REVIEW OF BIOFILTRATION OF ODORS AND VOLATILE ORGANIC COMPOUNDS (VOCs)

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INTRODUCTION

- Biofiltration of odors and volatile organics has been practiced successfully for over three decades
- Media used in biofiltration can be categorized into two main types:
  - * Natural Media – Compost, soil, peat
  - * Synthetic Media – plastic, ceramic..
- Currently, there is no systematic way of comparing the cost-performance of various media

PURPOSE OF BIOMEDIA

1. Provide high surface area biofilms to the gas stream, containing the contaminants;
2. Allow biomass attachment to the biomedia surface;
3. Allow gas and liquid to be distributed evenly within the biofilter bed; and
4. Allow excess biomass growth to slough-off and exit the bed, without plugging the biomedia.

FAVORABLE BIOMEDIA CHARACTERISTICS

1. High biologically-active surface area
   Typical areas are in the range of 30 – 250 ft^2/ft^3 or 100 – 820 m^2/m^3

2. High void fraction (percentage of open space)
   Varies from 15% to 98%. Desired void fraction should exceed 80%.

3. Large free passage diameter – largest sphere that can pass through the packing; Provides resistance to clogging or plugging by biomass growth.

FAVORABLE BIOMEDIA CHARACTERISTICS

continued

4. Low cost per unit surface area.

5. Low bulk density and good mechanical strength.

6. Low gas-phase pressure drop; and

7. Ability to distribute the water evenly and prevent gas channeling.

NATURAL MEDIA

1. % Organic Carbon – Ability to adsorb organics and inherent growth of organisms

2. Water retention capacity

3. Void Fraction – Created by using wood chips, synthetic beads, etc.

4. Acid Neutralizing Capacity – ability to maintain pH in the presence of acidic or acid-forming compounds

5. Amount of bioavailable Nitrogen & phosphorus

SYNTHETIC MEDIA

1. Rock, Gravel, Lava Rock

   Disadvantages: - Low void fraction causes plugging
   - Using large gravel size decreases biologically active surface area
   - High bulk density (heavy)

2. Fibrous mesh pads

   Disadvantages: - Small free passage diameter causing media plugging
   - Compresses due to biomass film weight
   - Needs to be cut to filter diameter and requires large number of pads

SYNTHETIC MEDIA

continued

3. **Polyurethane foam pieces**
   Disadvantages:
   - **Fills up with biomass and prevents dead biomass from sloughing off effectively**
   - **Poor mechanical strength**
   - **Does not distribute water evenly**

4. **Extruded plastic, random packings**
   Disadvantages:
   - **Identical to packings used in gas absorption and stripping towers, but are not designed for biological growth on surface**

SYNTHETIC MEDIA

continued

5. **Structured Packings**

Used extensively in trickling filters for water treatment; Material of construction, such as PVC, polypropylene, etc. is initially hydrophobic, but becomes fully wettable within 1-2 weeks.

Good mechanical strength and light weight.

Do not require grids for support and can rest on beams.

Specific area varies 48 – 120 ft^2/ft^3

Void fraction: 95 – 98%; Low bulk density.

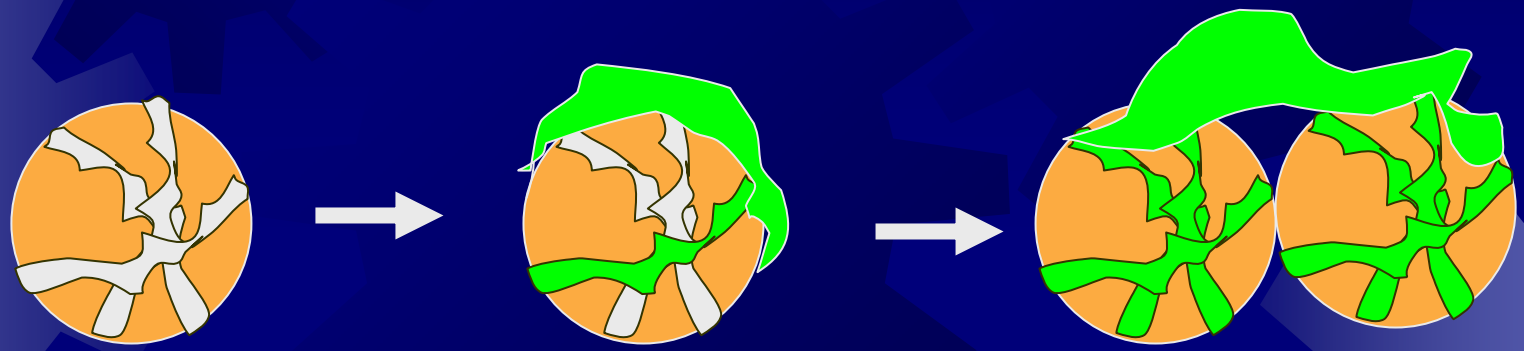
Disadvantages: Poor distribution of water in biofilters, since water flow rate is significantly less than trickling filters or gas absorbers; High gas phase mass transfer resistance, due to large openings and laminar flow of gas.

POROSITY AND SURFACE AREA

FILTER MEDIA	POROSITY	AREA (m^2/m^3)
Compost	40-80%	300-1300
Polyurethane foam	85%	620-800
Ceramic Saddles	68%	750
Ceramic pellets	34%	1400
Lava Rock	46%	4800
Fibrous Pads	87%	5700
Structured design	95%	3700

EFFECT OF BIOMASS GROWTH

Reduction of Effective Surface Area



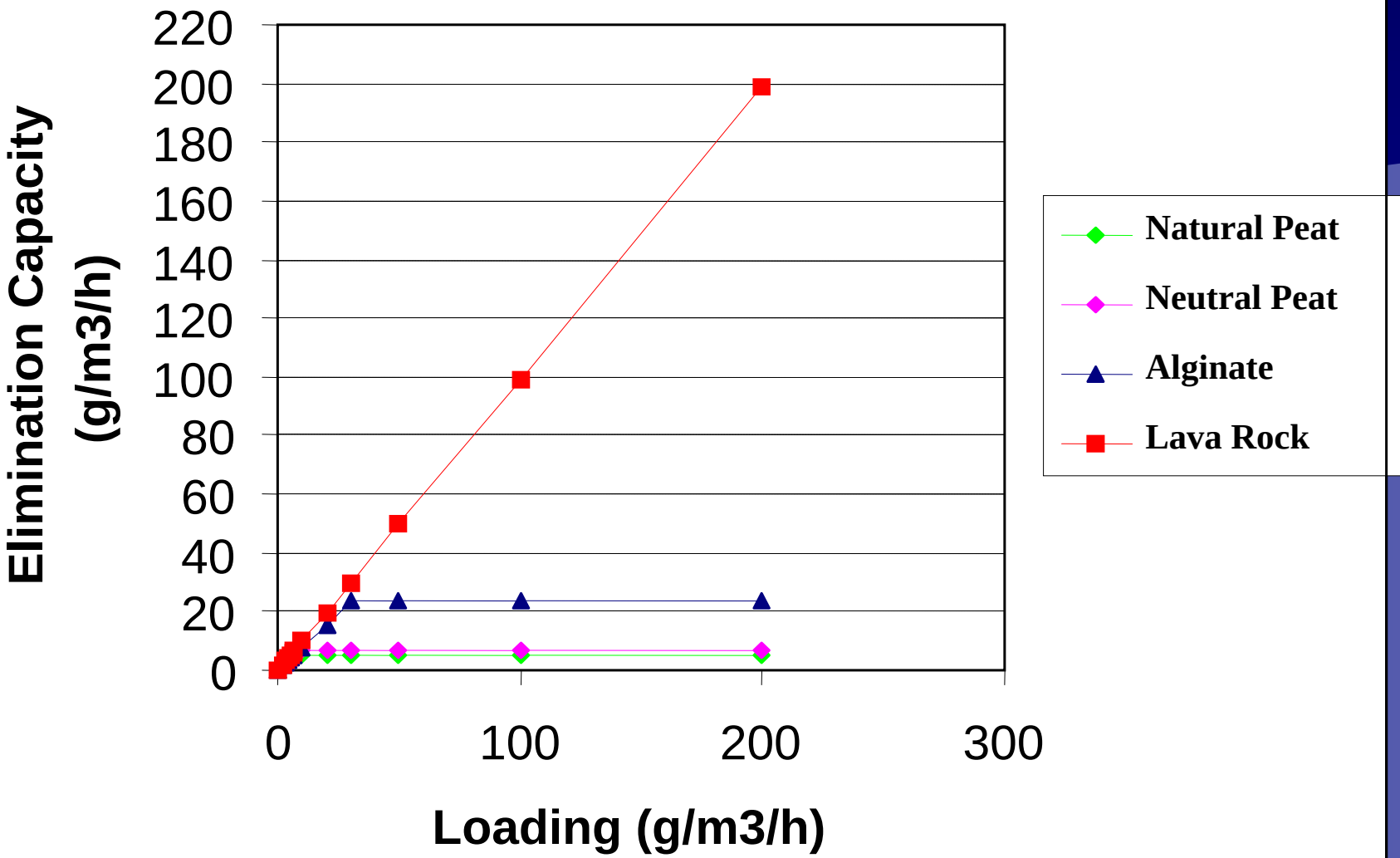
High Surface Area

Decreased Area due to Biomass Growth

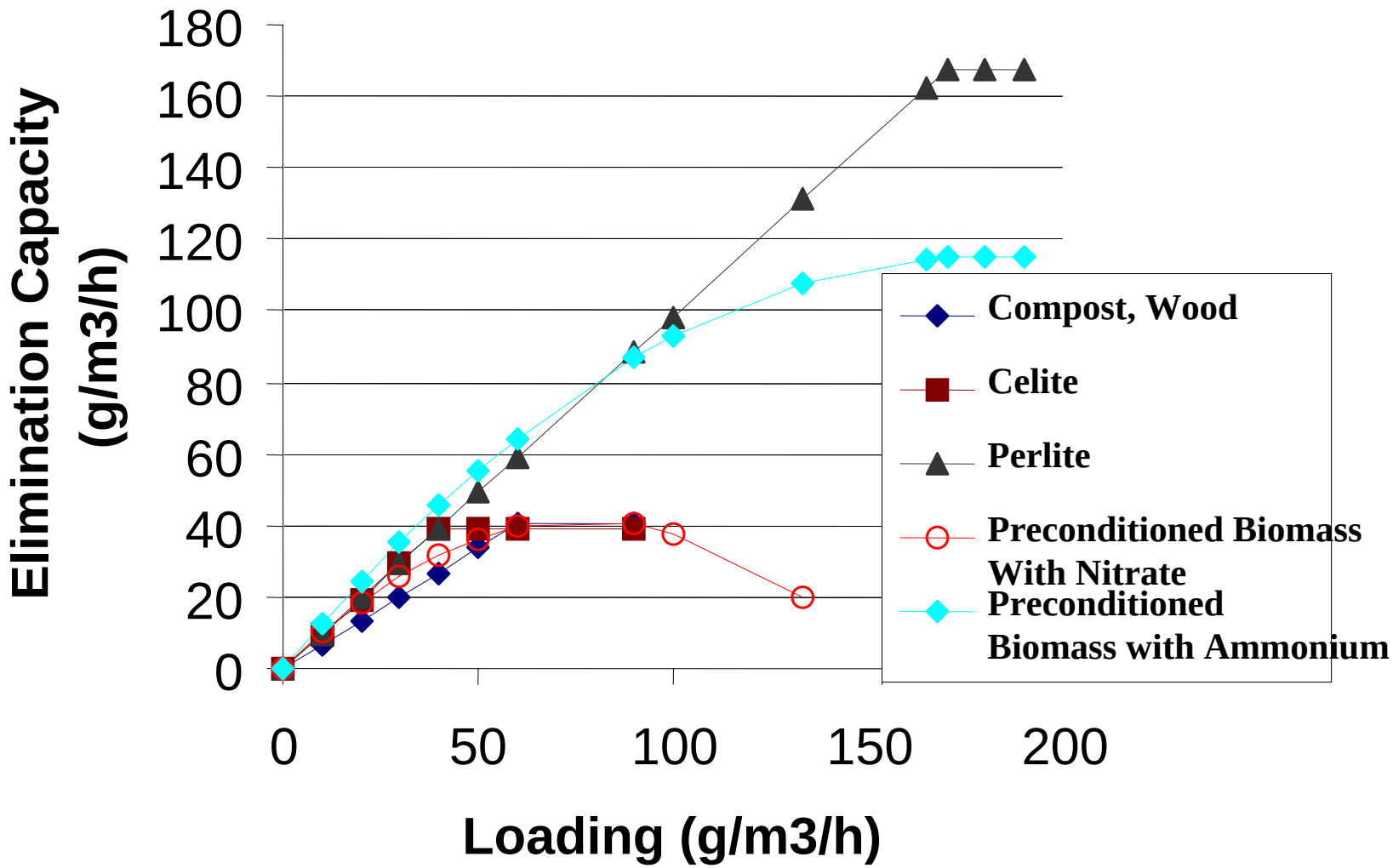
Low Surface Area due to Growth

Superficial + Micropore + Macropore → Superficial

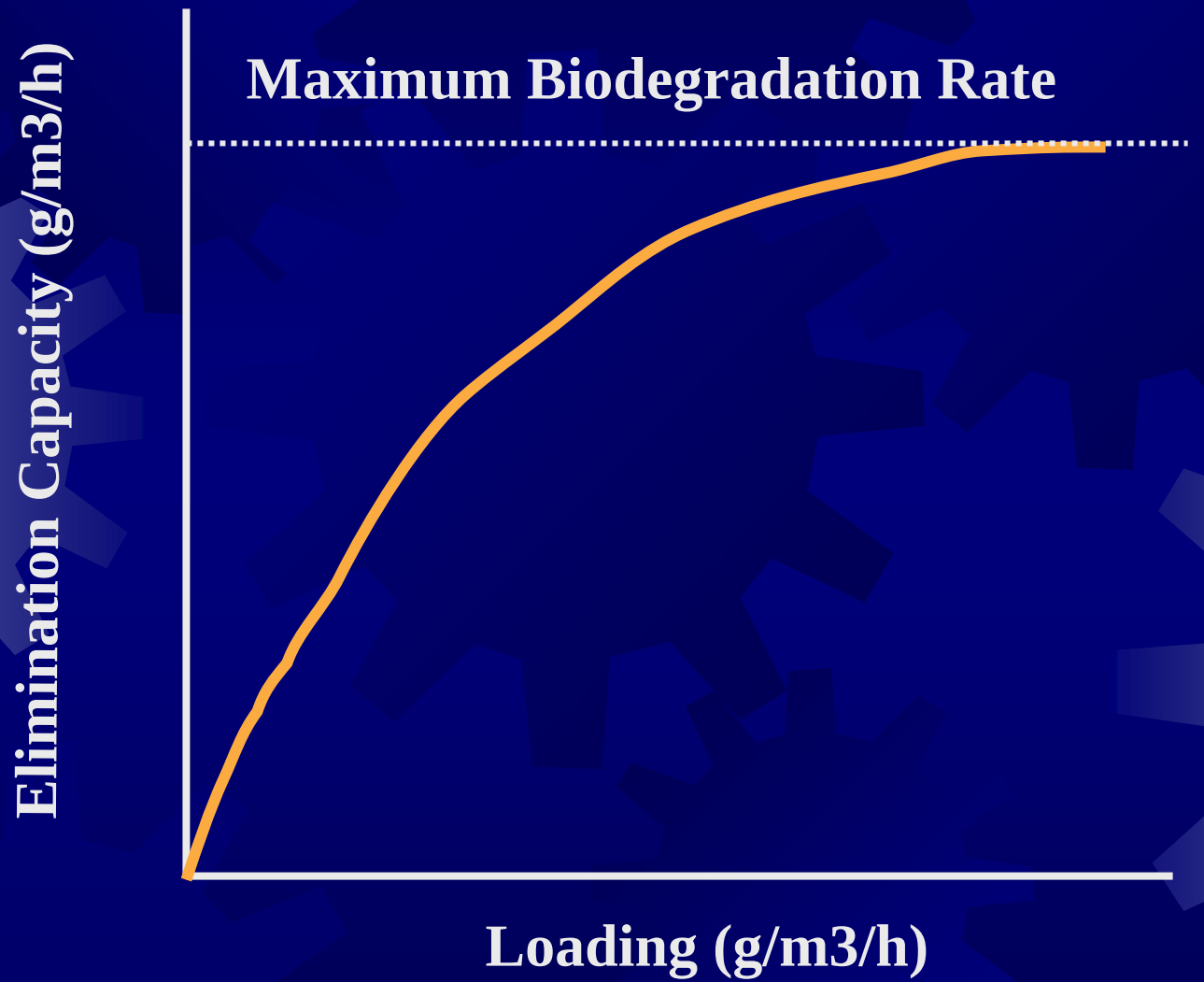
Treatment of Hydrogen Sulfide using different Biomedia



Elimination Capacity of Styrene Using Different Media



COMPARISON OF MEDIA



CONCLUSIONS

1. Experimental Data for various compounds using different Biomedia were compared to determine the best criterion for comparing the media's effectiveness

2. It was found that the Maximum Reaction Rate, as determined from the plateau value of the Elimination Capacity Graph, was the best measure for comparing various Biomedia

3. The best Biomedia is different for different compounds