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Morphological based Mechanism for Adsorption of Hg from Natural Gas using Solid Supported Ionic Liquids

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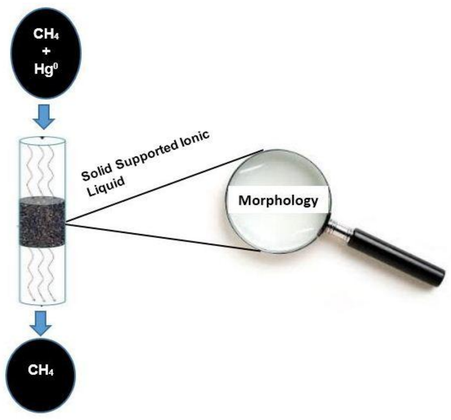
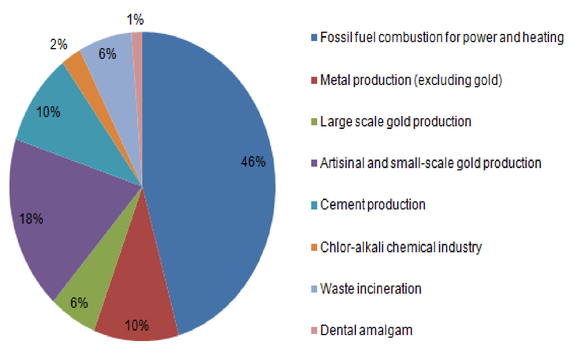
Abstract

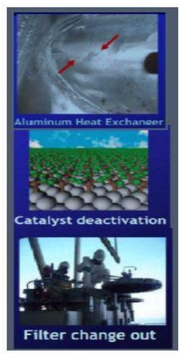


Introduction

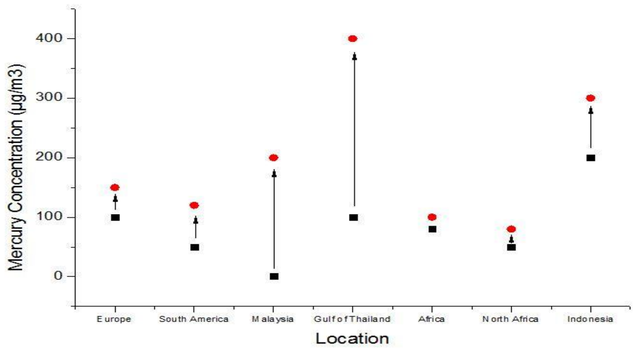
- Fossil Fuels are one of the main anthropogenic source of mercury (Hg) emission
- Hg in natural gas presents predominantly as elemental mercury (Hg^0)
- Hg in gas plant affects downstream processes and deposits in equipment that poses a health and safety risk for workers involved in maintenance or inspection activities
- To protect the equipment and environment, Hg needs to be removed efficiently.
- Carbon Supported Ionic Liquids have better ability to remove Hg from gas stream than other technologies i-e sulfur or halide impregnated carbon etc.



Anthropogenic mercury sources

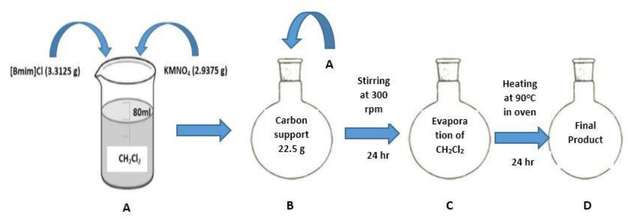


Threating effect of Hg in Oil and Gas Industry



Mercury concentration in gas for different regions

Methodology



Synthesis of Carbon Supported Ionic Liquid

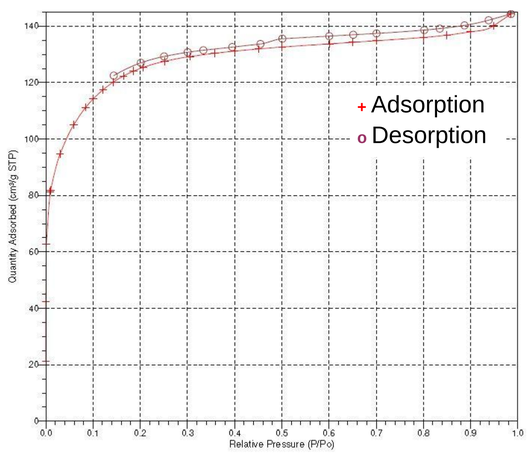
Adsorption Experimental Set up

- Surface area, pore size and pore volume of fresh activated carbon and coated (ionic liquid + KMnO4) were evaluated.
- Morphology of adsorbent was studied.
- EDX elemental analysis and mapping were performed for spent adsorbent.

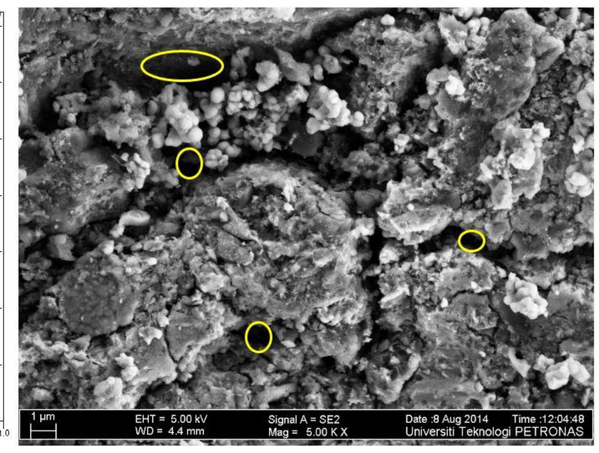
Results

BET surface area, micropore area, volume and pore size

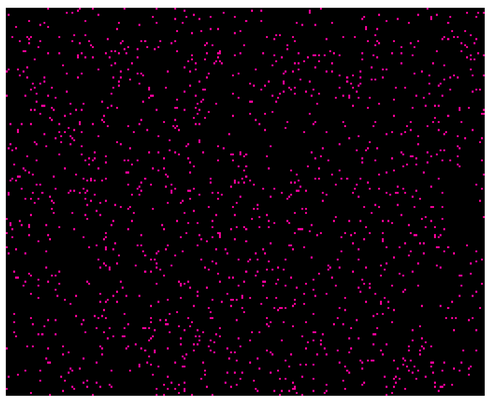
Adsorbent	BET surface area (m^2/g)	t-Plot Micro pore Area (m^2/g)	t-Plot micro pore volume (cm^3/g)	Pore Size (nm) (average pore diameter)
Fresh Carbon	640.93	549.25	0.22	7.25
[Bmim]Cl + KMnO4 coated Carbon	448.85	226.93	0.10	6.37



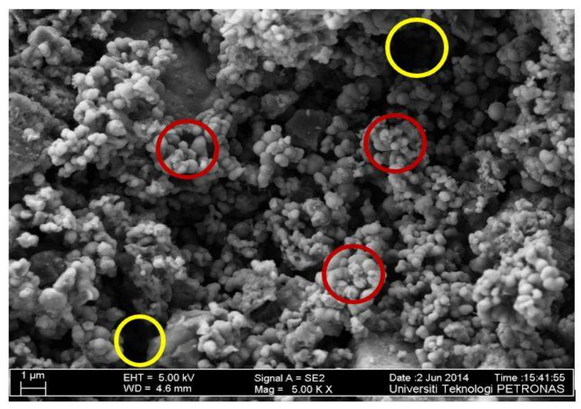
BET isotherm for [Bmim]Cl + KMnO4 coated carbon



Surface morphology of fresh [Bmim]Cl + KMnO4 coated carbon at 5000X



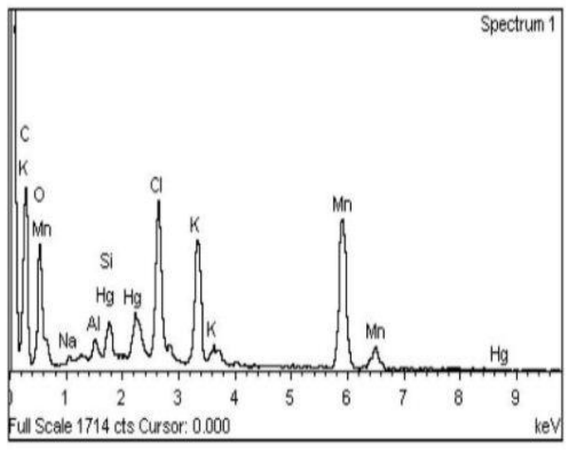
EDX mapping spent adsorbent ([Bmim]Cl + KMnO4 coated carbon)



Surface morphology of spent adsorbent ([Bmim]Cl + KMnO4 coated carbon) at 5000X

Elemental analysis of spent adsorbent ([Bmim]Cl + KMNO4 coated carbon)

Element	Weight %
C	32.32
O	26.64
Na	0.50
Al	0.72
Si	1.17
Cl	7.49
K	6.61
Mn	19.83
Hg	4.71



EDX spectra of spent adsorbent ([Bmim]Cl + KMnO4 coated carbon)

Conclusion

- It was found that the surface area and pore size of adsorbent were reduced due to micropore blockage by the immobilization of ionic liquid.
- The carbon coated with [Bmim]Cl & KMnO4 showed promising ability to capture Hg from gas stream. The capacity of Hg removal was found 6.8 mg/g of adsorbent in 72 hours (gas flow rate and Hg^0 vapor concentration were 60ml/min and 15ppm).
- In the case of spent adsorbent, change in surface morphology was noticed due to the formation of Hg complex ($HgCl_2$)with [Bmim]Cl.
- EDX elemental analysis and mapping confirmed the presence of Hg on the surface of adsorbent which may be due to chemisorption between Hg and [Bmim]Cl.

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