Hydrogen Sulfide and Ammonia Removal from Biogas using Water Hyacinth-derived Activated Carbon

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Introduction

Despite the increased utilization of biogas both in industries and domestics there are some impurities associated with biogas which are harmful and toxic. Hydrogen sulfide (H_2S) is one of these toxic components which on low level exposure causes eye and respiratory system irritation. It also causes loss of consciousness and death when the exposure reaches 750-1000 ppm (Milby and Baselt. 1999). Its acidity nature leads to acidic rains when present in the atmosphere and corrosion of metallic materials and concrete metallic materials (MA, Cheng et al. 2000). On the other hand, ammonia (NH_3) when released to the atmosphere interferes with cloud formation and distribution as well as the increase of albedo by formation of NO_2, a greenhouse gas (Kirkby, Curtius et al. 2011). Additionally, ammonia leads to emission of NOx from turbine engines. Removing these components using water hyacinth –derived activated carbon has multiple advantage as it reduces detrimental effect in aquatic life.

Aims and Solutions

- Preparation of activated carbon from water hyacinth (WHAC)
- Adsorption of H_2S and NH_3 using WHAC from biogas

Significance of the Study

- Provision of clean biogas for industrial and domestic use
- Minimizing the effects caused by H_2S and NH_3
- Provision of alternative way of solving water hyacinth effects to aquatic nature

Methodology

1. Collection, drying and grinding of the water hyacinth from Lake Victoria
2. Carbonization at 450, 550, and 650°C to get water hyacinth porous carbon (WHC)
3. Activation with KOH at 700°C in 1:0.25, 1:0.5, and 1:1 WHC:KOH for increasing porosity to get water hyacinth activated carbon (WHAC)
4. Adsorption of H_2S and $NH_3$from biogas using the WHAC at Banana Investment Ltd

Results

i. Characterization

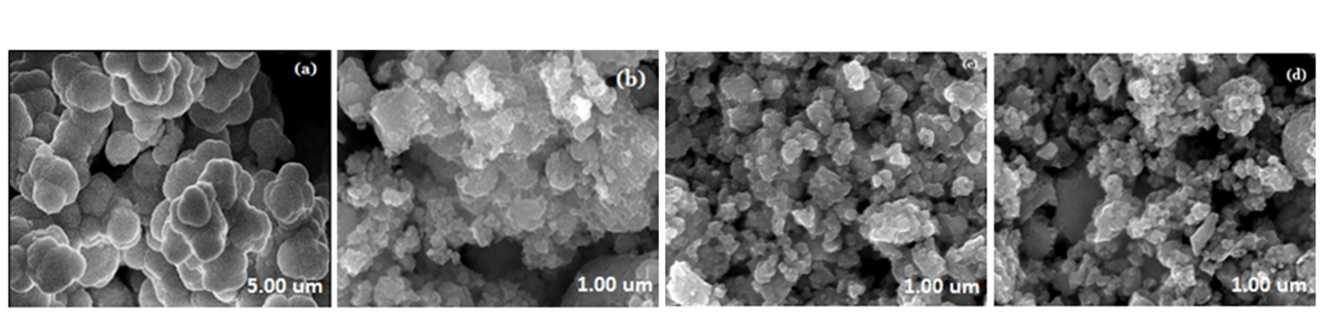

Figure 1: SEM images of 650˚C activated carbon where (a) is WHC, (b) is 1:0.25 WHAC, (c) is 1:0.5 WHAC, and (d) is1:1 WHAC

The surface morphology of WHC shows smooth surfaces with nearly spheric al shape. The activation process of WHC at 650˚C with ratios 1:0.25, 1:0.5, a nd 1:1 deforms the smooth surfaces and decrease of the particle size which are good for adsorption.

ii. Adsorption

- WHC carbonized at 650°C (WHC-650) had a H_2S adsorption of 5 1% followed by WHC-550 30% and WHC-450 22%. That of NH_3 was 72, 50, and 42% respectively. The activated samples followe d the same trend.
- WHAC had best performance on adsorption of both H_2S and NH_3 compared to WHC. The performance increased with the increase of activation ratio. The adsorption capacity of H_2S by WHAC-650-1, WHAC-650-0.5, WHAC-650-0.25 and WHC-650 were 32, 26, 2 3, and 8g/100g respectively at their breakthrough time.
- NH3 adsorption by WHAC-650-1, WHAC-650-0.5, WHAC-650-0.2 5 removed 100% of NH_3 in 2 h.
- The adsorption of the two gases also increased with the decrease of gas flow rate and increase of adsorbent mass

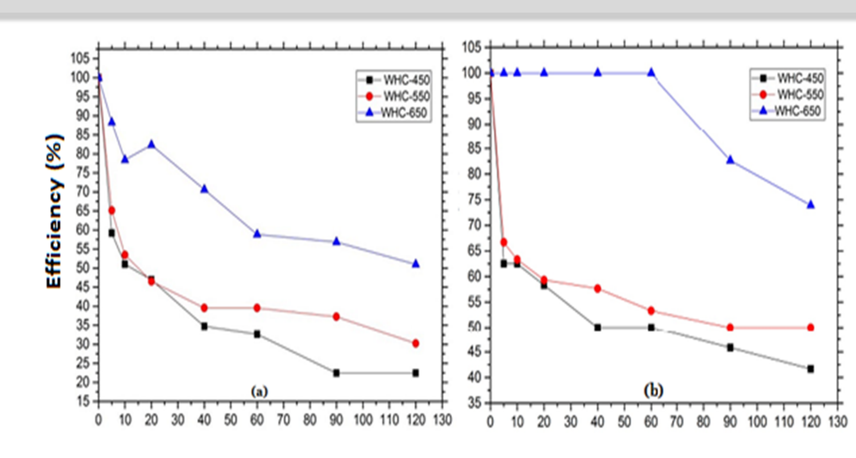

Figure2: Effect of carbonization temperature on (a) H_2S adsorption (b) NH_3 adsorption

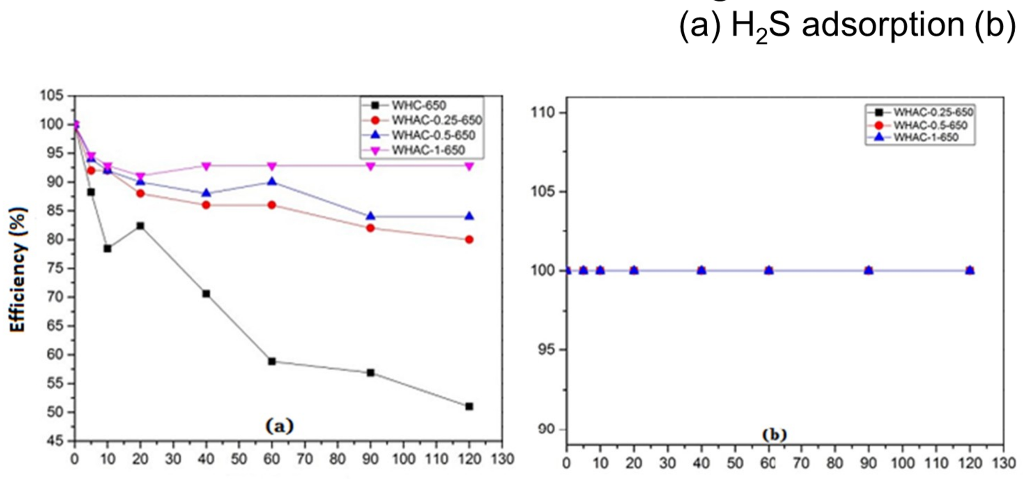

Figure3: Effect of impregnating ratio WHC:KOH (a) H_2S adsorption (b) NH_3 adsorption

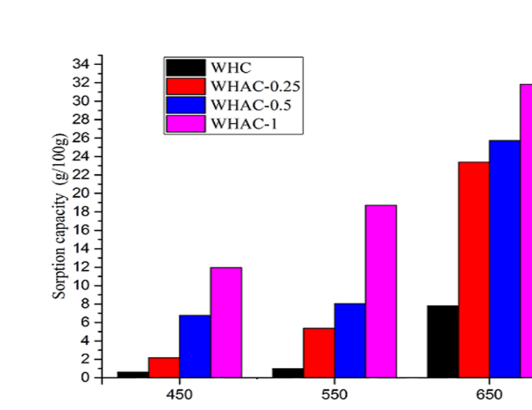

Figure 4: Sulfur sorption capacity of activated carbon

Conclusion

- The synthesized WHAC has high efficiency of removing H_2S and NH_3 from biogas through adsorption.
- The use of water hyacinth for AC production adds to the ways of minimizing problems posed by these plants in aquatic environments.

References

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