 25%– 50% reduction in energy use. There is many supporting devices for the sustainable retrofits. They are

6.1 MOVEMENT ACTIVATED AIR CONDITIONING

The air conditioning design that utilizes sensors along aluminium rods hung from the ceiling. By the movement it will activate the sensors. In other words, the air conditioner only kicks on when people are present.

6.2 SENSOR ENHANCED VENTILATION

This system consists of a sensor driven vents that replace a home's existing ceiling wall, or floor vents. A smart phone app can control the room by room temperature control.

6.3 VENTILATOR WITH DEHUMIDIFICATION

This ventilator removes excessive moisture from ventilated air in buildings located in areas with mild temperatures and high humidity in winter. Without this ventilator the air conditioner has to do all the work of conditioning the humid outdoor air, which can lead to over cooling and wasteful energy management. The ventilator removes humidity from the ventilated air before it reaches the building's living space.

Fig 4: Ventilator with Dehumidifier

6.4 SENSI TOUCH Wi-Fi THERMOSTAT

The new sensi touch wi-fi thermostat features control comfort temperature. Whether you are at home or travelling the touch screen display and mobile app make it easy to access your thermostat. By this way we can save energy and cost reduction factors.

7.ADVANTAGES & DISADVANTAGES

ADVANTAGES

* Energy Efficiency

* Quiet Operation

* Heat and Cool Simultaneously

* Consistent Comfort

* Less Downtime

* Requires Less Space

* Modern Controls

DISADVANTAGES

* Initial installation cost is high

* Provides low cooling effect

* Primary disadvantage of air conditioners is their cost

8.CONCLUSIONS

The HVAC systems are responsible for a very important share of the globally consumed energy. If they work under the conditions indicated by the manufactures the energy consumed in under the nominal conditions. However, the absence or inadequate maintenance makes the HVAC system run out of those conditions. The energy consumption raises and the expected equipment life time can be significantly reduced. Both situations are against the sustainability guidelines and for so should be avoided.

The HVAC systems include several energy consuming parts. This review paper presented some data related to the importance of renewable energy sources with HVAC systems. By using our renewable sources of energy like solar, water, geothermal energy etc with HVAC systems reduce the energy consumption and increase the efficiency of HVAC systems. By using of green technology in HVAC systems, it will save our environment from greenhouse gases and keep our environment clean and green for coming generation.

From Green Technology in HVAC system, the main aim is to gain thermal comfort by the utilization of minimum amount of energy to attain sustainability. It will optimize the system operation and it improves the robustness of building by Green HVAC Technology. By the Green technology in HVAC systems we can achieve sustainable development for the future generation.

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