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ADSORPTION OF PHENOL BY OIL SHALE AND FCC SPENT CATALYST: KINETIC, EQUILIBRIUM AND THERMODYNAMIC STUDIES

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Oil shale and petroleum industries are well-known to produce a large amount o esidues. The Brazilian oil shale industry can generate up to 7,000 ton per day o y-products, such as pyrolyzed oil shale and oil shale fines, which are turned bac o the mine with no utilization. The world production of spent fluid catalyti racking (FCC) is around 400,000 ton per year. Most of them are usually solidifie nd deposit in landfills [1].

Hence, the present work was aimed at study the adsorption of phenol by oil shal and spent FCC catalyst residues. The oil shale samples used in this study wer obtained from PETROBRAS units: (FOS) Oil Shale Fines; (POS) Pyrolyzed O Shale; (TOS) pyrolyzed Oil Shale with Tire dosage (about 5%); spent FCC (CAT All samples were dried for 24 hours without any activation. The adsorptio experiments were carried out as a function of different initial phenol concentratior and under the room temperature (≅25 °C), 20 °C and 60 °C. The kinetic study wa conducted using a jar test apparatus at room temperature of 15 min to 24 hr base on the equilibrium time previously obtained. The Freundlich and Langmuir mode were adjusted to equilibrium data through non-linear regression using trust-regic and robust bisquare algorithms. The description of the adsorption process wa given by a Homogeneous Surface Diffusion Model (HSDM). The original HSDM was developed for the granular active carbon adsorption proce simulation. Later it was adapted to use with powdered activated carbon [2,3]. Tl HSDM estimated the Diffusion coefficient (Ds) according to the analytical soluti proposed by Crank [4] and Skelland [5] and using the numerical optimizati technique [6].

In general, the equilibrium data fitted well to both Freundlich and Langmu adsorption models. The thermodynamic results indicated that the increase of t temperature did not favored the adsorption process to FOS (q_m = 1.30 to 0.91 mg $^{-1}$) and favored to POS (q_m = 2.60 to 3.37 mg.g^{-1}), TOS (q_m = 1.28 to 3.44 mg.g and CAT (q_m = 0.78 to 1.41 mg.g^{-1}), which were confirmed by the Gibbs energ The positives values of enthalpies to POS, TOS and CAT were obtained whi indicated the endothermic nature of the adsorption process. The enthalpy value w more significant in TOS (142.32 kJ.mol^{-1}) and CAT (84.07 kJ.mol^{-1}). Neverthele FOS presented a negative value of enthalpy (-43.91 kJ.mol^{-1}). This confirmed t

...hermic nature of the adsorption process ($\Delta H < 0$). A positive value for ΔS ...cal of endothermic processes [7]. In this study, ΔS assumed positive values for POS, TOS and CAT were related to an increase in the degree of freedom of the ...rbed species [8]. A positive value of ΔS suggested increased randomness at the ...l/solution interface with more efective action among adsorbate and adsorbent ...s, a positive ΔS denoted an increase to access a functional groups on the ...rbent surface active sites. The diffusion coefficient (*Ds*) confirmed ...factorily the experimental data. FOS sample presented higher value than other ...rbents from oil shale residues (FOS = 9.9E-8 cm^2.min^{-1}) and CAT showed ...)0E-8 cm^2.min^{-1}.

...he presented study showed that the oils shale and spent catalyst FCC have ...ively good removal of phenol from aqueous solution and may be used for ...ronmental purposes.

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