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DESIGN AND FABRICATION OF ACTIVATED CARBON MANUFACTURING MACHINE AND EXPERIMENTAL INVESTIGATION OF SAW DUST ACTIVATED CARBON

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Abstract - *Saw dust activated carbons produced by steam activation process are of good quality when considered to other non-graphitic forms. It is superior because of its macro porous structure rendering maximum adsorption of gas or vapour and for the removal of colour and odour of compounds. Commercially the same is extensively used in the refining and bleaching of vegetable oils, chemical solution, water purification, recovery of gold etc. This being predominantly macro porous, becomes well suited for organic chemical adsorption, with its highest hardness matches ideal for water purification. Activated carbon manufacturing machine is a CPS, it works with the help of an electrical AC motor to drive the gear drive and actual experimental setups, in the generation of the deactivated carbon. The gear box assembly, hopper setup, screw conveyor and stand were fabricated with a simple design and with easily available materials. The output obtained is tested and results are analyzed.*

Key Words: **CPS –Chemical Powered System**, **AC – Alternating Current.**

1. INTRODUCTION

Activated carbon is a form of carbon species that is processed and prepared to have high porosity and very large surface area available for adsorption. Activated carbons are sometimes called as active carbons due to their highly developed internal surface area and porosity. The large surface area implies a high capacity for adsorbing chemicals from gases and liquids. The most widely used commercial active carbons have a specific surface area varying from 800 to 1500 m^2/g as determined typically by nitrogen gas adsorption. Difference in pore size affects the adsorption capacity for molecules of different shapes and sizes, and so is one of the criteria by which carbons are selected for a specific application .It appears to be black, tasteless, nontoxic absorbent, with large specific area and three class of pore size distribution after a serial of physical and chemical processions including carbonization, activation, acid cleaned and washed. It has properties of both physical and chemical adsorption, selecting and adsorbing matters of small and macro molecular in gas and liquid phase to do functions of crocking, refining, deodorization, sterilization, decontamination and purification. Activated carbon is an essential industry product for food, pharmaceutical, chemical, water treatment, environment-protection, chemical national defense and agricultural industry.

1.1 Application

Activated carbon is used in gas purification, gold purification, metal extraction, water purification, medicine, sewage treatment, air filters in gas masks and respirators, filters in compressed air and many other applications. One major industrial application involves use of activated carbon in the metal finishing field. It is very widely employed for purification of electroplating solutions, for removing organic impurities from bright nickel plating solutions. A variety of organic chemicals are added to plating solutions for improving their deposit qualities and for enhancing properties like brightness, smoothness, ductility, etc. Activated carbon treatment removes impurities and restores plating performance to the desired level. In environment field activated carbon adsorption has numerous applications in removing pollutants from air or water streams both in the field and in industrial processes such as spill clean-up, Groundwater remediation, Drinking water filtration, Air purification, volatile organic compounds capture from painting, dry cleaning, gasoline dispensing operations, and other processes. In medical applications activated carbon is used to treat poisonings and overdoses following oral ingestion. It is thought to bind to poison and prevent its absorption by the gastrointestinal tract. The granular activated carbon is always preferred for adsorption of gases and vapors as their rate of diffusion is faster. The activated carbons pellets are made especially for use in vapor applications in industries. Aquarium charcoal or activated carbon is used as a water filter in fish aquariums. Activated carbon pellets is made especially for use in a vapor applications. The product is highly double screened and de-dusted in the normal process and prior to packaging to assure a very clean, dust free product and hard with long service lifespan.

1.2 Raw materials used in the production of activated carbon.

Activated carbon is produced from a wide variety of carbon-rich raw materials, including wood, coal, peat, coconut shells, nut shells, bones and fruit stones. New materials are currently under investigation as sources for activated carbon. Almost any organic matter with a large percentage of carbon could theoretically be activated to enhance its adsorptive characteristics. In practice, however, the best candidates for activated carbon contain a minimum

amount of organic material, have a long storage life, are hard enough to maintain their properties under usage conditions, may be obtained at a low cost, and obviously are capable of producing a high-quality activated product when processed. The widespread use of a particular raw material as a source of activated carbon is obviously limited by the supply of that material. As a result, wood is by far the most common source of activated carbon, followed closely by coal; coconut shell and peat are also used in large quantities, but they are more expensive and less readily available. The raw material from which a given activated carbon is produced often has a large effect on its porosity distribution and surface area. As a result, activated carbons produced from different raw materials may have much different adsorbent qualities.

Table -1: Material and Carbon Content

SLNO	MATERIAL	%CARBON CONTENT
1	Wood	40
2	Coconut shell	35
3	Lignite	60
4	Bituminous Coal	75
5	Anthracite	90

2. ADSORPTION MECHANISM OF ACTIVATED CARBON

Activated Carbons are the most powerful adsorbents known. It is basically a solid material consisting mainly of pure carbon. A characteristic feature is its porous structure and the resulting immense surface area which may be as large as 1500 m^2/gm. Due to its exceptional adsorption qualities, activated carbon is widely used in process destined to purify, discolour, recuperate and remove odours at low cost and superior efficiency

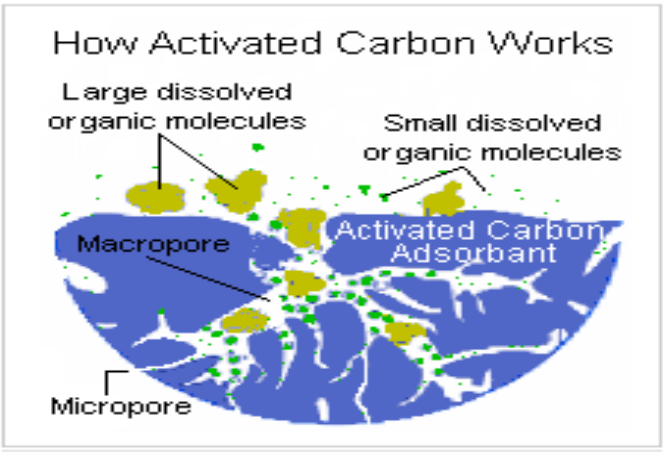

Figure illustrating the working of Activated carbon

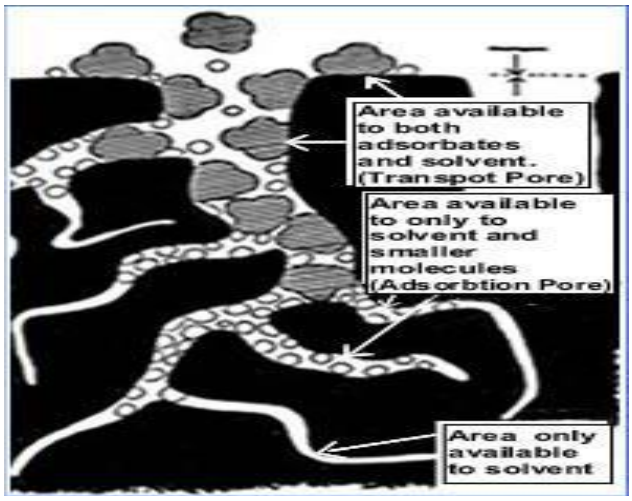

Fig -1: Adsorption mechanism

Activated carbons work on the principle of adsorption. Adsorption is an interfacial process involving the collection of gaseous or solute components on the surface of adsorbent solids. This phenomenon is associated with physical attractive forces that bind gaseous and solute molecules commonly known as Van-der-Waals forces. Adsorption is thus a physical process, i.e. the substances adsorbed on the solid do not undergo any chemical reaction with the latter. The adsorbing solid is referred to as adsorbent and the substance to be adsorbed from the liquid or the gas phase as the solute. The adsorption power and rate is determined by the kind of activated carbon, the particle size, the pore size and its distribution. When the carbon is activated it leads to opening of various pores in its structure.

In water and wastewater treatment systems, activated carbon is almost always used as a filter medium in an independent treatment operation. In some cases, powdered activated carbon (PAC) is added to the actual wastewater stream to adsorb contaminants, then removed later from the stream and discarded. Because PAC has a faster adsorption rate, it was often used in the past, but disposal and handling concerns have made granular activated carbon (GAC) a more popular alternative for most applications. GAC is used in the filtration process in water treatment, and then regenerated when it becomes less effective due to saturation with chemicals. GAC is also usually much easier to handle and transport then PAC.

Three primary types of filter beds are used with GAC as substrate. The differences involve the method by which carbon is removed from the system as its capacity is consumed. All three require the constant monitoring of effluent in order to determine when the 'breakthrough' occurs of effluent with a high concentration of solute. This breakthrough, of course, indicates that the carbon is no longer adsorbing effectively. While activated carbon is especially known for its effectiveness in removing organic chemicals from water and waste water, it is also surprisingly

effective in removing a variety of inorganic constituents would not necessarily be predicted by the chemistry of activated carbon, low levels of these chemicals can be removed effectively, primarily due to physical adsorption mechanisms. Applications for this process can be found in water and wastewater engineering, metallurgy, and analytical chemistry.

Both anions and cations have been removed from waters with activated carbon. In general, it is true that carbon adsorption is not nearly as effective at removing metals and inorganics as it is at removing organic compounds. This is primarily because metals often exist in solution either as ions or as hydrous ionic complexes. Based on previous discussions of adsorption chemistry, neither of these forms is effectively adsorbed by carbon.

3. ACTIVATED CARBON MANUFACTURING MACHINE

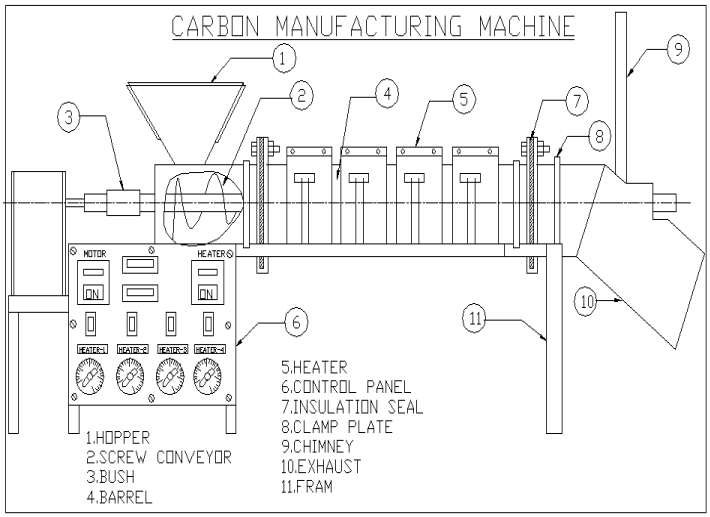

Fig -2: Schematic diagram.

3.1 FABRICATION

Table -2: Specifications

SL NO	PART NAME	MATERIAL	SIZE (mm)	MANUFACTURING PROCESS
1	Hopper	Sheet metal	300× 300	Submerged Arc Welding
2	Bend pipe	Steel	140 dia	Submerged Arc Welding
3	Stand	Mild steel	2mm thick	Submerged Arc Welding
4	Shaft	Mild steel	25dia	Lathe process (turning)
5	Worm & worm wheel	Cast iron	40 & 60	Milling & Hobbing

Fig -3: Activated carbon manufacturing machine

4. WORKING PRINCIPLE

Waste products taken from wood industries are dried for two to three days. The heating chamber switch was switched ON so that the regulator has to be adjusted gradually to reach the maximum temperature.

Then it was allowed to heat up to thirty minutes. Then wooden waste dried is taken and mixed with NaCl with proportionate rate of 1:4.Then motor was switched ON. Thus screw conveyor rotates. Then proportionate mixture of sodium chloride and wood dust was put inside the hopper. The conveyor has taken it inside the hopper. Inside the extruder more heat is generated because the heat is transferred from heat chamber to the extruder. Thus the wooden waste burnt inside the extruder with NaCl. The NaCl prevents the wooden dust from forming of ash while heating. The heat produced around is 300°C. The sawdust is burnt completely and taken away as deactivated carbon by the conveyor. The carbon is fed down through the bend pipe.

Then the carbon getting out have to be dipped inside the Conc. HCl hydro-chloric acid which was mixed with water with permanent proportionate rate of (1:10). Thus it will now form as diluted hydro-chloric Acid. The deactivated carbon was dipped in the acid for few seconds. Thus the chloride content present in carbon is removed by chlorine present inside the HCl. Thus it was taken and dried and the resultant product obtained was known as “Activated carbon”.

5. RESULTS AND EXPERIMENTAL ANALYSIS

Table -3: Result

SLNO:	NAME OF TEST	RESULT (%)
1	Moisture	49.38
2	Volatile matter	18.66
3	Ash content	1.17
4	Sulphur	0.067
5	Carbon	27.07

Analysis, which is more comprehensive, is dependent on quantitative analysis of various elements present in the activated carbon sample, such as carbon, hydrogen, Sulphur, Oxygen, and nitrogen. It helps us to assess the amount of moisture, volatile and ash content with the residual carbon present in the sample .It shows that the moisture content of activated carbon prepared from Saw dust is high while the volatile and ash content are the least.

6. CONCLUSIONS

Activated carbons from Saw dust are good enough for the treatment of any kind of liquid and gaseous effluents. The results indicate that activated carbon they have higher apparent density, lower moisture content and lower ash content, more finely distributed in sizes. Activated carbon obtained from saw dust can be converted into various forms such as pellets, briquettes and granular etc.

The sawdust was burned during the movement of Screw Conveyor in the Heating Chamber. It Recovers Deactivated Carbon. Then it is dipped to get activated carbon is done with Dil. HCl. The quality of the Activated Carbon obtained was found to near Industrial Standard.

Activated carbon obtained from machine is tested and is found that it has low sulphur & ash content. It has also got high carbon & fixed carbon content. Due to chemical activation using Dil. HCl moisture content is found to be high.

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