Air Purifiers & Carbon-Based Foam

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A poster by Kyle Ainsley. A special thank you to both Northumbria University and nustem, as well as Dominika Zabiegaj for taking the time to discuss this topic with me.

Introduction:

- There is a large concern over greenhouse gas emissions.
- The largest human contribution is carbon dioxide (CO_2). [1]
- Methods of CO_2 absorption are being developed to improve air quality.
- These methods not only need to be easily accessible, but also sustainable.

Air Quality:

- Poor air quality can have significant implications for a persons health and wellbeing.
- Every year in the UK, approximately 36,000 people die from lung cancer, but 1 in 6 of these people are non-smokers. [2]
- A possible cause of this, is poor air quality.

- Poor air quality can range from lots of greenhouse gases to having microparticles in the air which can irritate the lungs.
- These microparticles can also worsen existing heart and lung diseases.
  - By entering the blood stream, the particles can travel around the body
- A major cause of the poor air quality is emissions, both commercial and industrial.

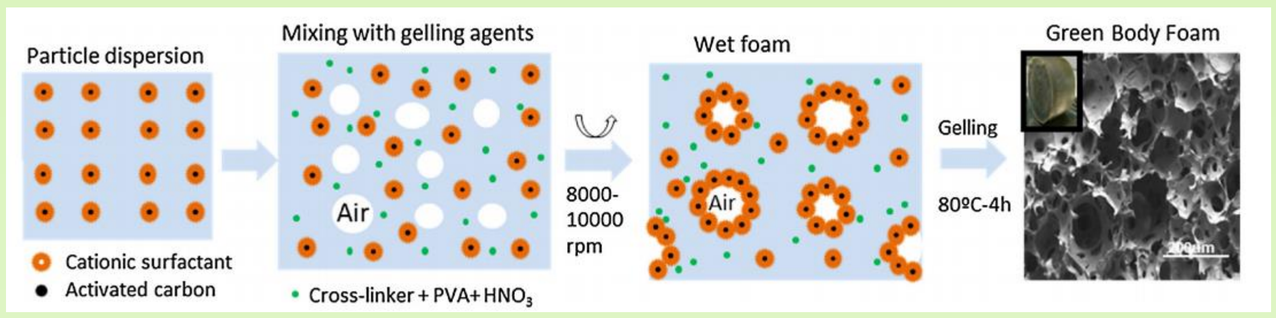

Fig 2. Representation of the green foam synthesis procedure. [1]

Production of carbon based foams:

- Activated carbon can be produced from many different carbonaceous materials.
- One method is to heat the substance in the presence of CO_2, an inert gas or steam to 500-1000°C.
- An alternative method is to first add a chemical before heating to a similar temperature. [5]
- Once the activated carbon is produced, it can be mixed with gelling agents to produce wet foam, before undergoing gelling to produce a green body foam.

Results from experiments:

- The experiments carried out by (D. Zabiegaj, 2018), show that the carbon monoliths had excellent gravimetric CO_2 adsorption.
- Additionally, they were shown to have good performance in selective CO_2 capture when in simulated post-combustion gas streams.

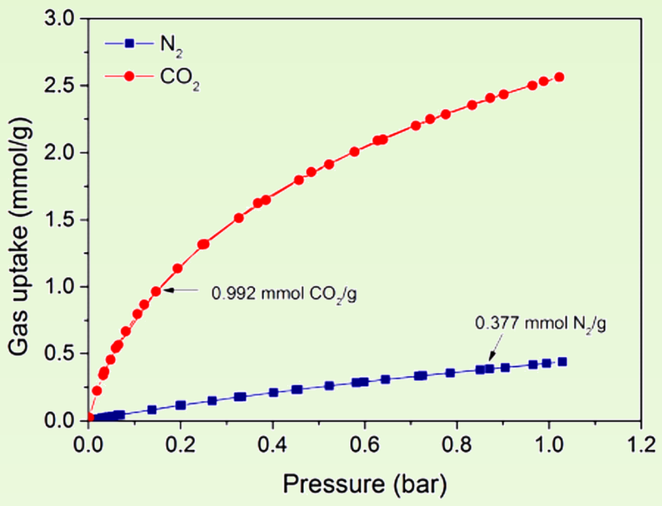

Fig 4. Equilibrium adsorption isotherms of CO_2 and N_2. [1]

Current air purifiers:

- There are many types of air purifiers currently being used: [3]
- Filters, clean the air by removing particles that cannot pass through a small gap.
- Ionising purifiers, ionise particles so that they are attracted to metal plates inside the device.
- Ozone generators, alter O_2 molecules into O_3 molecules. This method of air purification has not yet been proven to be successful.
- UV light, is able to kill micro-organisms and these are often featured within a device.
- Adsorbents, are used to trap substance on the surface of another substance, thus removing it from the air.

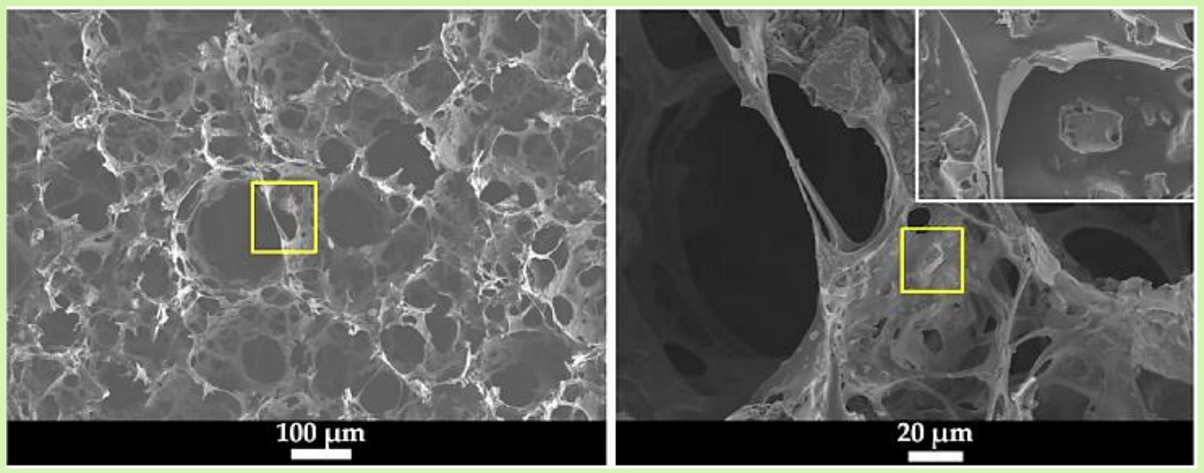

Fig 1. Image produced by SEM showing the embedded activated carbon particles within the foam.[1]

Carbon Based Foams:

- A carbon based foam is one that features both macroscopic and microscopic pores.
- These pores allow the carbon monolith to be used within air purifiers, as they can adsorb gas molecules and microparticles from the air.
- The high pore density of these foams allow for lots of particles to be captured on the surface of these foams.
- By removing microparticles from the air, the quality of air is significantly improved.

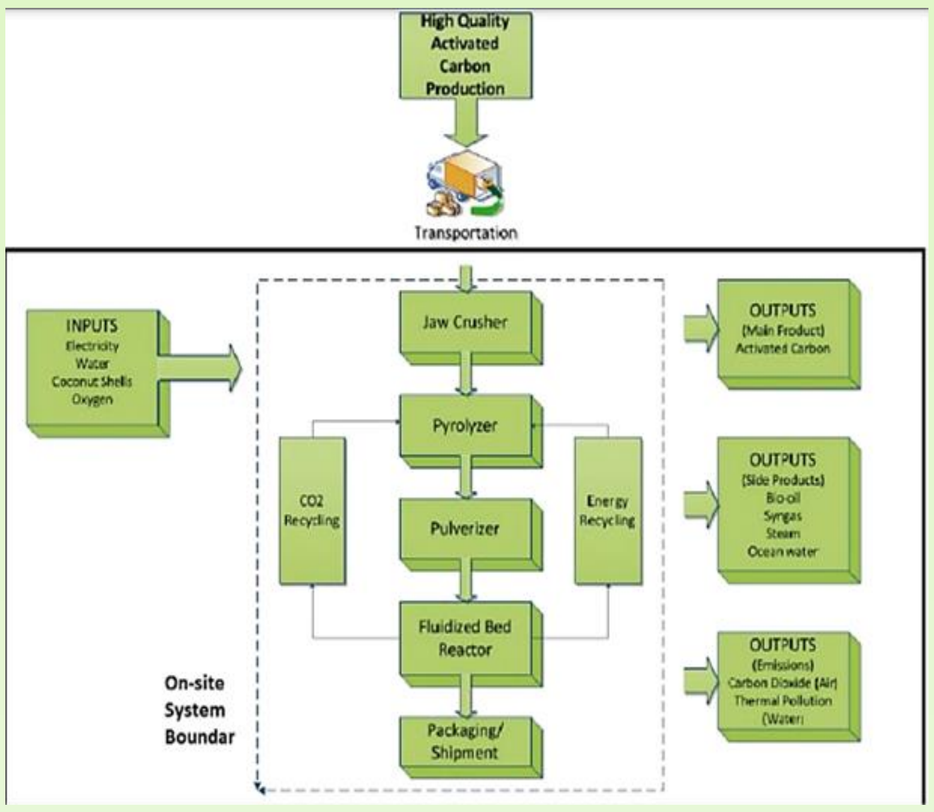

Fig 3. Life Cycle Assessment of the production of activated carbon [4]

Conclusion:

- Not only do air purifiers reduce greenhouse gas emissions, they also provide health benefits.
- By using sustainable resources to produce them, air quality can be significantly improved, potentially preventing thousands of deaths, while also removing waste products like coconut shells.

References:
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