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ENERGY STORAGE TECHNOLOGY

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Abstract- Energy storage is the convenient and economical storage of energy from a non storable form (kinetic energy, electricity etc) to a storable form of energy. Energy storage is accomplished by using a specific device usually referred to as an accumulator. Storage of energy maintains the equilibrium of supply and demand of energy in the nature. Energy storage can be done for mechanical, electrical, biological as well as chemical and thermal form of energy. Energy storage can be long term as well as short term depending on the type mechanism opted for storing energy.

I. INTRODUCTION

Energy storage has been occurring in our nature naturally since a long time. For example,*" the solar energy which is used in solar collectors for heating is the energy being stored in sun and stars at the time of initiation of universe."* A single piece of paper can also act as an energy storing device when coated with single-walled carbon nanotube and silver nanowire films. In this process a specific energy of 30-47 Watt-hour/kilogram, a specific capacitance of 200F/g and a specific power of 200,000 W/Kg is achieved [1]. Thus it can be clearly said that even a commercially available paper can also act as a potent energy storage device. This conducting paper can also be used as current collector in lithium-ion batteries for the replacement of existing metallic counterparts.

Storage of solar energy becomes an aspect of more importance because of its lesser availability especially in winters. Moreover energy storage systems help in conservation of fossil fuels as well as downfall in the carbon dioxide and CFCs emissions. Another application of energy storage systems is the storage of enormous energy from waste energy of air conditioners as well as industrial processes [2]. This type of storage would be highly applicable for large scale centralized heating systems.

For thermal energy storage, water and phase change materials including rocks, soil are used worldwide. Rock particles of size around 20 to 50 mm are used along with two phase change materials unless we provide a heat pumping system. Even well designed rock beds have various characteristics which make them suitable for energy storage. "*Oil-rock system is an excellent example of storage of thermal energy at medium temperature, around 38–304°C.*" Whereas for high temperature storage of thermal energy, molten nitrate salt systems can be used at temperature, around 120–566°C [3]. Carbon nanotubules are being prepared by using chemical vapor deposition of carbon within the pores of alumina membranes for the purpose of electrochemical energy storage." *Carbon nanotubules are further filled with platinum and rubidium used for the electrocatalyzation are nowadays an excellent example of energy storage material in environment friendly manner"*[4].

One biggest drawback of electric power sector is the fluctuating demand of electricity versus the short interval of generation of electricity. Thus this increases the requirement of energy storing devices which produces renewable form of energy which can be controlled through Grid Operators. Such energy storing devices also helps in maintaining a proper equilibrium between the network load and the power thus generated.

II. RECENT ASPECTS IN ENERGY STORAGE TECHNOLOGY

A current ongoing energy storage programme is the Office of Electricity's energy storage programme, in collaboration with California Energy Commission and New York State Energy Research and Development Authority which includes electrochemical capacitors,superconducting magnetic energy storage (SM ES), power electronics and control systems [5].

Incorporation of aluminum thermal conductivity promoters of various designs into the body of paraffin wax can also prove to be a great thermal energy storage unit. It is also found that expanded aluminium provides much better ground for energy storage as compared to promoters constructed of sheet metal [6].

A right and optimum combination of a

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n electrode and an electrolyte can also prove to be a good energy storage material. Nanoparticles such as carbon nanotubes and porous carbon provide high capacitance and power and thus can prove to be a good material electrode material for energy storage. Graphene can also be used for the same but the only drawback lies in the low capacitance of Graphene. For electrolytes purpose we can use solutions of [N(C2H5)4]BF4 in acetonitrile or propylene carbonate [7]. For more cost effective approach to make energy storage device sodium sulfate can be used which is very inexpensive and widely used for commercial purposes. Even vanadium is tested and found to have been giving significantly positive results as an electrode while being tested in sulfurous solutions [8]. The main objective of using vanadium as an electrode material is to create a vanadium redox flow battery which is a marvelous energy storing device. The results for behavior of vanadium ions in sulfurous solution were also found to be positive and satisfactory. For experimental model purpose, a vanadium redox flow battery of power potency 5Kw was being tested for voltage and energy efficiencies and has been found to give satisfactory performance[8].

An excellent example of energy storage can be seen in Netherlands, where wind energy is amplified as well as electrical energy is stored. In this country, three large scale energy storage models have been employed namely pumped hydro accumulation storage (PAC), underground PAC and compressed air energy storage. Heat boilers are installed in combined heat and power locations (CHP) thus increasing the operational flexibility of these three units. In this system installed in Netherlands, it is being observed that more the amount of wind power installed more is the amount of energy being stored [9]. One more significant thing to be noted in this system is that carbon emissions are prominently increased since energy storage is from cheap power plants instead of expensive gas during load times.

A series connection of supercapacitors has also been shown to provide energy storing capacity [10]. In series connection the voltage is equalized and a higher amount of instantaneous power is being generated. Such connection of batteries also provide a platform for energy storage with proper voltage maintenance within the series circuit.

Energy can also be stored in superluminal barrier tunneling where more is the group delay more is the energy being stored [11]. This gives rise to the concept of Hartman effect in which the group delay becomes independent for thickness of opaque barriers. Thus energy storage can also be done in this fashion of propagation phenomenon. The base of Hartman effect is actually the saturation of delay with increasing thickness of superluminal barrier. This finally has widened the scope of energy storage by this methodology.

Energy storage in the grid is also one of the emerging techniques being employed for energy storage. Energy storage in grid involves the integration of renewable energy resources and it manages the costing of production during peak times. Sodium sulfur batteries and redox flow batteries are mainly incorporated in grid system for energy storage since it proves to be cost effective and conveniently cheaper.

III. CONCLUSION

Thus it can finally be conferred that as a result of greenhouse gases and global warming the renewable energy resources are depleting very fast. Catastrophic conditions may arrive in future if this haphazard continues. Thus there is huge requirement for the energy storage systems development and their economical installation. Moreover with the help of rapidly developing science scientists are able to create many artificial energy storage units with many in their final stage of development. But the installation of these systems in various countries is also a big challenge. These energy storage systems are not only the means of conservation of energy for the present generation but these systems will act as pioneers of energy storage for future generation. Energy storage also converges us on the sustainable development path where we are preserving for the future generation also. These systems not only provide means for energy management but also the utilization of current available energy in a more refined manner.

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