**List of Supplementary Materials**

**Powder X-ray Diffraction Analysis**

Raw material (*Reptonia Buxifollia* seeds) and ACs prepared from raw material were investigated using XRD which is illustrated in Fig. 1. The figure indicates AC exhibit broad diffraction peaks at two theta position of 25o which, clues for presence of graphitic carbon. However, the absence of sharp diffraction peak at 2Ɵ of 25o reveals a predominantly amorphous structure, which is an advantageous property for well-defined porous materials.1

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Fig. 1.X-ray Diffraction of R.B seeds and ACs

**Fourier Transform Infrared (FTIR) Analysis**

The chemical composition of raw (*Reptonia Buxifolia* seeds) and ACs prepared from raw material were determined by Fourier Transform Infrared (FTIR) as shown in Fig. 2. The result of raw material shows a presence of the various functional groups which include hydroxyl groups, amines, various unsaturated hydrocarbons, aldehydes and carbonyl compounds. However, pyrolysis causes loss of some of these peaks in ACs. In raw sample the broad band was observed at 3285 cm-1. This band is matched to stretching vibration of hydroxyl group on the surface. The sharp band observed at 2919 cm-1 and 2850 cm-1 are due to the asymmetric and symmetric stretching of the methylene C-H bond respectively. However, these peaks disappeared in ACs, as ACs loss these functional groups in heat treatment. The band observed at 2162 cm-1(Fig. 3) corresponds to presence of silane(Si-H) groups. 2 The band due to silane was also retained in ACs. The band observed at 1235 cm-1 is matching to stretching vibration of C-O. The band found at 1627 cm-1 and 1032 cm-1 were due to the presence of phenol. In ACs new peaks at 1404 cm-1 is observed which might be due to the carbonate group develop in ACs.



Fig. 2.FTIR spectra of raw material and ACs

**Pseudo-1st Order Kinetic Equation**

A pseudo-1st-order kinetic model successfully explains the kinetics of many adsorption systems. The Lagergren equation is given as follows.3

(1)

Where, *Q*t is the amount of Pb+2 adsorbed (mg/g) at any time t, *Q*e is the amount of Pb+2 adsorbed (mg/g) at equilibrium, and *K1* is the rate constant.

The value of *K1*can be evaluated from the intercept and slope of the linear plot of *ln(Qe-Qt)* against time t as shown in Fig. 3. From the plot the value of correlation coefficient *R2* was found to be 0.687 and 0.824 for biomass and activated carbon, respectively. The value of *R2* obtained suggests that the adsorption of Pb+2 ions on biomass does not follow the pseudo-first-order kinetics.



Fig. 3 Pseudo-first-order kinetic plot for the biosorption of Pb+2 on R.B seeds and ACs

*Adsorption Models*

TABLE 1**.** Comparison of adsorption parameters calculated using Langmuir isotherm for adsorption of Pb(II) on adsorbents

|  |  |  |
| --- | --- | --- |
| **Constants** | **Adsorbents** | |
| **R.B seeds** | **AC** |
| *R2* | 0.99 | 0.998 |
| *KL*, dm3/mg | 0.01 | 0.10 |
| *RL* | 0.23 | 0.02 |
| *Qm*, mg/g | 259.97 | 525.78 |

TABLE 2**.** Comparison of adsorption parameters calculated using Freundlich isotherm for adsorption of Pb(II) on adsorbents

|  |  |  |
| --- | --- | --- |
| **Constants** | **Adsorbents** | |
| **R.B seeds** | **AC** |
| *R2* | 0.95 | 0.87 |
| *Kf,* mg/g | 3.11 | 148.70 |
| *1/N* | 0.69 | 0.22 |

**Thermodynamics of Pb+2 Adsorption**

Temperature greatly influence on the adsorption phenomena. In the current study, the temperature was varied in the range of 283 K to 343 K, as shown in Fig. 4. The results revealed that adsorption decreases as the temperature were increased. From these results, it is concluded that adsorption of Pb(II) on AC is physiosorption in nature. The negative value of enthalpy change (Table 3) suggests that Pb(II) adsorption, on AC is an exothermic process. The adsorption decreased with an increase in temperature. The spontaneity of the Pb(II) adsorption on the R.B seeds and AC were estimated by varying thermodynamic parameters, such as, free energy (ΔG0) and K0 by the following equation.4, 5

 (2)

Where *Ko* is the equilibrium constant and determined as:

 (3)

Where, *Cs*represents Pb(II) amount adsorbed per mass of adsorbent (mol/g) and *Ce*shows the Pb(II) concentration in solution at equilibrium (mol/ml), *As* is the activity of adsorbed Pb(II), *Ae* is the activity of the Pb(II) in solution at equilibrium, *Vs* is the activity coefficient of the adsorbed Pb(II) and *Ve* is the activity coefficient of the Pb(II) in solution. The *Ko* values were used to determine *ΔG0, ΔH0* and *ΔS0*.

The average standard enthalpy change (*ΔHo*) of the system was calculated by using Van’t Hoff equation:  (4)

Where, *T2*represent the final temperature and *T1*represent initial temperature. The standard entropy change (*ΔS0*) can be obtained by the equation:

  (5)

The thermodynamic parameters of R.B seeds and AC are listed below in Table 3 and Table 4, respectively. A negative standard free energy change shows that the adsorption reaction is a spontaneous and reversible process. Greater negative value of Gibbs free energy for AC further support the higher adsorption of Pb(II) on AC. The value of Gibbs free energy, for AC, prepared from R.B seeds give similar results revealed in the adsorption of Pb(II) on *Mucor rouxii* biomass.6 While, the adsorption of Pb(II) on raw R.B seeds is matching with HNO3-modified *P. Americana* bioadsorbent.7



Fig. 9.Effect of temperature of Pb(II)biosorption on R.B seeds and AC

TABLE 3**.** Thermodynamic parameters values for Pb(II) adsorption on raw R.B seeds

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Thermodynamic constants** | **Temperature, *K*** | | | | | | |
| **283** | **293** | **303** | **313** | **323** | **333** | **343** |
| *Ko,* mL /g | 1118.12 | 713.59 | 295.93 | 245.60 | 176.77 | 149.01 | 51.51 |
| *ΔGo*, ,kcalth / mol | -3.95 | -3.83 | -3.43 | -3.42 | -3.32 | -3.31 | -2.69 |
| *ΔHo,* kcalth /mol | -8.87 | -8.87 | -8.87 | -8.87 | -8.87 | -8.87 | -8.87 |
| *ΔSo,* kcalth / mol deg | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 | -0.02 |

TABLE 4**.** Various thermodynamic parameters values for Pb(II) adsorption on AC

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Thermodynamics constants** | **Temperature, *K*** | | | | | | | | | | | |
| **283** | **293** | **303** | | **313** | | **323** | | **333** | | **343** | |
| *Ko,* mL /g | 1459.2 | 1091.34 | 1061.72 | 955.69 | | 902.60 | | 769.29 | | 600.35 | |
| *ΔGo,* kcalth / mol | -4.097 | -4.07 | -4.195 | -4.27 | | -4.37 | | -4.397 | | -4.36 | |
| *ΔHo,* kcalth / mol | -2.42 | -2.42 | -2.42 | -2.42 | | -2.42 | | -2.42 | | -2.42 | |
| *ΔSo,*kcalth /mol deg | 0.006 | 0.006 | 0.006 | 0.006 | | 0.006 | | 0.006 | | 0.006 | |

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