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WORLD
WASTE-to-WEALTH
SUMMIT & EXPO

Biosolids Upcycling via Technological Integration: Feed Pre-treatment to Energy and Resources recovery

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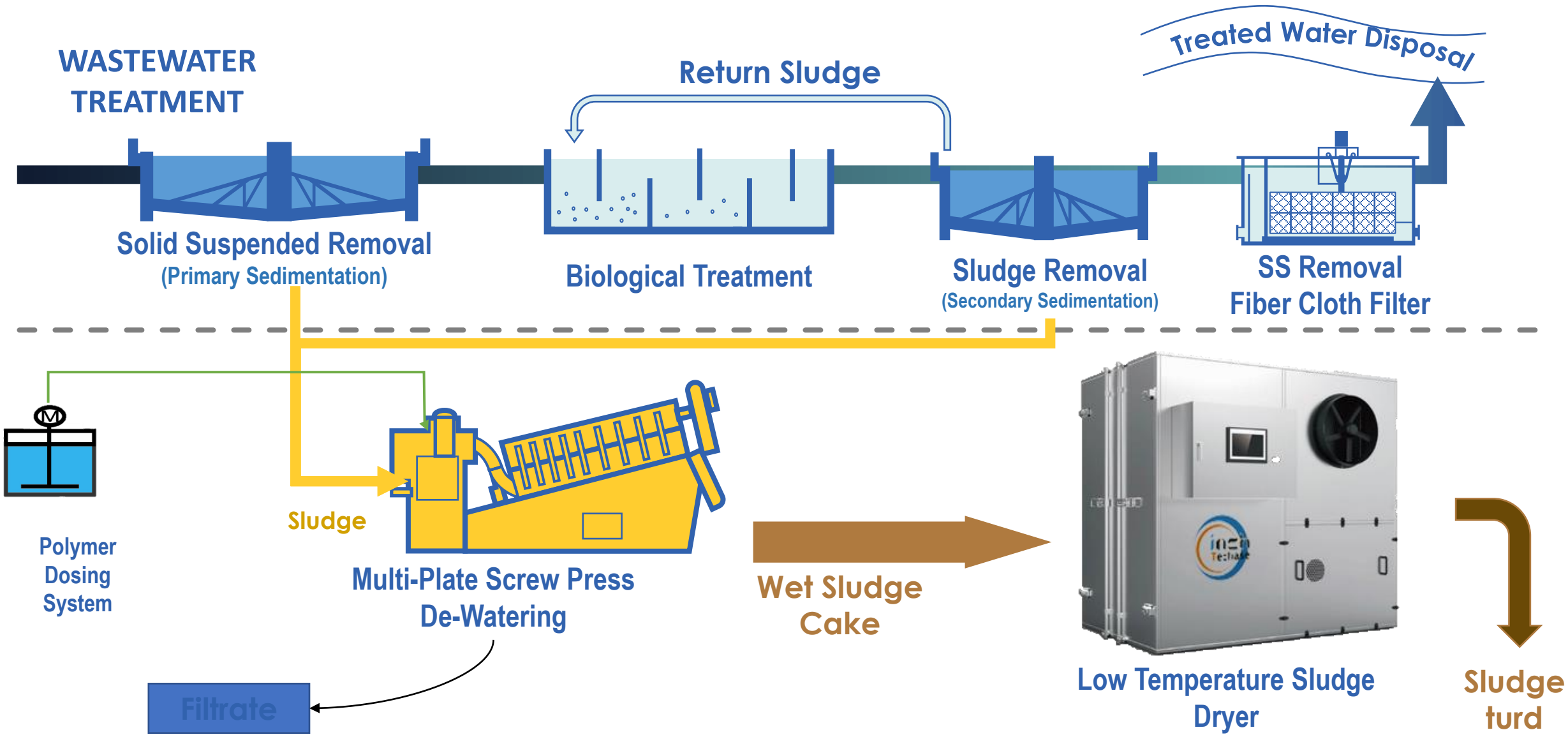
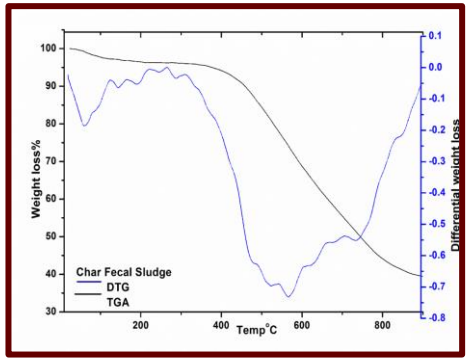
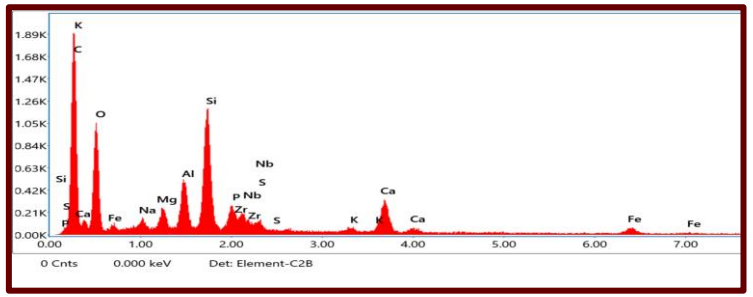
Sludge Management: Big Picture



Biosolids Upcycling

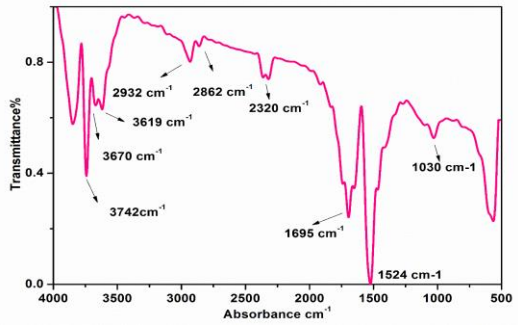




Pyrolysis

Sludge Biochar

- Characterization
- Soil Application
  - Plant Growth
  - Culturable Microbial Community Analysis



Pyrolysis

Temp. 500°C

Pyrolysis Gases 23.3%

Pyrolysis Char

800 g

40 %

Pyrolysis Oil

734 g

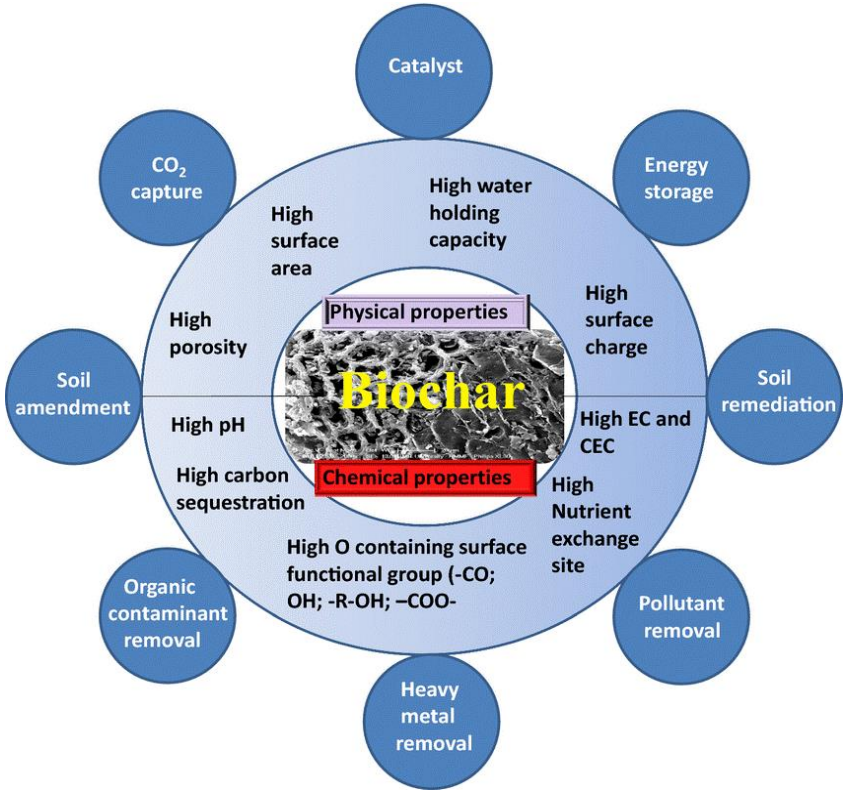
36.7 %

Biochar

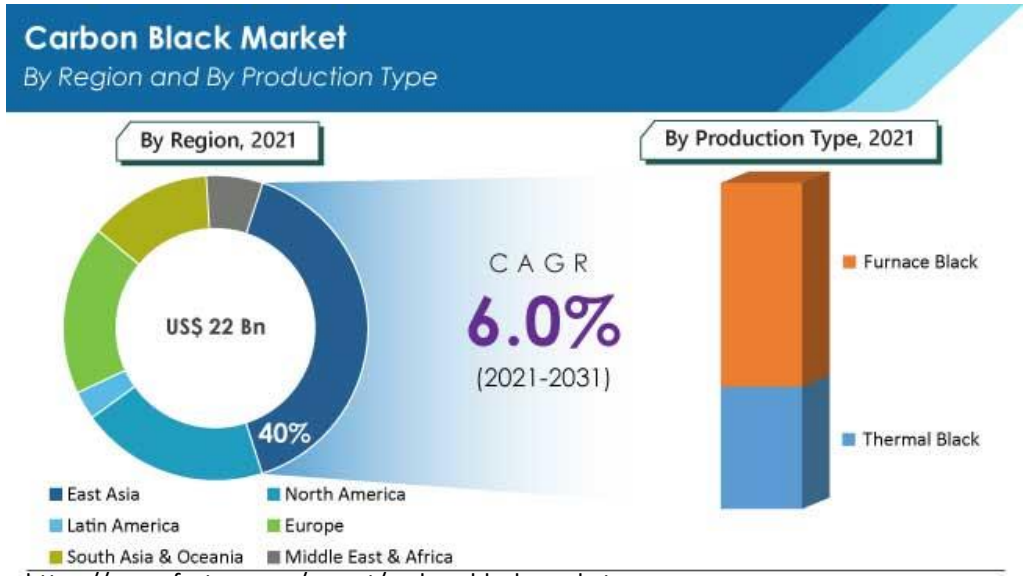
- Non-agricultural applications
  - Thermal e.g., solid fuel, catalyst and energy storage.
  - Non-thermal e.g., nutrient recovery and adsorbent
- Agricultural applications
  - Fertilizer and water treatment plant etc.

Non-Agricultural Applications

- Nutrient recovery
- Catalytic bio/chemical reactions
- Removal of pollutants from gas and liquid streams
- Additive to rubber and construction industries
- Secondary fuel for thermal processes
- Smart energy systems

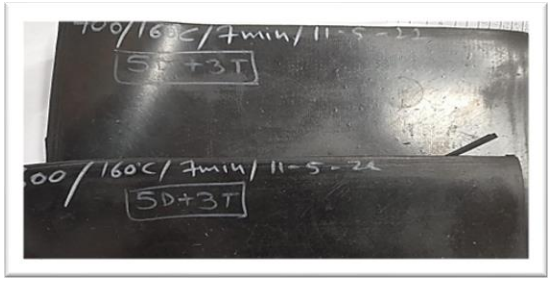


Rubber Compounding



https://www.factmr.com/report/carbon-black-market

Compounding Ingredient	STD	Blank	**Biochar @600**	**Biochar @700**
SBR1502	100	100	100	100
ZnO	3	3	3	3
SA	2	2	2	2
SRF N774	50	0	0	0
Biochar	0	0	50	50
CBS	1.5	1.5	1.5	1.5
TBBS	0.5	1.5	0.5	0.5
SULPHUR	1.5	1.5	1.5	1.5



		STD	Blank	**Biochar @600**	**Biochar @700**
Rheometric Properties @160°C					
i)	Maximum Torque (MH)	14.19	59.75	11.3	13.4
ii)	Minimum Torque (ML)	1.11	7.61	1.1	1.1
iv)	TS2 (Minutes)	4.38	8.83	2.7	3.0
v)	Tc90 (Minutes)	11.86	14.64	6.0	6.8
Molding time for slab@160°C, minutes		13	16	7	7
Uncured batch		Ok	Ok	Ok	Ok
Surface finish of cured Sample		Ok	OK	Ok	Ok

Properties tested	Test Method	STD	Blank	**Biochar @600**	**Biochar @700**
Physical Properties on sample					
Hardness (Shore A)	ASTM D2240	63/64	46	58	60
Modulus at 100% (Kg/sq.cm)	ASTM D412	23	9	19	20
Modulus at 200% (Kg/sq.cm)		61		30	33
Modulus at 300% (Kg/sq.cm)		113	16		
Tensile Strength (Kg/sq.cm)		123	18	40	43
Elongation at break(%)		320	350	300	283
Tear Strength (kg/cm)	ASTM D624	66	14	23	25

Construction

Additive to cement

Production of one tone of cement can emit one tone of CO_2, and contributes to nearly 8% of global CO_2 emissions.

Biochar with high pH and high water-retention rate can absorb water during concrete mixing and release during hardening, which can result in stronger concrete.

Addition of 1% biochar:

Increased the compressive strength of structural concrete by 20%,

Increased the water permeability by 50%.

Fired clay bricks

The volatiles present in biosolids have a calorific value of 12 MJ/kg which can be combusted to supply the energy required for firing (2 MJ/kg). Combustion of its volatiles increases the pore volume, thus giving rise to a reduced density and compressive strength of bricks (35.5 MPa for 10% biosolids which is significantly higher than the accepted value for low-rise buildings i.e. 5 MPa.)

Locking carbon in bricks can help brick manufacturing industries to reduce their carbon footprint.

http://fingerlakesbiochar.com/

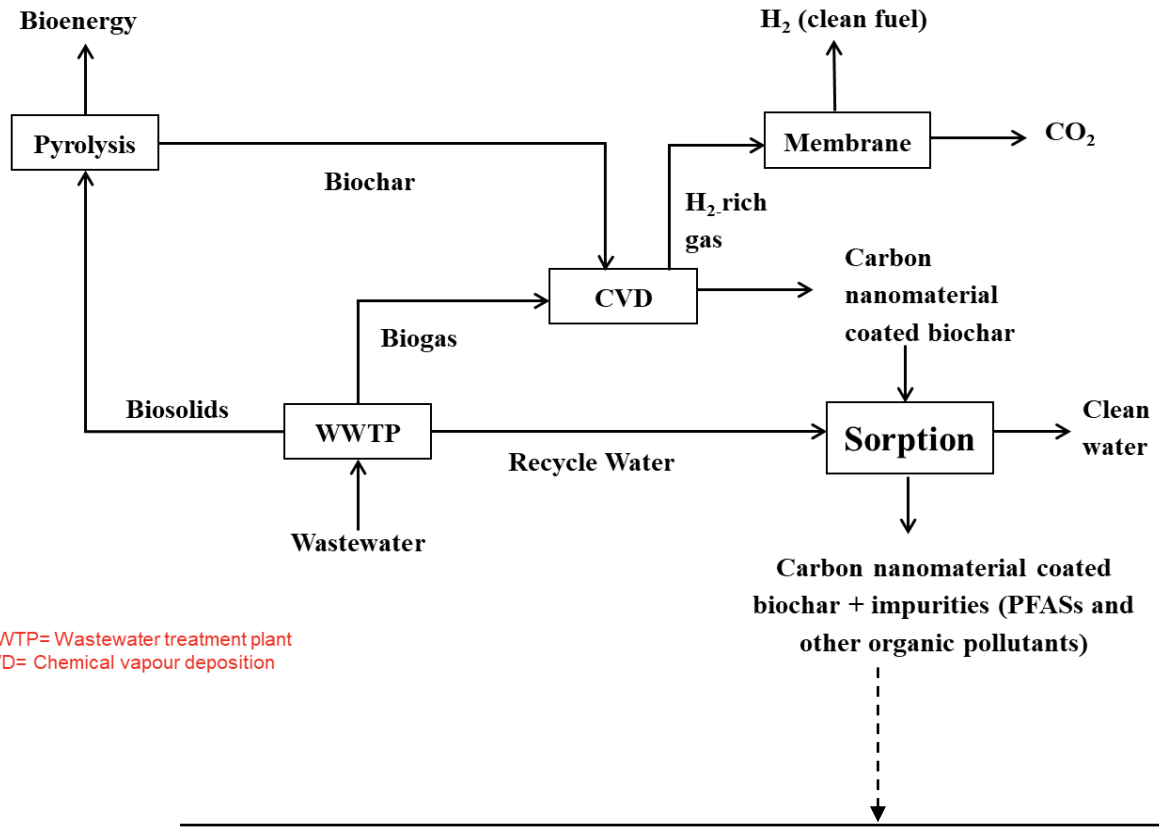
Plaster

Biochar has a extremely low thermal conductivity and high water holding ability. It can regulate the humidity, adsorb toxic compounds, conserve wood, cement, and plaster, reduce dust and electromagnetic radiation, insulate, act as an antibacterial and fungicide, and be a noise protector.

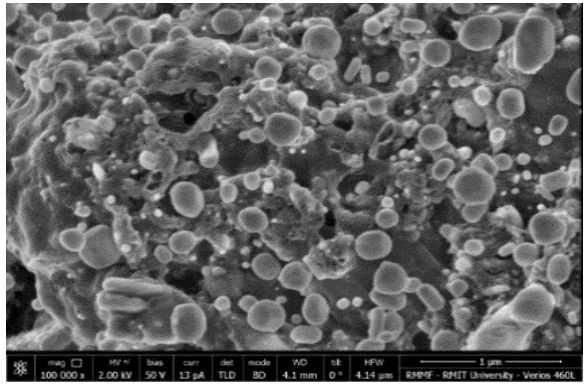
It stores carbon in buildings in a natural way. After demolishing a building, the biochar amended plaster can be composted, thus carbon cycle can be continued.

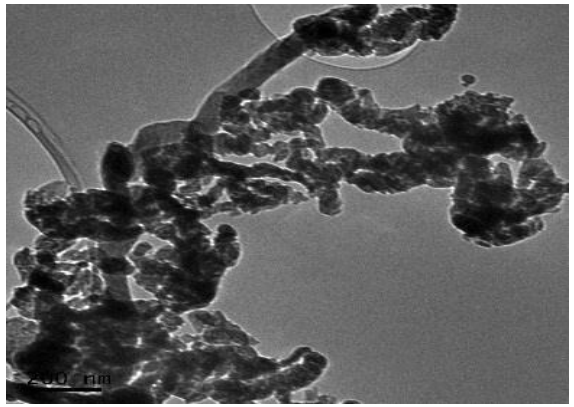
https://www.biochar-journal.org/en/ct/3

Circular Solution



WWTP= Wastewater treatment plant
CVD= Chemical vapour deposition





	PFOS (µg/l)	PFOA (µg/l)	PFHxS (µg/l)
Initial Concentration	310	25	140
Biochar	38	9.7	50
Biochar + Carbon nanosphere	17	7.3	39
Ilmenite	110	19	130
Biochar + Ilmenite + CNS + CNF	43	14	97
Activated carbon (GAC)	0.52	0.07	0.18

Thank You

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