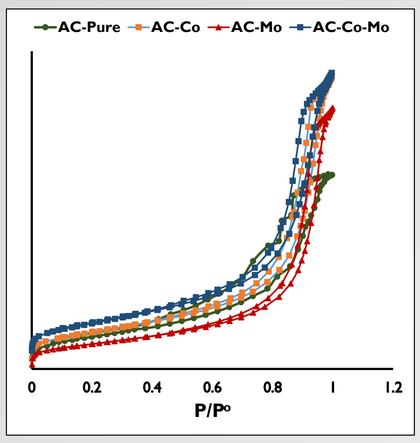
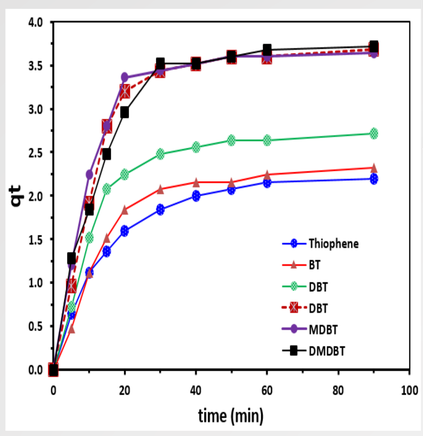
Synthesis of AC/CoMo Composite and its Adsorptive Desulfurization Efficiency in Some Sulfur Containing Compounds

Abdulkadir Tanimu
Department of Chemistry, King Fahd University of Petroleum and Minerals

Abstract

The role of cobolt and molybdenum nanoparticles loaded on activated carbon (AC) on the adsorptive desulfurization ability of some sulfur containing compounds was investigated at room temperature. The AC was first synthesized and activated, followed by incorporation of the cobolt (Co), molybdenum (Mo) and both Co and Mo nanoparticles. The adsorption activity parameters of the developed composites were determined using surface characterization and N_2 physisorption techniques. AC/MoCo composite showed the best adsorption properties than pure AC and the other composites.

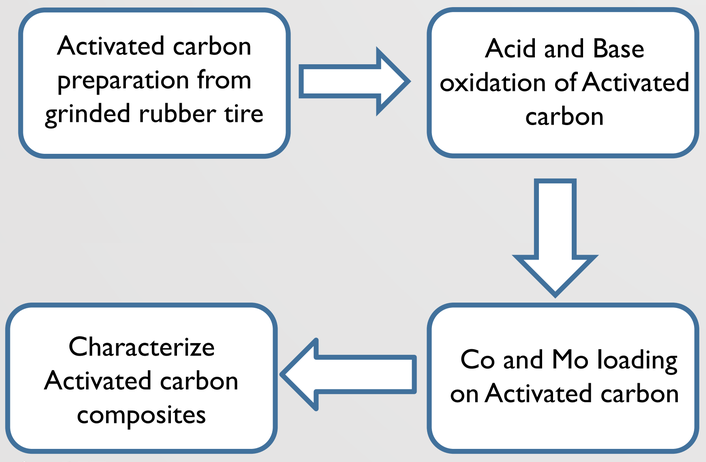




Introduction

The most important source of energy up to date still remain the fossil fuel[1, 2]. Indeed, crude fossil fuel is refined to light oil such as gasoline and to heavy oil such as jet fuel[3-5]. The majority of refined oil is used in combustion engines for vehicles' transportation[6], hence the need to ensure that smoke coming from exhaust engine is less detrimental to environmental safety by supplying clean fuel to the engine. In order to achieve this clean fuel level, the fuel must be of very low sulfur content since high concentration of sulfur would generate sulfur oxides during combustion which are poisonous to engines and environment. These are the reasons why European Union and United States of America recent regulations for the maximum allowed sulfur in fuel were 15 ppmw and 10 ppmw respectively.

Methods and Materials



- BET
- TGA-DSC
- SEM
- FTIR

Performance test was done in a batch mode adsorption experiment where various amounts, in the range between 0.01 to 0.5 g of adsorbents were introduced into 20 ml of the model fuel solution prepared by dissolving T, BT, DBT, MBT, MDBT and DMDBT, in the initial concentrations of 50 ppm each, in 17:3 hexane:toluene solvent. The analyte adsorption (q_e, mg/g) at equilibrium was calculated using the below equation:

$$q_e = (C_0 - C_e)\frac{V}{W}$$

Results and Discussion

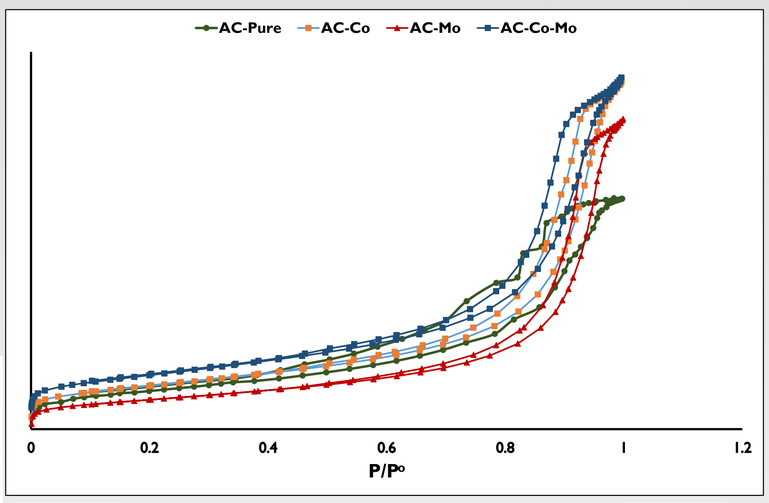


Figure 1. N_2 Adsorption-Desorption isotherm.

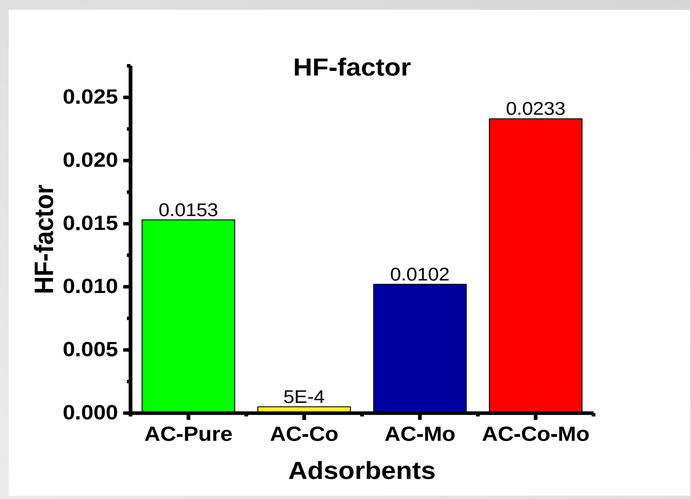


Figure 2. HF-factor obtained from textural parameters of adsorbents

Table 1. Textural properties of the adsorbent materials

Adsorbent	S_{BET}[a]	S_{Meso}[b]	S_{Micro}[c]	V_{micro}[d]	V_{total}[d]	PS[e]
AC-Pure	118	105	13	0.005	0.29	9.28
AC-Mo	89	86	3	0.0002	0.39	13.36
AC-Co	128	116	13	0.005	0.44	11.46
AC-Co-Mo	157	131	26	0.012	0.43	10.13

[a] m^2/g.
[b] m^2/g, t-plot external.
[c] m^2/g, t-plot micropore.
[d] cm^3/g, t-plot.
[e] nm, average BJH adsorption.

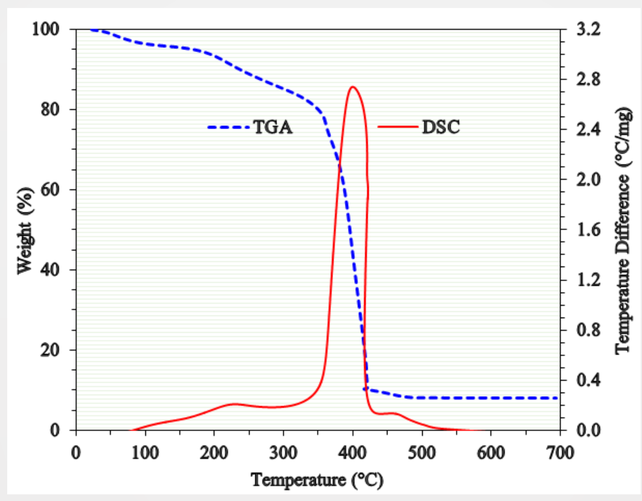


Figure 3. TGA – DSC simultaneous thermal analysis of AC-Co-Mo sample at a heating rate of 10 °C/min. .

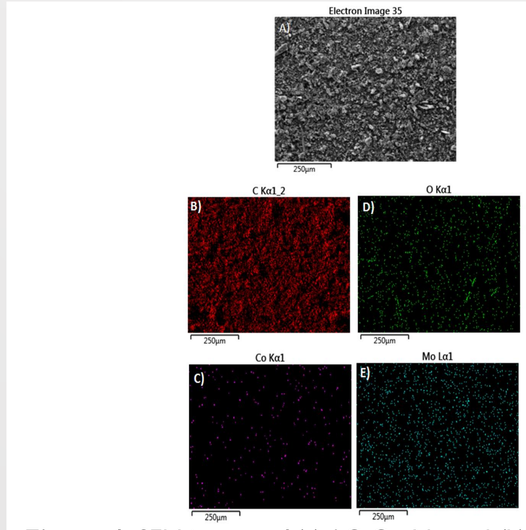


Figure 4. SEM images of (a) AC-Co-Mo and (b) mapping of the elemental analysis before adsorption

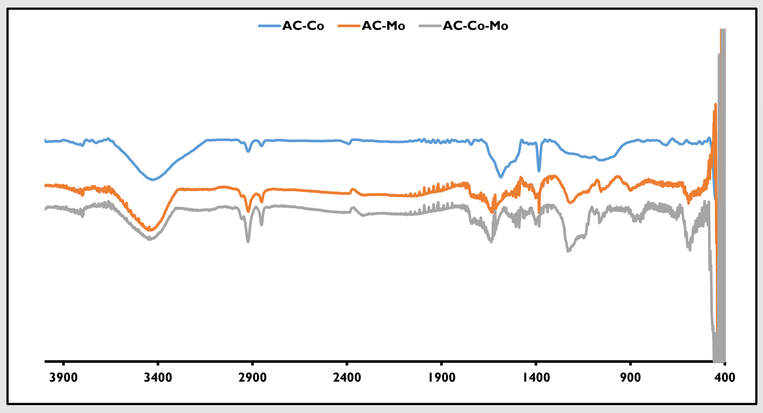


Figure 5. FTIR analysis of AC-Co-Mo, AC-Co and AC-Mo

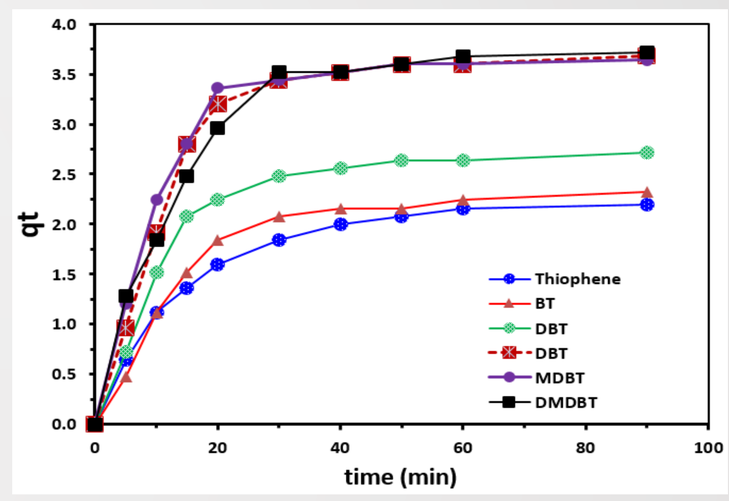


Figure 6. Effect of contact time at different initial concentrations

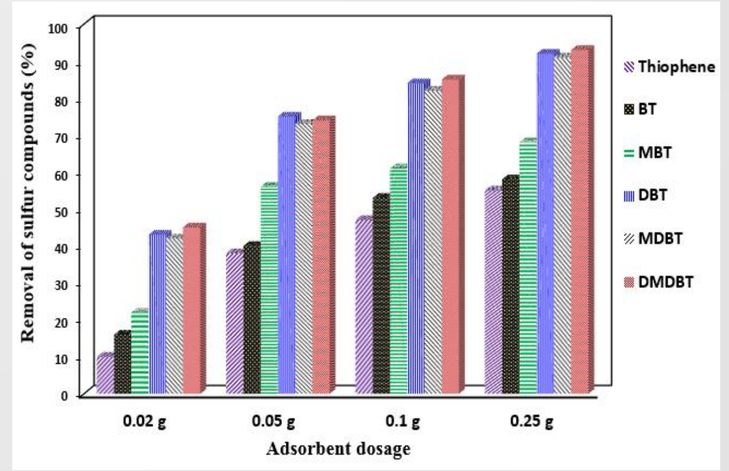


Figure 7. Effect of adsorbent dosage

Conclusions

Activated carbon was synthesized from rubber tires and oxidized via acid-base treatment. The AC when incorporated with Co and Mo to form a composite showed improvement in the adsorptive desulfurization of some sulfur containing compounds, better than the pure AC or AC/Mo and AC/Co composites.

Contact

< Abdulkadir Tanimu >
<KFUPM>
Email: g201303070@kfupm.edu.sa
Website:
Phone:

References

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