



Removal of trace organics by activated charcoal

Faisal Ansari and Z.I. Bhatti, Pakistan

TRACE ORGANIC COMPOUNDS, like phenolic compounds, are frequently found in surface and waste waters. These compounds are also reported to be creating odour and colour problems in drinking waters. Different types of organic compounds potentially hazardous to human health are also present in water supplies. Effluents from conventional biological treatment processes usually contain a moderate quantity of soluble organic material. These organics are mainly synthetic organic compounds and they contaminate the receiving water bodies causing public health concern. Thus there seems to exist a need to remove trace organics in drinking and waste waters.

Activated carbon adsorption (ACA) is one of the well established methods for the removal of trace organic compounds. This method is widely used due to its simplicity, effectiveness, low space requirement and nuisance free operation. Activated carbon (AC) can be produced from a variety of materials such as wood, coal, peat, lignin, coconut shells, etc. Although the raw material is cheap, its activation at elevated temperatures makes it costly and skillful.

The application of ACA in Pakistan, apart from other reasons, has gained little appreciation due to high cost. If the cost of activation and regeneration can be brought down, the application of ACA can be widened. This study is an endeavour towards assessing the possibilities of application of low-cost activated coal (charcoal) for trace

organics removal in Pakistan. This study is divided into two parts. Part one encompasses the application of activated charcoal to trace organics removal whereas part two includes the evaluation of potential of low-cost activation mechanism. This paper presents the results of part one study.

Materials and methods

Charcoal, which is a cheap and abundant coal in Pakistan, was used as the test adsorbent. The charcoal was broken down with a hammer into small pieces which were then passed through series of sieves to obtain four representative sizes of 4.75-3.35, 3.35-2, 2-1, and <1mm. The sieved charcoal sizes were heated in a muffle furnace for activation at various temperatures. Dehydration and carbonization of the charcoal was not done. Para-Nitrophenol was used as the test pollutant. Concentration of Para-Nitrophenol was determined on a Spectronic Genesys 5 model spectrophotometer at 400 nm wavelength. Batch and continuous tests were carried out in beakers and burettes to investigate the optimum temperature for activation, optimum time for activation, optimum removal concentration and adsorption efficiency. For temperature optimization, 50 mL of 10 ppm Para-Nitrophenol was added in beakers containing 0.5g of each charcoal size and then activated for 10 min in a temperature range of 100-1100°C. A contact time of 6 hr, 5hr, 2hr and 10 min was provided to charcoal size of

Figure 1. Effect of activation temperature on the removal efficiency of para-nitrophenol

Figure 2. Effect of activation time on the removal efficiency of para-nitrophenol

4.75 – 3.75mm, 3.35 – 2mm, 2 – 1mm, and < 1mm, respectively. After finding the optimum temperature, each size was then activated at its optimum temperature for 5–100 min to investigate the optimum activation time for each size. After establishing these conditions, Para-Nitrophenol from 5–100 ppm concentration was tested with activated charcoal to investigate the Para-Nitrophenol removal efficiency.

Results and discussion

The effect of activation temperature on the removal of Para- Nitrophenol is shown in Figure 1. It indicates that optimum activation temperature for 4.75–3.35mm, 3.35–2mm, 2–1mm, and <1mm charcoal size is about 1000°C, 1000°C, 900°C and 800°C, respectively.

Figure 2 demonstrates the effect of activation time on the removal efficiency of Para-Nitrophenol. The optimum activation time for 4.75–3.35mm, 3.35–2mm, 2–1mm, and <1mm charcoal size was found to be 10 min, 60 min, 30 min and 30 min, respectively. 60 min activation time for 3.35–2mm size charcoal seems to be unrealistic and the exact reason is not understood. One possible reason may be some analytical error or error in the preparation of charcoal for this size.

The results of adsorption of Para-Nitrophenol at various concentrations from 5–100 ppm are illustrated in Fig.3 a – d for the four charcoal sizes. The results demonstrated

that Para-Nitrophenol concentration in the range of 5–100 ppm did not have a significant effect on adsorption efficiency for all charcoal sizes and adsorption efficiency for all charcoal sizes and that the average variation in this range was around 10 per cent. This suggests that the test charcoal can be effectively used for Para-Nitrophenol removal in the concentration range of 5-100 ppm. However, the contact time for achieving optimum adsorption was less in smaller size charcoal than in the bigger sizes as can be seen from Fig. 3 a-d. Therefore, for obtaining shorter hydraulic retention times, use of small sized charcoal is advantageous.

Adsorption isotherm was also drawn for the test charcoal as shown in Fig. 4. The 'n' and 'k' values were found out to be 2.50 and 0.077, respectively.

Conclusion

The experimental results of this study indicate that the locally activated charcoal can be effectively used in a single or series reactors for the removal of trace organics but a cost optimization study must be made to find a low-cost activation technique to make its application attractive.

FAISAL ANSARI, Graduate Student, IESE, NUST, Pakistan.
Z.I. BHATTI, Assistant Professor, IESE, NUST, Pakistan.

Figure 3. (a-d) Effect of concentration of para-nitrophenol on the removal efficiency (a) 4.75-3.35mm (b) 3.35-2mm (c) 2-1mm and (d) <1mm

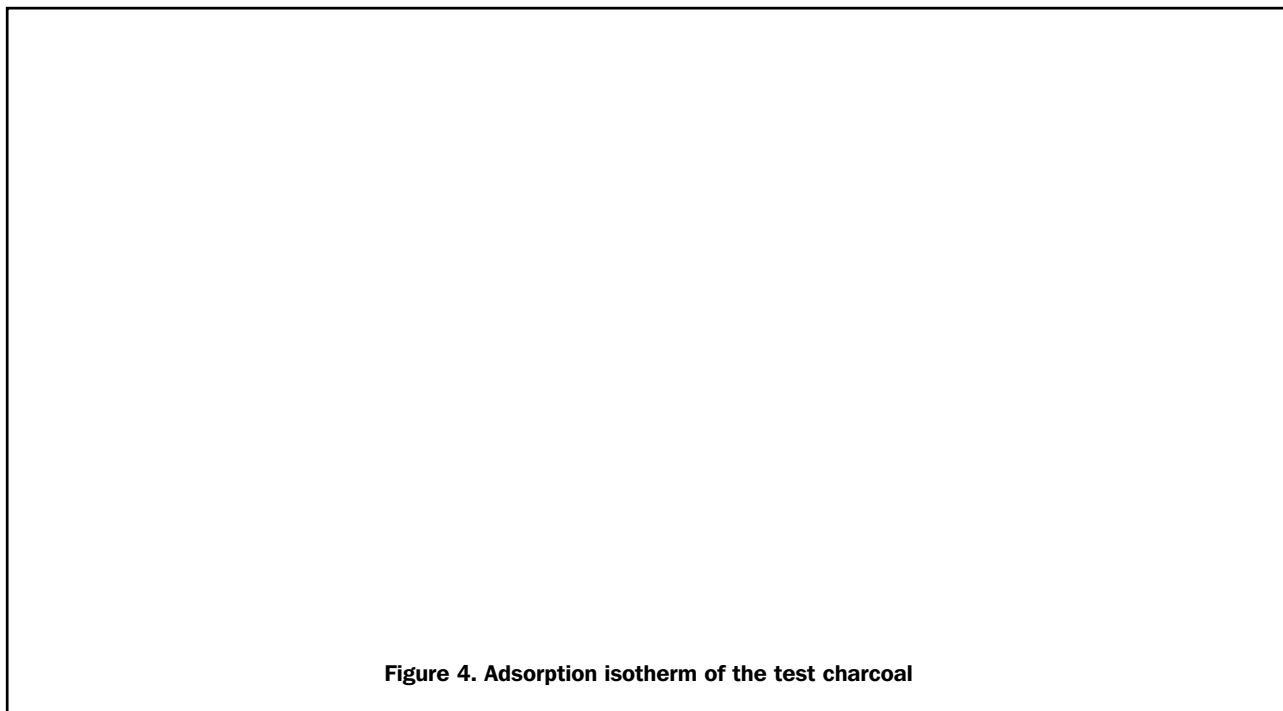


Figure 4. Adsorption isotherm of the test charcoal