OPTIMIZATION OF PREPARATION CONDITIONS FOR NANO POROUS CATALYTIC CARBON FROM POST CONSUMER POLY ETHYLENE TERPHTHALATE BOTTLES USING RESPONSE SURFACE METHODOLOGY

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Abstract - Using response surface techniques, this research proposes the best conditions for producing Nano porous catalytic carbon from post-consumer polyethylene terephthalate (PET). The carbon yield and surface area of post-consumer PET-based AC is evaluated. The PET-based AC was rendered using a zinc chloride-based chemical activation technique (ZnCl$_2$). The results of three preparation variables, including activation temperature, activation time, and chemical impregnation (ZnCl$_2$:char) ratio, on both surface area and yield, were studied. To assess the impact of planning conditions on responses, the central composite design (CCD) method was used Quadratic models for surface area and yield were constructed using the CCD. The study of variance revealed the effects of the three main parameters, the properties of activated carbon, and the important factors on each experimental design reaction (ANOVA). Using a 5% impregnation ratio, a 1000ºC activation temperature, and the best conditions for PET-based AC preparation were found to be at 60-minute activation time, yielding 1102.62 m$^2$/g of surface area and a 16.218 % yield.

Keywords: Activated carbon, Surface area, RSM, CCD, PET, Design Expert

1. Introduction

PET stands for polyethylene terephthalate and is the most widely used polymer on the planet. PET polymer is most commonly known as "Polyester" and is a translucent, semi-crystalline material that is extensively used in everyday life. PET (polyethylene terephthalate) bottles have been entwined and entangled in our lives. PET is commonly used, flexible, and reliable plastic materials on the planet. PET plastics provide more than half of the world's synthetic fibre and container market.

PET production and use have grown at the highest pace in the global plastics industry in recent years (Kuczenski and Geyer, 2010). PET intake in the industry rose from around 13 million tonnes per year in 1998 to around 27 million tonnes per year in 2007 (Karayannidis and Achilias, 2007) and is estimated to be about 19.1 million tonnes by 2017. Between 2012 and 2020, it rose by 5.2 percent per year, reaching around 244.1 million tonnes per year in 2020. Due to the a significant
volume of solid waste generated, the rejection of post-consumer PET bottles poses a significant challenge for waste management strategies.

Environmental regulations have made it necessary to find viable substitutes that can be recycled or reused (Hayashi et al., 2005). PET is a clean, solid, lightweight, durable, and non-toxic substance which is recycled and used as precursor. Incineration or recycling are the most popular technologies used to solve the PET disposal crisis. Due to its increased level of CO$_2$ content and abundance in a comparatively natural state, it is proposed that this cheap and plentiful PET waste be transformed into Nano porous catalytic carbon to allow better use oft.

While various precursors can be used to make activated carbon, enabled carbons that are commercially available are also considered expensive. This is how a non-renewable resource was used and comparatively costly starting fuel, such as coal, in emission control applications, which is unjustified. (C. Sourja.,2005 , M.J. Martin.,, 2003). As a result, an tremendous interest in the manufacture of activated carbons from sustainable and less expensive precursors, such as Mustard Husk, Banana pseudo stem, and Thespesia Populnea pods, in recent years. (M. Arulkumar., 2010), Coconut shell (Yang et al., 2010), Turkish lignite (Filiz Karacan.,, 2006), Rice husk (Foo and Hameed, 2011), Oil palm fiber (B.H. Hameed.,, 2008), Sugarcane (Kalderis et al.,, 2008), Tamarind wood(J.N. Sahu.,, 2009) Oil palm (B.H. Hameed.,2008), Bamboo (Liu et al.,, 2010),Coconut Husk (I.A.W. Tan.,, 2007), Corn cob (Song et al.,, 2013), Manogosteen peel (Mohd Azmier Ahmad.,,2010), Jatropha hull (Duan Xin-hui.,, 2010), Rice straw (Gao et al.,, 2011). Whatever the case may be, having a sufficient supply of PET bottles make the processing of activated carbon are highly economically feasible while also landfills of solid polymer waste (Laszlo, 2005).

Chemical activation and Physical activation is one of the approaches to produce AC but chemical activation have benefits over physical due to its single process and high yield in the end of the process. Carbonization is the method of changing carbon dioxide in to raw materials is accompanied by activation with CO$_2$ or steam in the physical activation process. When compared to physical stimulation, chemical activation is more effective. Chemical activation has many benefits over physical activation. Chemical activation allows for simultaneous carbonization and activation. Chemical activation has many benefits over physical activation, the first of which is the lower activation temperature, which allows the procedure to be completed in a single stage, and the second of which is the normal yield of chemical activation is generally higher since burn-off char is not necessary. PET has been identified as a best resource for preparing AC by physical and combination (physical + chemical) activation by a number of researchers (Bratek et al., 2013; Kartel et al., 2006). A small amount of study has been done on direct one-step chemical activation. Various studies have researched the effects of various chemical reagents on the processing and efficiency of Nano porous catalytic carbon. Among the multiple dehydrating agents, zinc chloride is the most commonly used chemical agent in the preparation of Nano porous catalytic carbon. Understanding the various variables that occur during the activation phase is critical for developing the porosity of carbon
required for a specific application. Because of the effect of chemicals, chemical activation by ZnCl₂ enhances pore formation in the carbon structure. Carbon yields are typically high. As a result, the use of zinc chloride for carbonization can be beneficial in terms of cost and activated carbon chemical composition. The most significant properties of activated carbon are its surface area and yield, which are heavily determined by the preparation conditions (Olivares-Marín et al., 2006).

The RSM is used in conjunction with the CCD a well-known mathematical technique for optimising process conditions since it only requires a limited number of controlled experiments, saving time, money, and energy. It will evaluate the interactions between parameters that influence conditions of the mechanism (Ahmed et al., 2009). The RSM is a commonly used mathematical and computational tool for modelling and evaluating a mechanism in which various variables influence the a positive response, with the interest of optimising the response. Dependent variables are the factors that influence the mechanism, while dependent variables are the responses.

The RSM looks at an relationship of approximation between input and output values in order to find best process conditions of an device or an area of the factors sector that meets the requirements. Response surface Methodology employs two main laboratory designs, are CCD and Box-Behnken Designs (BBD). The Central Composite architecture is a two-level factorial design with 2k (the number of independent variables is denoted by the letter k) points (star points) added between the axes, and at the centroid, replicate points.

The trials are randomised, as are all successful experimental designs. RSM has been extensively used to optimise laboratory conditions in a variety of applications, including the preparation of mangosteen peel is used as a precursor for activated charcoal (Ahmed et al., 2010), tamarind timber (Sahu et al., 2010), and husk of the coconut (Ahmed et al., 2010). (Tan et al., 2008). Nonetheless, as far as we know, no one has looked at using RSM as an enhancement strategy Using the chemical activation process with Zinc chloride as an activating agent to make activated carbon from PET. The goal of this research is to improve the preparation conditions for activated carbon made from PET that has a large surface area and high yield. The effects of three numerical preparation variables on surface area and yield were investigated using a core composite configuration: chemical impregnation ratio, activation temperature, and activation time. Using mathematical simulations, the surface area and activated carbon yield were then related to the three variables.

2. Materials and Approaches

Reagents

The precursor used for this project is post-consumer PET bottle obtained from the NIT in Rourkela, India. The chemical activation was done with analytical grade zinc chloride. Enabled carbon preparation

The precursor was cleaned and dried properly with purified water to clear soil from its surface. The dried PET was sliced into tiny 5-10 mm sections. A total of 100 mL is impregnated into
10g of PET granules of dilute ZnCl₂ at concentrations ranging from 10% to 70% of the samples have been soaked for 24 hours of about 85 degrees Celsius and after that it was dried for 3hr at 120 degrees Celsius. The impregnated samples were heated to final temperatures in a tubular furnace ranging from 1000 ºC to 1200 ºC with a constant heating rate of 10 ºC /min and a constant N₂ flow rate of 100 mL/min. The time spent at the final temperature was ranged from 30 to 90 minutes. The activated carbon was carefully washed with base after cooling (0.1 mol/L aqueous NaOH solution), then rinsed with hot water (80 ºC) until the rinsed water had a pH of neutral. The samples had to be dried for about 24 hours at 120 degrees Celsius and placed in airtight containers.

**Experimentation Design**

A central composite design, was used to investigate the criteria for preparing the activated carbon (CCD). This method is suitable for fitting a quadratic surface and assists in the optimization of effective parameters with a limited number of measurements, as well as the analysis of parameter interactions. The CCD is made up of 2n factorial runs, 2(n) axial runs, and 6 middle runs, with the number of variables denoted by n. The carbons activated in this sample were made using a chemical activation process, with the variables impregnation ratio (\(x_1\)), activation temperature (\(x_2\)), and activation time (\(x_3\)). As seen in Table 1, Based on the literature and preliminary analyses, these three variables, as well as their respective ranges, were chosen. The impregnation ratio, activation temperature, and activation time have all been found to have a major impact on the properties of the activated carbons produced. A 2³ complete factorial central composite architecture, Each categorical variable had eight factorial points, six axial points, and six replicates at the centre points, requiring a total of twenty experiments, as determined from Eq (1).

\[
Y = 2^n + 2n + n_0 = 2^3 + 2 \times 3 + 6 = 20
\]  

(1)

N is the cumulative number of experiments, and n is the number of variables. The centre points were used to assess the experimental error and data reproducibility. The independent variables are coded in the (-1, 1) interval, with 1 and +1 representing the low and high values, respectively. The axial points are (±∞, 0, 0), (0,±∞, 0), and (0, 0, ±∞), where ±∞ is the axial point's distance from the middle and makes the design rotatable. The ±∞ number was set to 1.682. (rotatable). To limit the influence of unregulated stimuli, the experimental series was randomised. The activated carbon surface area (\(Y_1\)) and yield (\(Y_2\)) were the answers. Each response was used to construct an analytical model that used a second degree polynomial equation to compare the response to the activated carbon preparation variables, as seen in Eq (2).

\[
Y = b_0 + \sum_{i=1}^{n} b_i x_i + \sum_{i=1}^{n} b_{ij} x_i^2 + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} b_{ij} x_i x_j
\]  

(2)
Here Y is the expected answer, $b_i$ the linear coefficients, $b_{ij}$ the interaction coefficients, $b_0$ the constant coefficient, $b_{ii}$ the quadratic coefficients and $x_i$, $x_j$ are the activated carbon preparation variables’ coded values.

**Statistical research and model fitting**

To fit the equations developed and determine the statistical significance of the equations, the statistical software package Design Expert was used to conduct regression analysis on the experimental results. The statistical parameters were estimated using ANOVA.

**Characterization of activated carbon**

An automatic adsorption instrument was used to evaluate the Activated carbon N$_2$ isotherms of adsorption and desorption at liquid nitrogen temperatures (-195ºC). For 24 hours, the material was degassed at 85ºC in Zncl$_2$ before analysis. The surface area is calculated using BET equation (Gregg and Singh 1982). The nitrogen molecule's cross-sectional area is estimated to be 0.162 nm$^2$. By translating the quantity of N$_2$ gas adsorbed at a pressure of 0.9975 to equal liquid volume of the adsorbate (N$_2$), the overall pore volume was calculated (Sricharoensaikul et al., 2008).

**Yield of Nano porous carbon**

The yield of activated carbon has a huge impact on the cost of manufacturing. The carbon yield was determined using the equation below:

$$ Yield(\%) = \frac{W_{ac}}{W_r} \times 100 $$

(3)

Where $W_{ac}$ and $W_r$ are the final activated carbon's dry weight (g) and the precursor's dry weight (g), respectively.

**3.Results and Discussion**

**Equations for regression models.**

A CCD was used to establish relationships between the activated carbon preparation variables and response values such as surface area and yield. Table 2 shows

**Table 1 The composite design's independent variables and their coded levels.**

| Variables(factors)         | Code | Units | -α   | Low  | 0   | High | +α  |
|----------------------------|------|-------|------|------|-----|------|-----|
| Impregnation ratio         | x1   | %     | 2.31821 | 3    | 4   | 5    | 5.68179 |
| Activation temperature    | x2   | °C    | 931.821 | 1000 | 1100| 1200 | 1268.18 |
| Activation time            | x3   | min   | 9.54622 | 30   | 60  | 90   | 110.454 |
plan matrices, as well as all of the research's response values runs 16 to 20 is performed. The surface area of activated carbon were found to varying among 800.12 m$^2$/g to 1102.62 m$^2$/g. The carbon yield, on the other hand, was found to vary between 10.13% to 16.218%. The models were chosen centred on polynomials of highest order with major additional terms and models that were not aliased, according to the sequential model sum of squares. According to the software, a quadratic model was chosen for both surface area and yield.

A positive sign in front of the words indicates synergistic results, while antagonistic effects are shown by a negative sign. The correlation coefficient value was used to assess the consistency of the model produced had R values of 0.9916 m$^2$/g and 0.9375 m$^2$/g, respectively. The R values obtained were both moderately high, meaning that the experimental and expected values from the models were in strong agreement. Surface area had an R2 of 0.9833 m$^2$/g and yield had an R2 of 0.8790 m$^2$/g. This meant that the experimental factors were responsible for 98.3 percent and 91.8 percent of the overall difference in surface area and activated carbon yield, respectively. For surface area of 1.92215 m$^2$/g, the standard deviations were 38.28 and 1.92215 m$^2$/g, respectively yield. The model would do well if the R2 value is close to unity and the standard deviation is low, since it will estimate a response value that is similar to the actual value. In comparison to $Y_1$, this meant that the expected value for $Y_2$ could be more reliable and closer to the real value.

### Table 2 Preparation of post-consumed PET-based Nano porous carbon using an experimental architecture matrix

| Runs | X1 | X2 | X3 | Impregnation ratio | Activation temperature | Activation Time | Surface Area | Yield |
|------|----|----|----|-------------------|------------------------|-----------------|--------------|-------|
| 1    | -1 | -1 | -1 | 4                 | 1100                   | 60              | 1103         | 16.04 |
| 2    | +1 | -1 | -1 | 3                 | 1000                   | 30              | 722          | 21.41 |
| 3    | -1 | +1 | -1 | 4                 | 1100                   | 60              | 1095         | 16.57 |
| 4    | +1 | +1 | -1 | 5                 | 1000                   | 30              | 696          | 15.38 |
| 5    | -1 | -1 | +1 | 4                 | 1100                   | 110.454        | 644          | 5.36  |
| 6    | 1  | -1 | +1 | 5.68              | 1100                   | 60              | 778          | 11.82 |
| 7    | -1 | +1 | +1 | 3                 | 1200                   | 30              | 558          | 18.44 |
| 8    | +1 | +1 | +1 | 3                 | 1200                   | 90              | 613          | 15.16 |
| 9    | A  | 0  | 0  | 2.32              | 1100                   | 60              | 695          | 16.11 |
The importance of the fitting model, as well as the results of their parameters, is investigated using analysis of variance (ANOVA). The surface area and yield of AC were investigated using ANOVA with the reaction surface quadratic model in this analysis. A higher F-value means that the variance about the mean is adequate, and a p-value (Prob. > F) less than 0.05 indicates that the variable is important.

The model F-value of 65.54 and Prob. > F as 0.0001 showed that the model is important in presented the ANOVA for activated carbon surface area in Table 3. In this case, \( x_1, x_3, x_1^2 \) and \( x_2^2 \) were significant model terms, whereas \( x_2, x_1, x_2, x_2, x_1, x_3 \) and \( x_3^2 \) For the answers, they were all meaningless. As a consequence, Eq. (4) can be used to examine how impregnation ratio, activation temperature, and activation time affect the activated carbon surface area. The ANOVA results for AC yield are shown in Table 4.

**Table 3. Analysis of Variance (ANOVA) Surface quadratic model for the response surface area of Nano porous catalytic carbon**

| Source         | Sum of squares | df | Mean square | F-value | P-value |
|----------------|----------------|----|-------------|---------|---------|
| Model          | 8.642E+05      | 9  | 96023.17    | 65.54   | <0.0001 | significant |
| A- Impregnation| 108.04         | 1  | 108.04      | 0.0737  | 0.7915  |
| Ration (IR) % | 31663.34 | 1 | 31663.34 | 21.61 | 0.0009 |
|------------|----------|---|----------|-------|-------|
| B- Activation Temperature(ºC) | 0.1452 | 1 | 0.1452 | 0.0001 | 0.9923 |
| C- Activation Time (min) | 2664.50 | 1 | 2664.50 | 1.82 | 0.2072 |
| AB | 1512.50 | 1 | 1512.50 | 1.03 | 0.3336 |
| AC | 3872.00 | 1 | 3872.00 | 2.64 | 0.1351 |
| BC | 2.679E+05 | 1 | 2.679E+05 | 182.85 | <0.0001 |
| A | 3.294E+05 | 1 | 3.294E+05 | 224.85 | <0.0001 |
| B | 3.889E+05 | 1 | 3.889E+05 | 265.44 | <0.0001 |
| C | Residual | 14651.27 | 10 | 1465.13 |
| Lack of fit | 14277.77 | 5 | 2855.55 | 38.23 | 0.0005 significant |
| Pure error | 373.50 | 5 | 74.70 |
| Cor total | 8.789E+05 | 19 |

The model F-value of 8.08 and Prob. > F as 0.0015 implied that the model is significant. In this case \( x_1, x_2, x_1x_2 \) and \( x^2 \) were significant model terms, whereas \( x_3, x_2x_3, x_1x_3, x^2 \) and \( x^2 \) response. Figures 1 and 2 display the surface area and activated carbon yield expected values versus experimental values, respectively. Since the expected values obtained were very similar to the experimental values, The models developed were shown to be effective in capturing the relationship between the PET based activated carbon preparation variables and the responses.

Figure 1 Predicated Vs. Experimental Surface area of post-consumer based PET-Nano porous catalytic Carbon
Surface area of the activated carbon

Both the impregnation ratio ($x_1$) and the activation time ($x_2$) had major effects on the surface region, according to the ANOVA findings in Table 3, while the activation temperature ($x_3$) had the least effect. The quadratic effects of impregnation ratio ($x_1^2$) and activation temperature ($x_3^2$) are well-fitting, while the quadratic effects of activation time ($x_2^2$), as well as the association effects of $x_1x_2$, $x_2x_3$, $x_3x_1$ and $x_1x_3$.

Figure 2 Predicted Vs Experimental Yield of post-consumer PET-based Nano porous catalytic Carbon

Figure 3(a) shows the three-dimensional reaction surfaces with the cumulative effect of the two variables impregnation ratio and activation temperature on the surface area of the activated carbon at a constant activation time (60 min). Growing the impregnation ratio and activation temperature slightly raises the surface area at first. This resulted from the evolution of reactive compounds, which resulted in the formation of uniform micropores. Higher impregnation and activation temperatures, on the other hand, allow micropores to expand into meso and macropores, reducing surface area.

Table 4. ANOVA for the quadratic response surface model for yield of Nano porous carbon

| Source                | Sum of squares | df | Mean square | F-value | P-value |
|-----------------------|----------------|----|-------------|---------|---------|
| Model                 | 249.07         | 9  | 27.67       | 8.08    | 0.0015  | significant |
| A- Impregnation Ratio (IR) % | 83.43         | 1  | 83.43       | 24.34   | 0.0006  |
| B- Activation Temperature(ºC) | 29.83         | 1  | 29.83       | 8.70    | 0.0145  |
Other researchers found similar findings for activated carbon made from coconut shells (Prauchner and Reinoso, 2012). At a constant activation temperature (1100 oC), Figure 3(b) shows a three-dimensional reaction surface designed to illustrate the combined effect of two variables (impregnation ratio and activation time) on the surface field. At a constant impregnation ratio of 4%, Figure 3 shows the influence of (activation temperature and activation time) on the surface area (c). As can be observed in these two graphs, the surface region of activated carbon gradually reduces as the activation time increases.
Figure 3 Post-consumed PET-based Nano porous catalytic carbon surface area reaction surface plots in three dimensions (a) Impregnation ratio and activation temperature effects, with a 60-minute activation period. (b) Impregnation ratio and activation time effects, with activation temperature set to 1100°C. (c) Impregnation ratio = 4%, effect of activation time and activation temperature.

The formed pores expand or even collapse over time, resulting in a reduction in surface area. These findings were in line with those of Diao et al. (2002), who investigated grain sorghum-based activated carbon activated with phosphoric acid. The created pores expand or even collapse as the activation time increases, decreasing the surface area (Diao et al., 2002).

Yield of activated carbon

Table 4 shows the ANOVA for the reaction surface quadratic model for activated carbon yield. The most important influence on activated carbon yield was observed to be $x_2$, as shown by the maximum F-value of 32.3. Similarly, the $x_1$ and association effect ($x_1, x_2$), had a similar but less significant effect as $x_2$. With the exception of ($x_1, x_2$) activation time, quadratic effects of all sources, and interaction effects, all other factors were insignificant. Figure 4 depicts the 3D surfaces created to demonstrate the effects of AC preparation variables on carbon yield. (Y$_2$) Figure 4(a) shows the cumulative effect of impregnation ratio and activation temperature on yield. Figure 4(b) depicts the effect of the impregnation ratio and activation time combined on yield, while Figure 4(c) depicts the effect of activation temperature and time when combined on yield.

The carbon yield was observed to decrease as the activation temperature, activation time, and impregnation ratio were increased. While all three variables were at their lowest points within the range tested, the highest yield was achieved. The outcome in line with the findings of (Kartel et al. (2006), who discovered that activation temperature had a substantial influence on the yield of activated carbon, while activation time had no impact. If the temperature rises, more carbon is burned off and more volatile compounds are released, resulting in lower yields (Adinata et al., 2007).
yield was highly influenced by the chemical impregnation ratio, which increased the release of volatiles from the precursor and caused an increase in carbon burn-off by adding an additional activation agent (Qian et al., 2007).

**Optimization Process**

High commodity yields are desirable in the manufacture of industrial activated carbons. However, achieving a good surface area is also important. As a result, the carbon yield of the activated carbon produced should be high as well as a large surface area in order to be economically viable. However, since the factors’ interesting regions are distinct, optimising both of these responses under the same condition is challenging.

Figure 4 (a) Impregnation ratio and activation temperature effects, with a 60-minute activation period. (b) Impregnation ratio and activation time effects, with activation temperature set to 1100oC. (c) Impregnation ratio = 4%, effect of activation time and activation temperature.
When a crop's surface area increases, the yield declines, and vice versa. As a result, the role of desirability was used with design specialist tools to find a middle ground between these two answers. The most desirable laboratory conditions were chosen for verification. Table 5 shows the experimental conditions used to make the activated carbons, as well as the expected and experimental surface area and yield values. 4% impregnation ratio, 1100ºC activation temperature, 60 minute activation time, 16.218 percent yield, and 1102.62 m²/g surface area produced the best activated carbon. The experimental results were shown to be in close agreement with the simulation results, with only small variations between the anticipated and actual results.

Table 5. Model validation.

| No | Impregnation Ratio (IR) % | Activation Temperature(ºC) | Activation Time (min) |
|----|--------------------------|-----------------------------|-----------------------|
| 4  | 1100                     | 60                          |

Characterization of activated carbon that has been prepared under optimum conditions

The prepared activated carbon's adsorption-desorption isotherms for N2 gas at liquid N2 temperature. According to the IUPAC classification, it is category – I, and it comes from a micro porous surface. In the region of low relative pressure (P/P0 2), the volumes adsorbed increase dramatically. This indicates that the majority of nitrogen molecules are adsorbed in the micro porous system. The prepared activated carbon's apparent BET surface area, total pore density, and average pore diameter were found to be 537m²/g, 0.36 cm³/g, and 1.67 nm, respectively. According to the IUPAC classification, the PET-based activated carbon prepared was in the micro porous area with an average pore diameter of 1.67 nm.

Surface morphology

Carbons made of raw PET and carbons that have been chemically activated FESEM micrographs in optimal preparation conditions. On the surface of the precursor, it is found that there are no pores. At higher magnification, well-developed pores were observed on the surface after chemical activation under optimal preparation conditions (1100ºC activation temperature, 60 min activation period, 4 percent impregnation ratio). It demonstrates that the activation agent ZnCl2 was successful in forming well-developed pores on the precursor's surface.

Comparative studies

Table 6 shows a comparison of pore properties of the prepared activated carbon with those of previous research. As can be shown, the carbon obtained in this study has similar properties to other PET-based activated carbon. The pore properties of PET-based AC prepared by physical or hybrid (physical + chemical) activation are stronger. Chemical activation, on the other hand, has a number of advantages over physical and hybrid activation, including a reduced activation temperature (1100ºC).
a single activation step, and a reduced activation period. Compared to other chemical activation methods, ZnCl2 activation gave a remarkable amount of visible surface area and pore depth to the PET-based AC. The properties of PET-based AC prepared using different methods and activation agents are compared in Table 6. PET was a good choice for manufacturing AC because it is readily available and inexpensive in India, reducing the cost of production. These results highlighted the promise of such a mechanism in the future.

4. CONCLUSIONS

The results AC processing parameters, namely using a CCD, the effects of chemical impregnation ratio, activation temperature, and activation time on the surface area and yield of AC were systematically established. The optimum conditions for PET-based nanoporous catalytic carbon preparation were obtained by using an impregnation ratio 4%, activation temperature of 1100ºC, activation time of 60 min, with an Surface area of 1102.62 m²/g and Yield of 16.218% and the Correlation Coefficients R² for Surface Area is 0.9833 which is a high range and an Yield of 0.8790 These results were calculated to agree with the expected values in a satisfactory manner. On the surface of the activated carbon prepared under ideal conditions, well-developed pores were discovered. PET has shown to be a cost-effective precursor for the production of activated carbon.

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