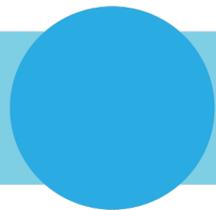


A photograph of an industrial water treatment facility. The scene is dominated by a complex network of large, dark-colored pipes and valves, supported by a metal framework. In the background, several large, light-colored metal storage containers or tanks are visible, along with a crane structure. The ground is dry and dusty, suggesting an arid environment. The sky is clear and blue.

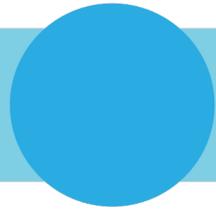
**Outlook of Applications for  
Commercial Activated  
Biocarbon**



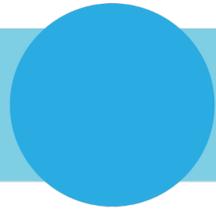
# AGENDA



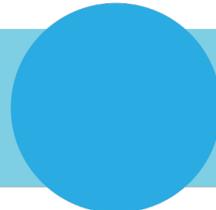
Introduction to Continental Carbon Group



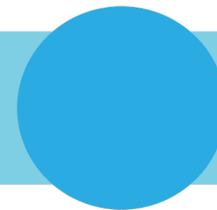
Activated Carbon Base Materials



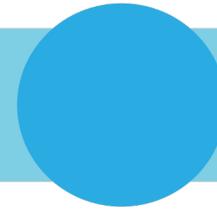
Activated Carbon Properties and Types



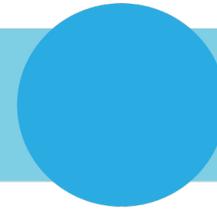
Bio-Waste to Bio-Activated Carbon Route



Potential Applications for Bio-Activated Carbon



Final Takeaways and Conclusions



Questions

# ABOUT US



Founded in 2009 Continental Carbon Group (CCG) is a turn-key solutions provider for air, soil, water and wastewater



Office in Stoney Creek, ON and Columbus, OH for sales, engineering, project management and field/technical services



Four divisions: Air treatment, Municipal services, Industrial groundwater treatment and Drinking water treatment



Technical staff has a cumulative experience of over 100 years in Municipal and Industrial applications market



# ACTIVATED CARBON BASE MATERIAL

## Coal

Bituminous  
Lignite  
Anthracite



## Coconut Shell

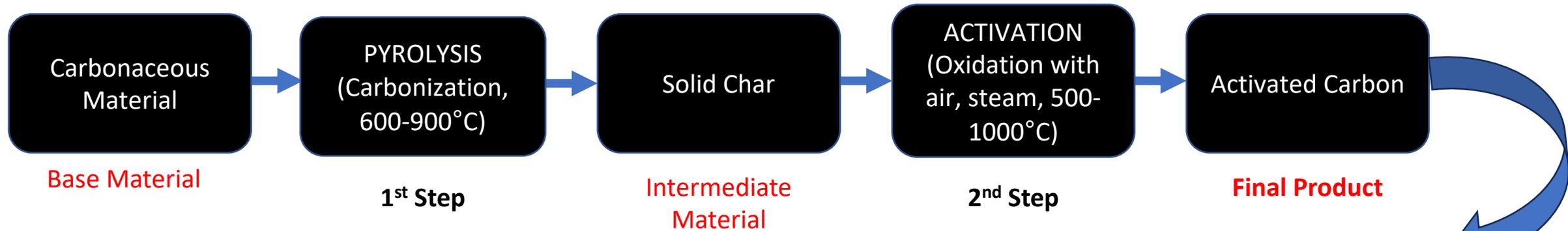


## Wood

Agricultural waste  
Lignin



# CONVENTIONAL PRODUCTION



Resulting Properties Will Depend On:

Base Material  
Composition

Temperature

Amount of  
Oxygen

Reaction  
Times





# PROPERTIES

- ▶ **Particle Size**
- ▶ **Surface Area**
- ▶ **Pore Volume**
- ▶ **Iodine Number**
- ▶ **Bulk Density**
- ▶ **Effective Size**
- ▶ **Abrasion Number**
- ▶ **Apparent Density**
- ▶ **Average Pore Size**

# ADSORPTION PORES IN CARBON

## Macropores

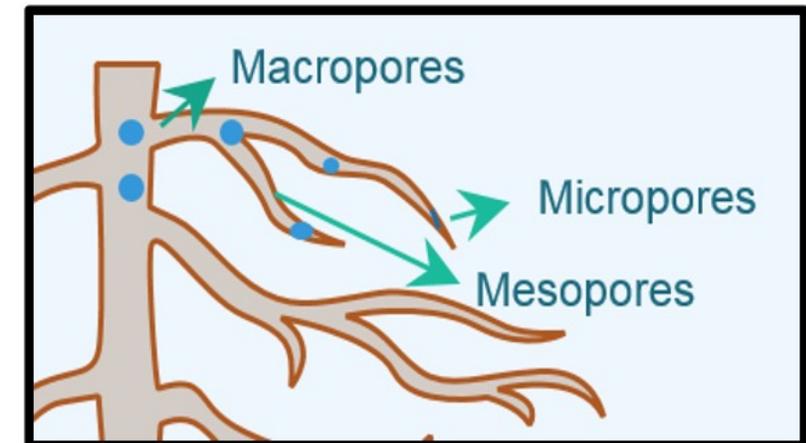
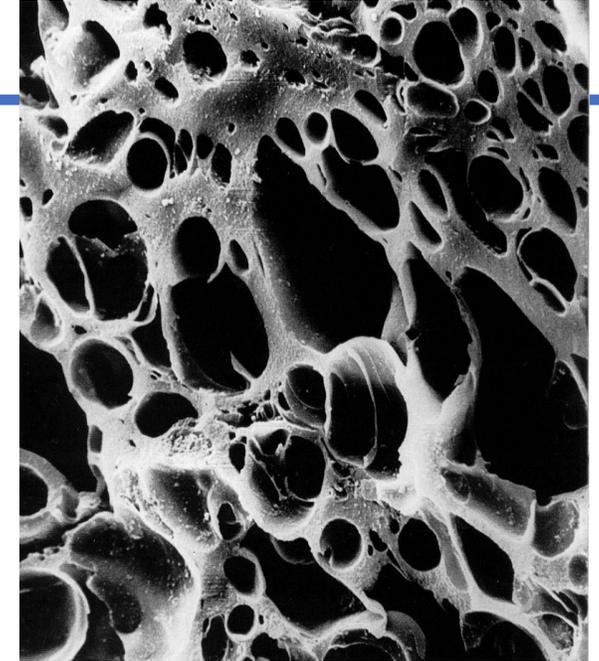
- Pore size range: 500-2000 nm
- Transport channel for contaminant

## Mesopores

- Pore size range: 2-50 nm
- Large molecular contaminants get adsorbed onto these pores

## Micropores

- Pore size: Less than 2 nm
- Adsorption energy strongest in these pores



# ACTIVATED CARBON TYPES



## Granular

- Primary use for water filtration and treatment
- Common contaminants: PCB's, PFAS, Pesticides etc.



## Extruded

- Air treatment applications
- Common contaminants: VOC's, H<sub>2</sub>S, Ammonia, Mercaptans etc.



## Powdered (PAC)

- Taste, colour and odour removal from water
- Targeted contaminants: Dyes, Natural organics (Tannins)

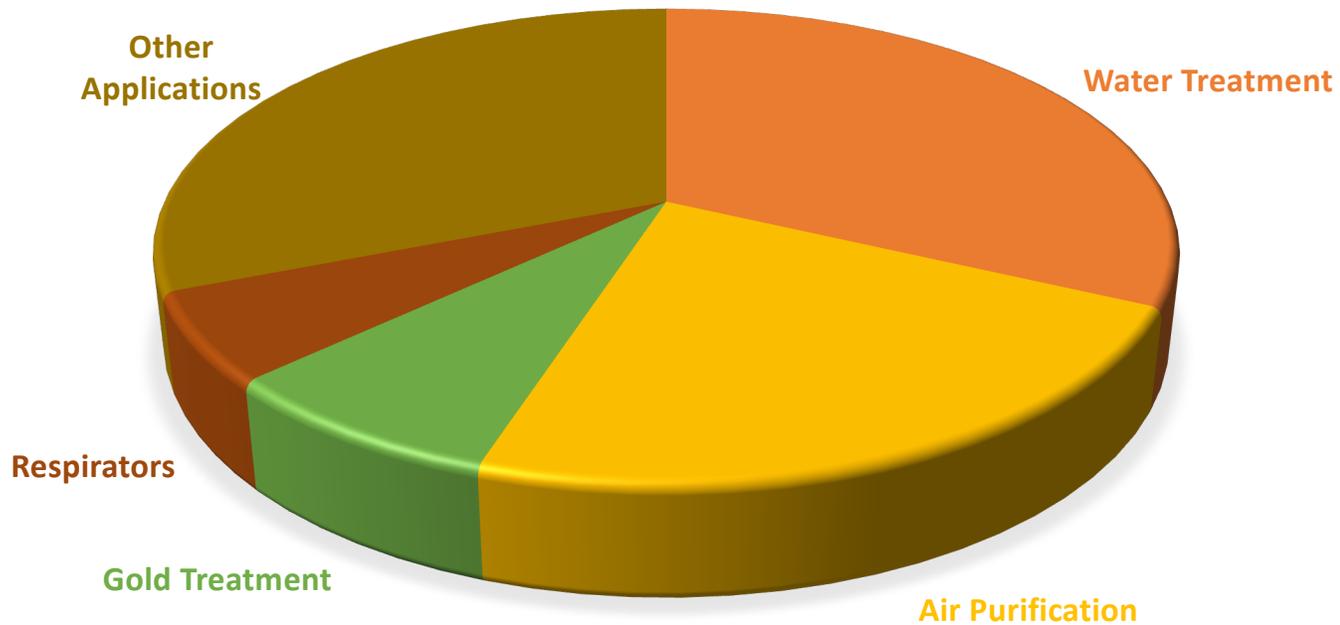


## Carbon Molecular Sieves (CMS)

- Medical air treatment: Nitrogen gas purification
- Used primarily for O<sub>2</sub> and CO<sub>2</sub> removal

# ACTIVATED CARBON GLOBAL MARKET OUTLOOK

## ACTIVATED CARBON APPLICATIONS



<u>Year</u>	<u>Market Value (USD)</u>
2022	3.9 billion
2023	4.4 billion
2030 (Forecasted)	8.4 billion

Source: Activated Carbon Market, Market and Markets, 2024

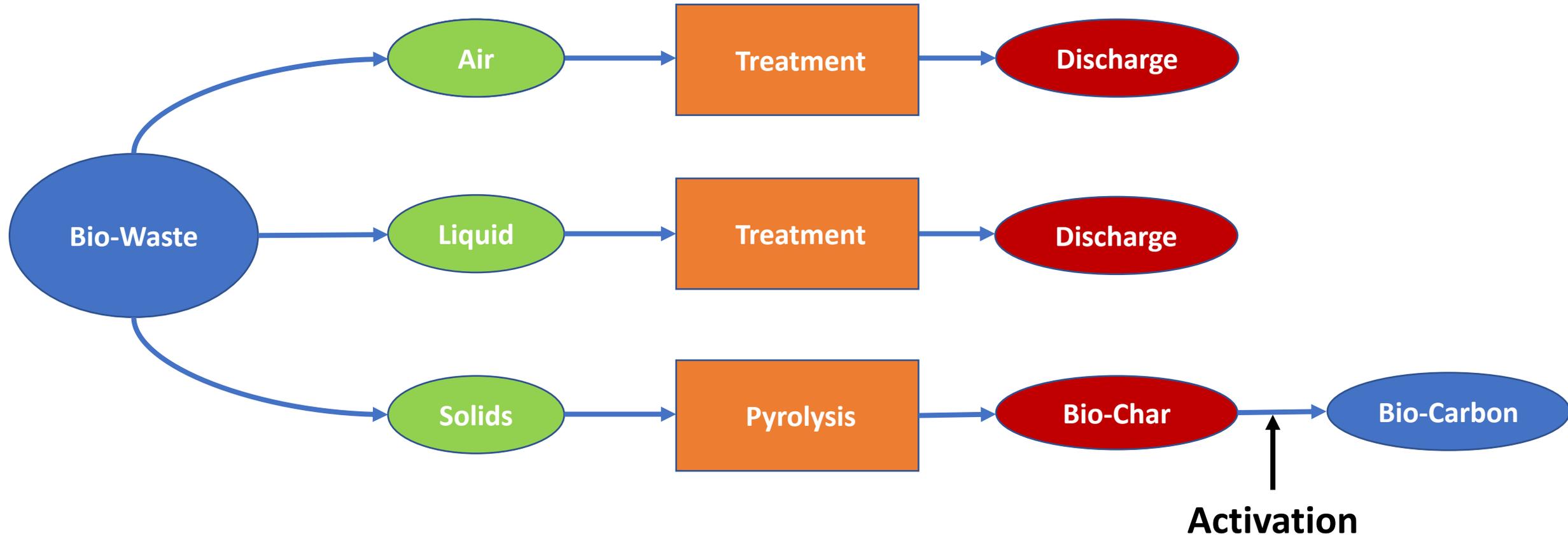
# ONTARIO LANDFILL PERSPECTIVE

In 2020, 12 million tonnes of waste was disposed of in landfills

Ontario's available landfill capacity is expected to be exhausted by  
2034

It takes 10-15 years to develop a landfill

# BIO-WASTE TO BIO-CARBON ROUTE



# ACTIVATED CARBON BASE MATERIAL

Raw material dictates all  
the product possibilities

- Ash impurities
- Density
- Hardness
- Transport pore structure
- Adsorption kinetics



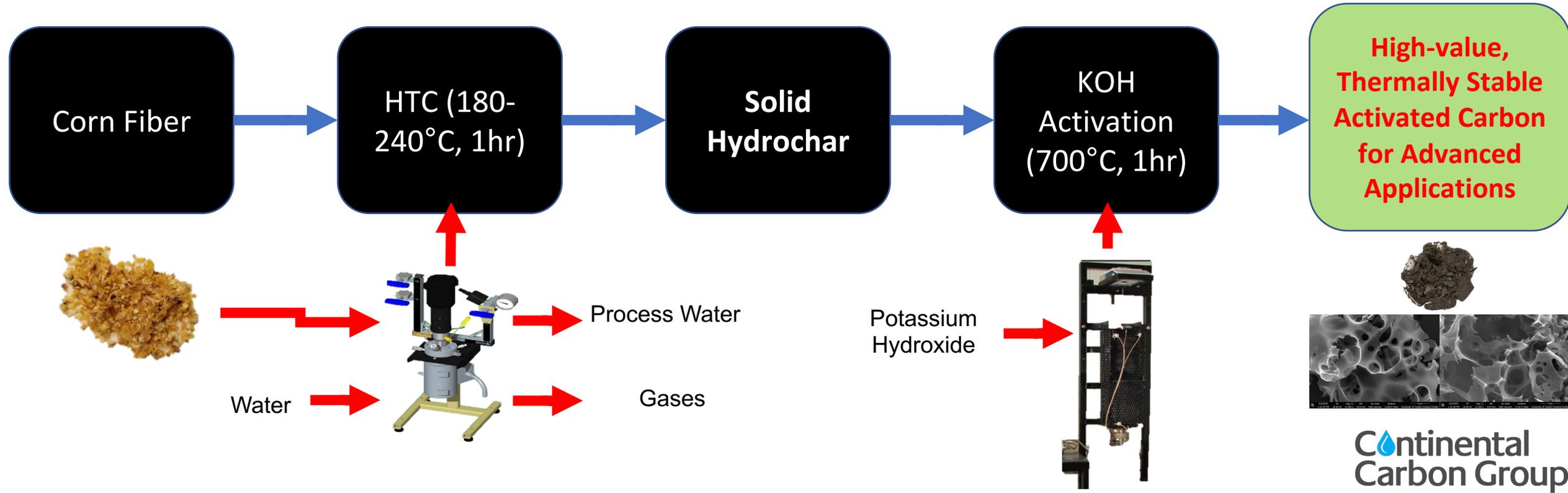
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# EXAMPLE ACTIVATED CARBON FROM BIO-WASTE

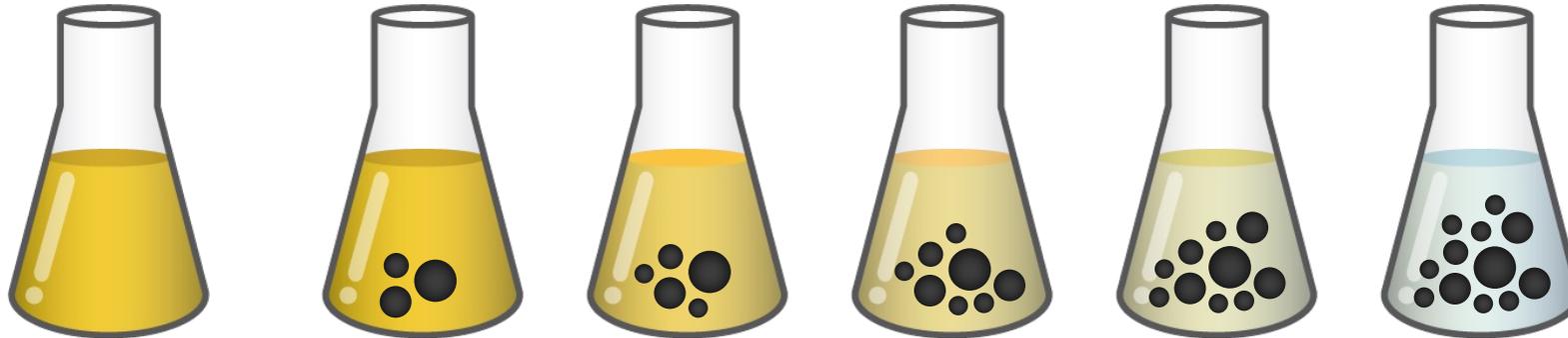
- Stage 1: Optional Graphene Oxide (GO) assisted Hydrothermal Carbonization (HTC)
- Stage 2: Chemical Activation with KOH

## Proposed 2-Stage Process: GO Assisted HTC of Corn Fiber With KOH Activation



# BATCH TESTING OF BIO-CARBON

## Batch Testing



INCREASING DOSE OF CARBON

Very basic test to estimate carbon performance for a given contaminant

$$D = \left( \frac{C_i - C_e}{m} \right) \times V$$

D → Carbon Adsorption Capacity (mg/g)

C<sub>i</sub> → Influent Concentration (mg/L)

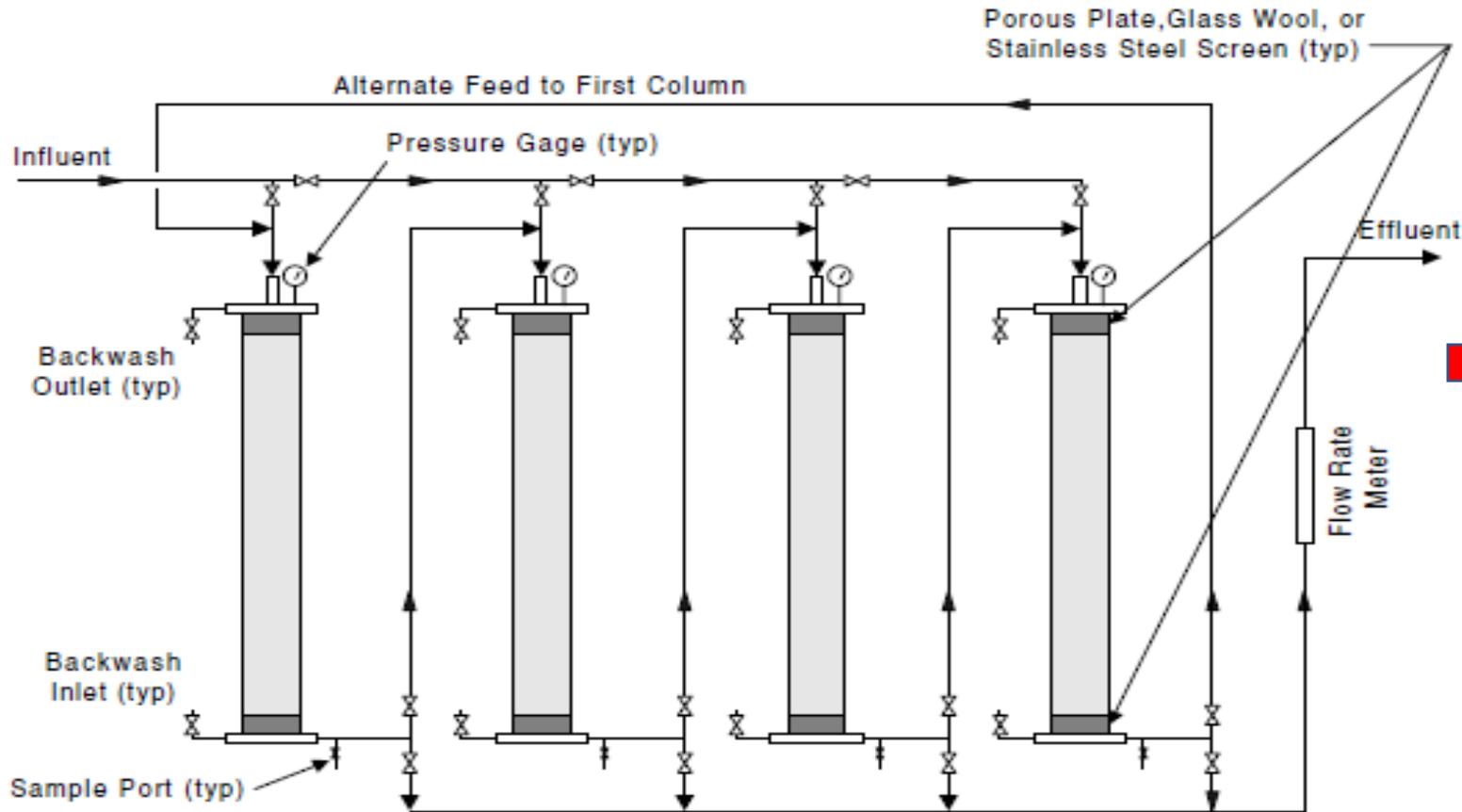
C<sub>e</sub> → Desired Effluent Concentration (mg/L)

V → Volume of Solution (L)

m → Mass of adsorbent (g)

# PILOT TESTING OF BIO-CARBON

## Column Testing



# POTENTIAL APPLICATIONS OF ACTIVATED BIO-CARBON



## Municipal



## Industrial



## Agriculture



## Food and Beverage

### Air Contaminants

- Ammonia
- H<sub>2</sub>S
- Mercaptans
- VOC's
- Mercury
- Nuclear gases
- Indoor and Electronic gases

### Water Contaminants

- Chlorine
- PCB's
- PFAS
- THM's
- Organics
- Oxidizers
- Pesticides
- Herbicides

# CONCLUSIONS



Multiple advantages of bio-waste based activated carbon



Extensive Research



Detailed Economic Analysis



Potential to help reduce dependence on importing Activated Carbon



# QUESTIONS

[www.continental-carbon.com](http://www.continental-carbon.com)

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