An Experimental Investigation of Manufacturing Activated Carbon Prototype Setup

R. Pravinkumar[1] J.Yasin[2]

PG Scholars, Department of Manufacturing Engineering,
Government college of Technology, Coimbatore, Tamilnadu, India.
Email: yasinyas007@gmail.com

Abstract — Activated carbons are used in industries for various applications like gold extraction, water and air purification, electrolyte cleaning, medical waste treatment, textile, cooking industries and so on. Mostly activated carbons are produced from coconut shell. These activated carbon preparing setup are comparatively very larger in size and capacity.In order to overcome this difficulty, we have fabricated an experimental prototype of manufacturing activated carbon with deformation and temperature analysis, at low cost and compact in size.

Keywords—activated carbon, experimental setup of manufacturing activated carbon, pyrolysis analysis.

I. INTRODUCTION

Activated carbon includes a wide range of amorphous carbon-based materials prepared to exhibit a high degree of porosity and an extended inter- particulate surface area. It is also a common term used for a group of adsorbing substances of crystalline form, having large developed internal pore structures that make the carbon more adsorbent.

There are many recipes for the proportion of clay, but they all strike different balances between mold ability, surface finish, and ability of the hot molten metal to degas.

In wastewater treatment, activated carbon is usually used as a filter medium in tertiary (later) treatment processes. In addition to its drinking water and wastewater treatment applications, activated carbon is used today for many other purposes. Some other common uses are corn and cane sugar refining, gas adsorption, dry cleaning recovery processes, pharmaceuticals, fat and oil removal, electroplating, alcoholic beverage production, and as nuclear power plant containment systems.

II. LITERATURE REVIEW

Mohammad Khah A., et al., (2009) [1], proposed that adsorption is a widely used as an effective physical method of separation in order to elimination or lowering the concentration of wide range of dissolved pollutants (organics, inorganic) in an effluent. It is big news that activated carbon is a well-known adsorbent that can be used efficiently for removal of a broad spectrum of pollutants from air, soil and liquids. Adsorbents are usually porous solids, and adsorption occurs mainly on the pore walls inside particles.

De Ridder D. J. (2012) [2], published a book on adsorption of organic micro pollutants onto activated carbon. In order to explain the capabilities of activated carbon, an appreciation of its structure is most useful. Much of the literature quotes a modified graphite-like structure; the modification resulting from the presence of micro crystallites, formed during the carbonization process, which during activation, have their regular bonding disrupted causing free valences which are very reactive. In addition, the presence of impurities and process conditions influence the formation of interior vacancies, in the microcrystalline structures.

High magnification electron scanning microscopy, at 20,000x magnification, has revealed the presence of residual cellular structures. These were previously unseen and unsuspected, except in the case of wood-based activates which have sufficiently open structures visible to the naked eye. Fig.1 shows the microscopic structure of activated carbon.

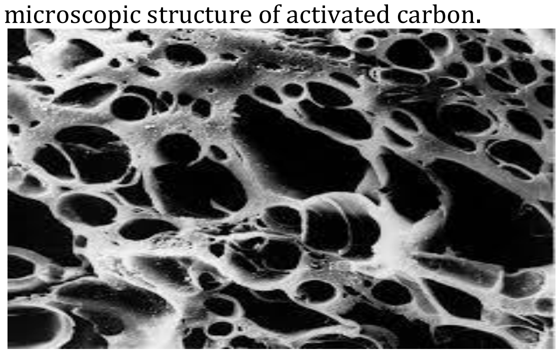


Fig.1 Microscopic structure of activated carbon

Most theories attribute the structure of activated carbon to be aromatic in origin, thus, allowing the carbon structure itself to be described as aromatic in order to explain active centres, etc. Final activates consist almost entirely of elemental carbon together with residual ash which, in the case of wood and coconut, originate from minerals within the vessels of living tissues; silica being the only constituent actually incorporated within the cell wall tissue matrix.

The ash content of coal is of different composition and due to intrusion of inorganic materials during coalification. Thus, the overall Structure consists of a modified cellular-like configuration with varying ash components depending on the particular raw material. The cellular-like structure theory offers a logical explanation for the differences in apparent density between activates of wood, coal and coconut.

Abbas Sabah thajeel et al, (2013)[3] proposed the preparation of activated carbon from local raw material (Rice husk & wood piece), as they are available in large quantities. A comparison between physical and chemical preparation methods and their efficiency were investigated. Results are shown that the preparation by chemical method is more efficiency than physical method due to bigger surface area of activated carbon, except treatment with NaOH. The optimum preparation conditions together with the effected of these conditions on the yield & efficiency of produced activated carbon have been studied.

III. EXPERIMENTAL SETUP

A. Components

The compound used for manufacturing the experimental setup are shown below

1. Motor
2. Gear box
3. Kiln
4. Heater
5. Screw conveyor
6. Pulley
7. Belt
8. Frame
9. Board

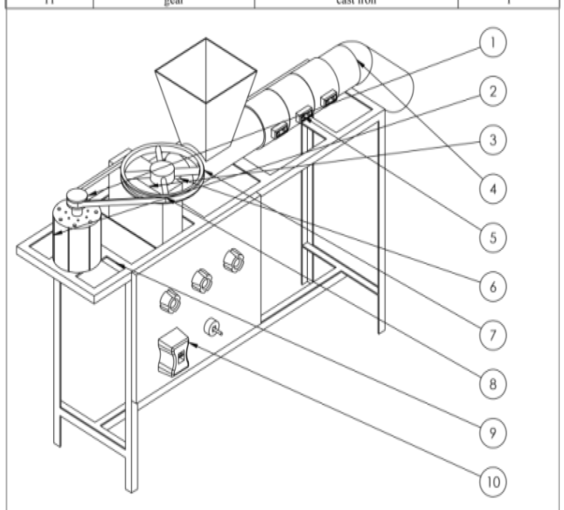
B. Fabricated model

Fig.2. Fabricated proto type model

C. Experimental setup design

The following Fig. shows the parts and completed experimental setup with bill of material.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	rotor	copper	1
2	motor	carbon steel	1
3	gear casing	c20 steel	1
4	kiln	mild steel	1
5	heater	aluminium alloy	3
6	conveyer	mild steel	1
7	pulley-large	cast iron	1
8	belt	leather	1
9	frame	mild steel	1
10	board	mild steel	1
11	gear	cast iron	1



PROJECT TITLE	EXPERIMENTAL SETUP FOR MANUFACTURING ACTIVATED CARBON		
ROLL NO.	12, 38, 54, 59	PART NO.	....
BATCH NO.	07	PART NAME	ASSEMBLY
SCALE	1 : 8	DRAWING NO.	14
		MATERIAL	.....
ALL DIMENSIONS ARE IN mm		QUANTITY	01

Fig.3. experimental model

IV. ANSYS ANALYSIS REPORT

The total deformation experienced by the frame due to the load offered by the motor, gearbox, Archimedes screw, heaters.

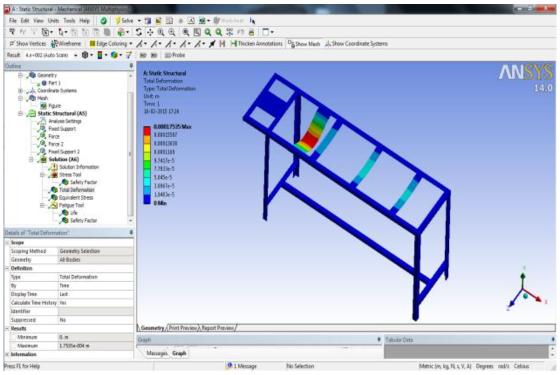


Fig.4Total deformation undergone by the frame

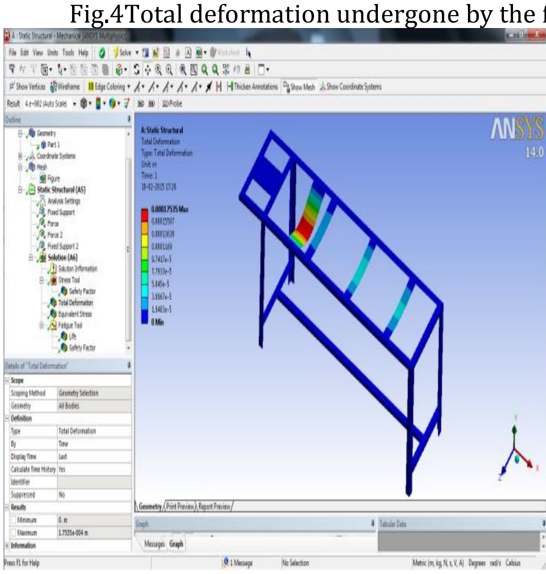


Fig.5. frame stress analysis (von mises)

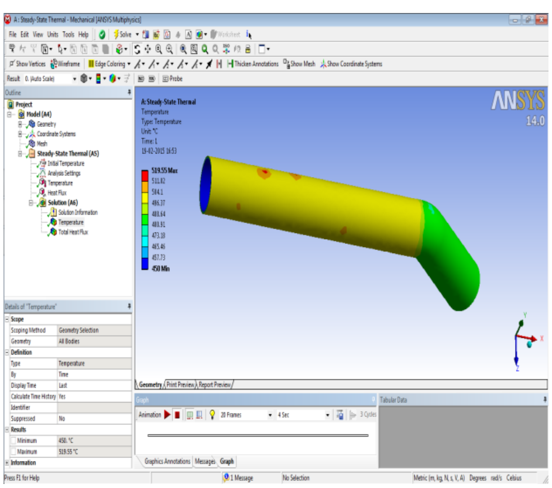


Fig 6. Temperature distribution of kiln

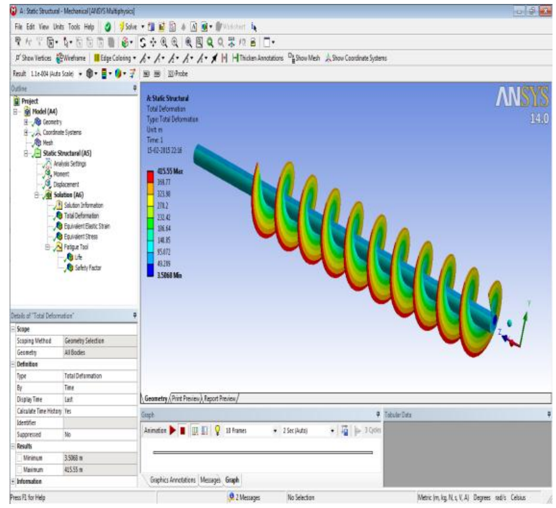


Fig 7 Total deformation of the Archimedes screw

The temperature distribution over the assembly during the operation and Fig.8 represents the directional heat flux of the assembly.

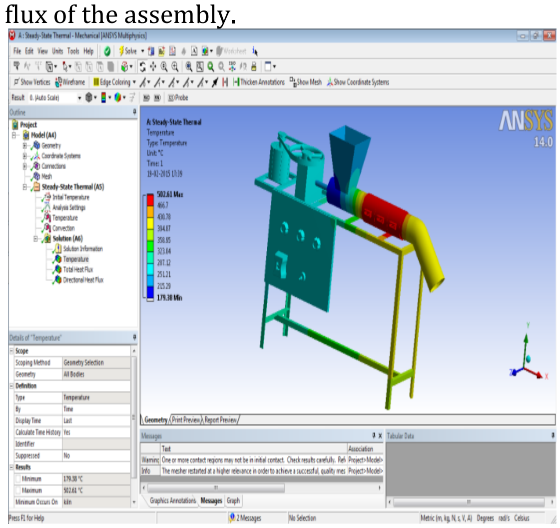


Fig 8.the directional heat flux of the assembly

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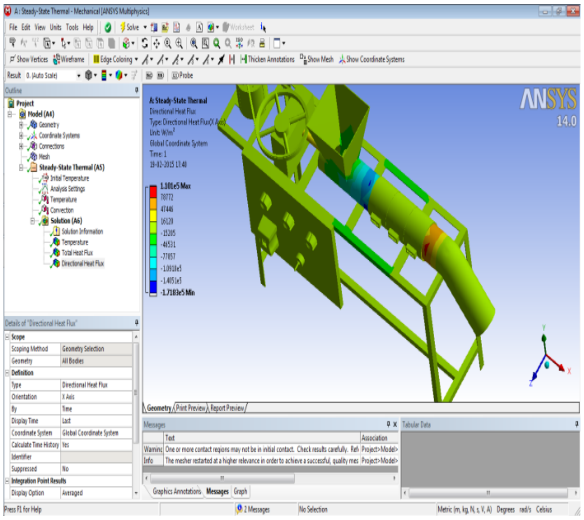

Fig.9.Temperature distribution over the assembly

A.Pyrolysis data analysis

Before pyrolysis was done, all the samples were first weighed using an electronic balance and the samples set to 1000 gm. After pyrolysis and activation the samples were reweighed. In order to calculate the weight loss during pyrolysis, the following formula was used,

Loss in wt of sample =
Wt before pyrolysis– Wt after pyrolysis
Percentage yield = (yield/initial Wt)*100

The following table 1 gives the data resulted from coconut shell at different temperatures and time.

TABLE. 1 COCONUT SHELL DATA

Time (min)	Temperature (^0C)	Acid Proportion (H_3PO_4)	WT loss (Kg)	Yield (%)
120	350	1:4	1.3	48
180	380	1:4	1.4	44
285	400	1:4	1.5	40

The following table 2 gives the result of activation of wood pieces at different temperatures and time.

TABLE .2 WOOD PIECES DATA

Time (min)	Temperature (^0C)	Acid Proportion (H_3PO_4)	WT loss (Kg)	Yield (%)
180	300	1:3	1.5	40
210	350	1:3	1.7	32
270	410	1:3	1.9	24

B.Methyleneblue adsorption result

The following table 4.4 shows the Methyleneblue adsorption results for various components at various temperature.

TABLE 3.
METHYLENEBLUE ADSORPTION

Raw material	Acticity time (min)	Processed temperature	adsorbance
Coconut shell	45	350	3.9
Coconut shell	45	350	4.1
Coconut shell	45	350	4.5
wood	45	300	8.9
Wood	45	350	9.1
wood	45	410	9.1

C.Graph results

The following Fig.10 shows the relationship between temperature and methyleneblue adsorption of coconut shell.

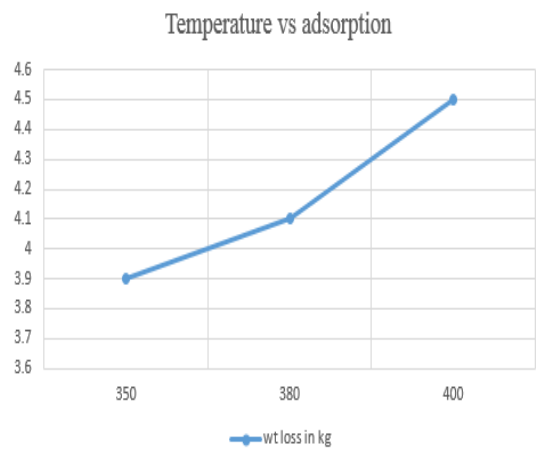

Fig. 10.Temperature vs. adsorption for coconut shell

The following Fig. 11 shows the relationship between temperature and methyleneblue adsorption of wood pieces. The optimum temperature for activation of wood pieces lies between 350 ^{0}C and 400 ^{0}C.

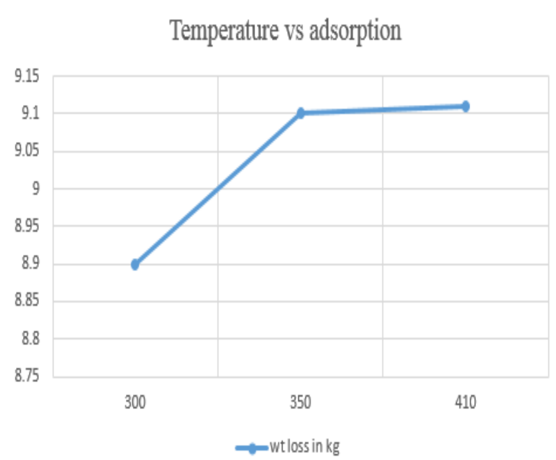

Fig.11 Temperature vs adsorption for wood

V. CONCLUSIONS

The experimental setup eliminates the need of using large sized highly cost consuming apparatus for producing activated carbon for testing. It reduces the area requirement for producing activated carbon. Defects and quality errors can be avoided by checking the resultant product of this setup without switching to mass production. Due to its small size it is portable and can be used anywhere for the activation process. The kiln used in the industry uses only coconut shell as the raw material for the production of activated carbon. In the designed experimental setup more than one raw material can be used.

The main advantage of this experimental setup is that it produces activated carbon from wood pieces which is not commonly practiced in the industry. Wood piece is one of the easily available raw material and when activated it shows an excellent adsorption rate. The designed experimental setup is able to reduce the cost of production. The experimental setup is designed with almost all the available technologies and guide lines given by the industry. The output produced by the setup helped the industry to carry out the further experiments in the chemical activation

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