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Development of a Mobile, 100 kg/h Plant For Pyrolysis, Using a Mechanically Fluidized Reactor (MFR)

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MFR



2 t/d



0.7 t/d



Gases +
Steam +
Ac. Acid



Fuel



Pharmaceuticals



0.8 t/d

Dry
Bio-oil



Pesticides



Adhesives

0.5 t/d



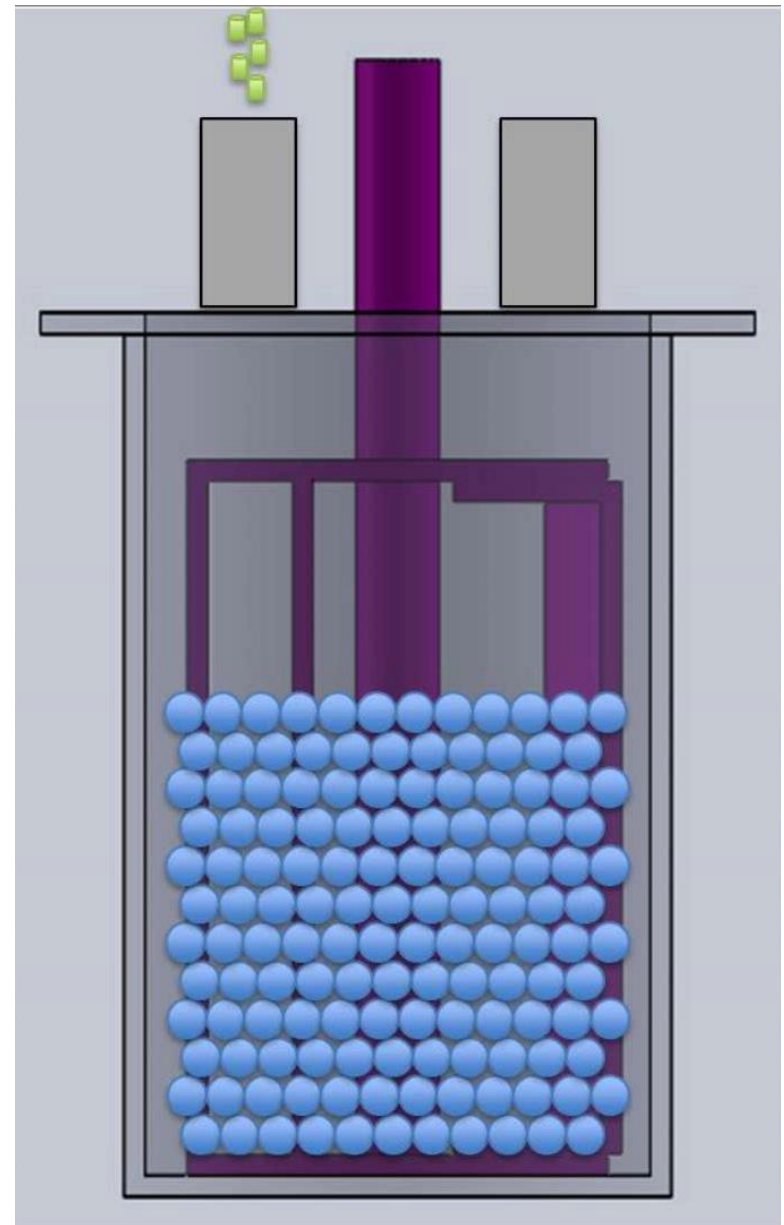
Biochar



Fertilizer

How does the MFR work?

Thesis from Valentina Lago



Hot electrostatic precipitator:

- Fine char

Condenser & electrostatic demister:

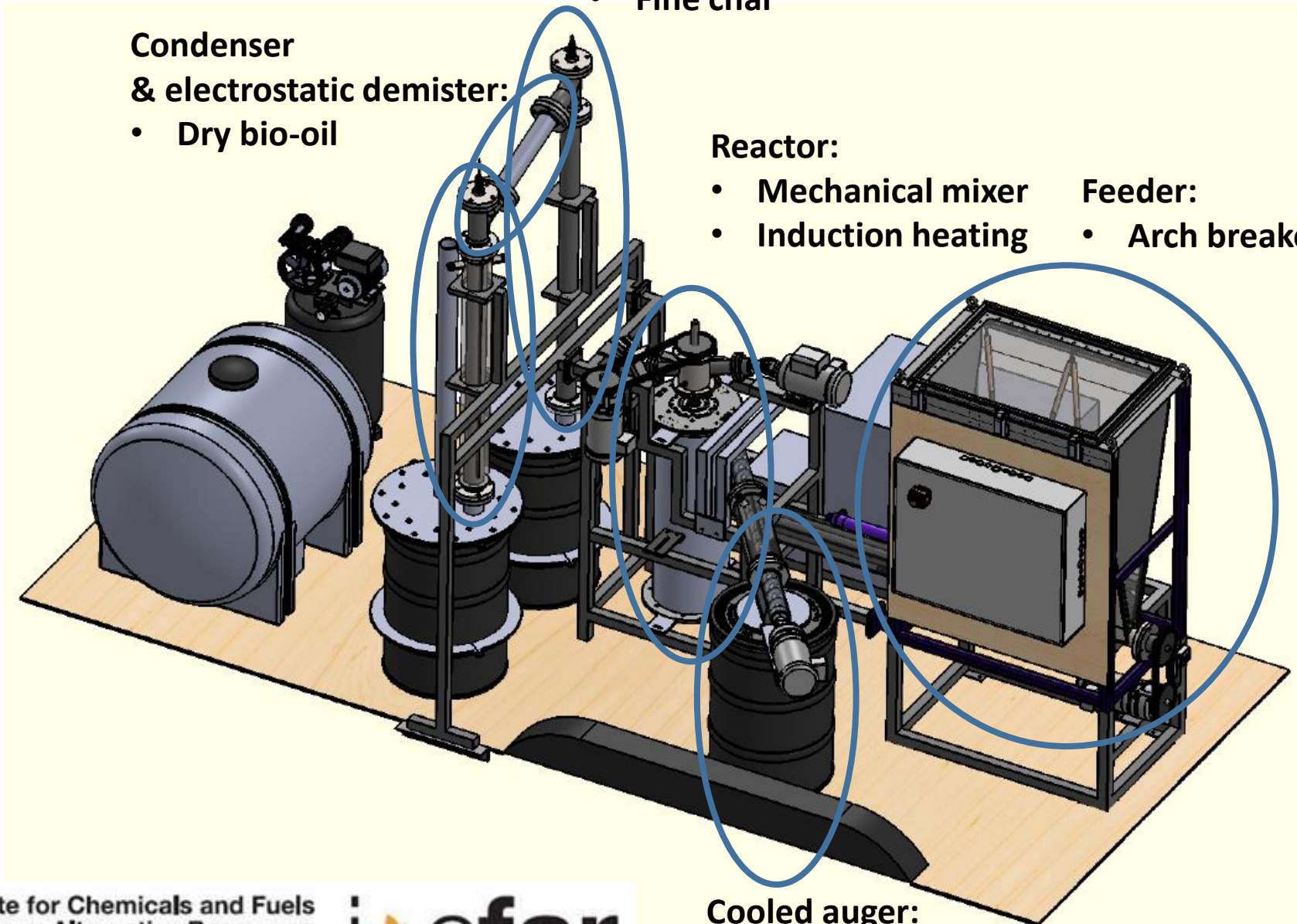
- Dry bio-oil

Reactor:

- Mechanical mixer
- Induction heating

Feeder:

- Arch breaker



Cooled auger:

- coarse char

FEATURES	Compact	Easy to Operate	Rapid Heating (20 min)	Feed Flexibility	Pure Char	High value Oil
Mechanical Mixing	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Induction Heating	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			
Hot Electrostatic Precipitator	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>
Condensation	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>

Measurement method for Wall-to-bed Transfer

- Set mixer RPM
- Constant flowrate of water added to MFR bed
- Wait for steady state
- Record:
 - Bed temperature
 - Wall temperature

Equations:

- (heat transfer from wall to bed) =
(heat for evaporation) + (heat losses from bed)
- (heat for evaporation) = (liquid flowrate) x (water enthalpy change)
- Estimate of heat transfer coefficient:
 - Neglect heat losses
 - Underestimates heat transfer rate from wall to bed

Two different bed materials were tested:

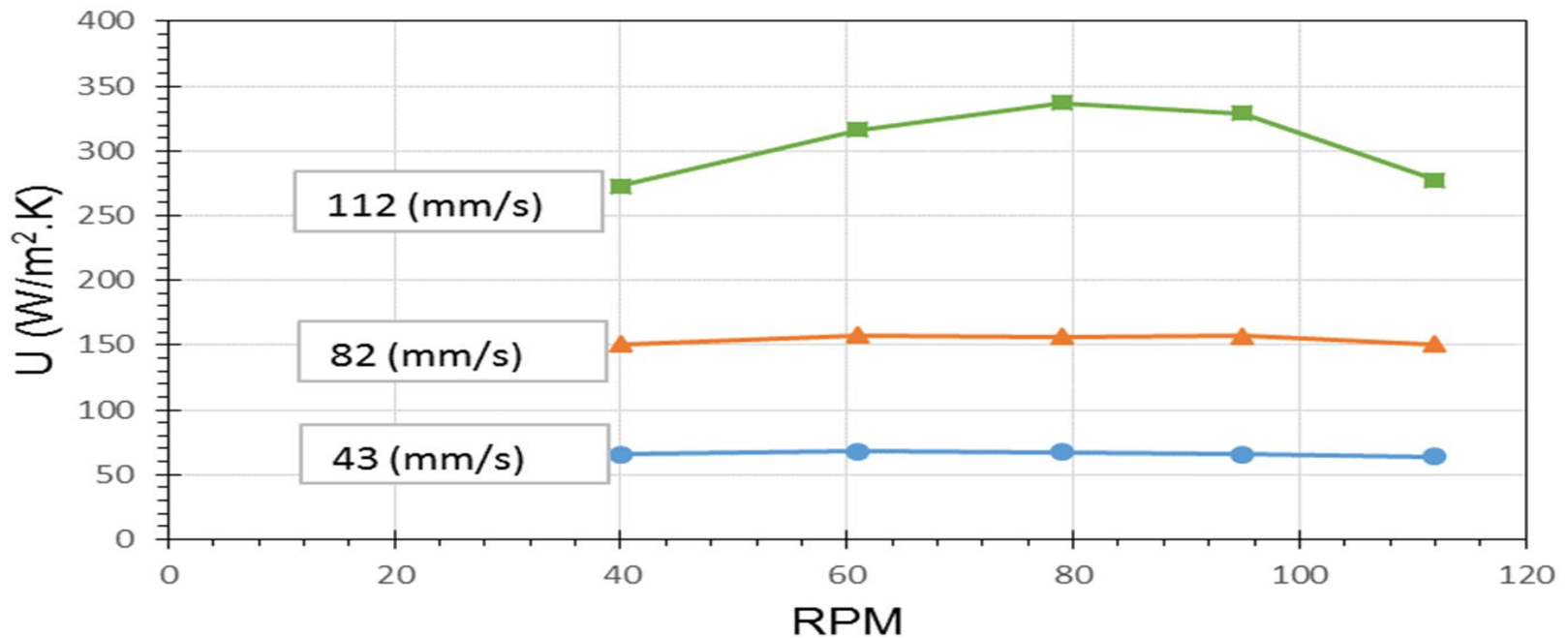
Properties	Units	Sand	Activated carbon
Particle diameter	μm	185	575
Particle density	kg/m^3	2650	750
Heat capacity	$\text{J}/\text{kg}/\text{K}$	830	1300

Two different reactors were tested:

Dimension	Units	Small MFR	MFR-1
Inner Diameter	m	0.1015	0.15
Height	m	0.127	0.25
Volume	litre	1.03	4.42

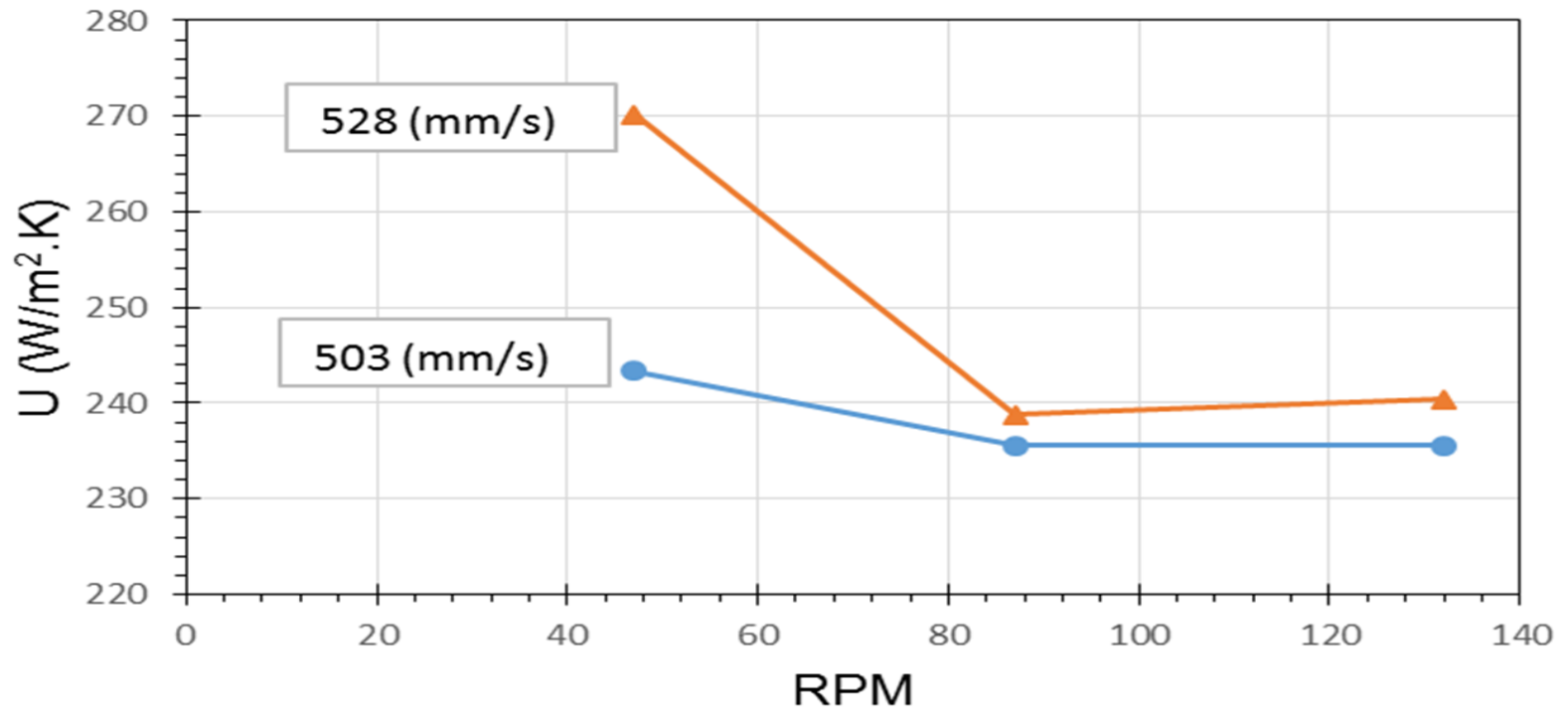
Wall- to-bed Heat Transfer with Sand Bed

FOR SMALL MFR:



Wall- to-bed Heat Transfer with Sand Bed

FOR MFR-1:



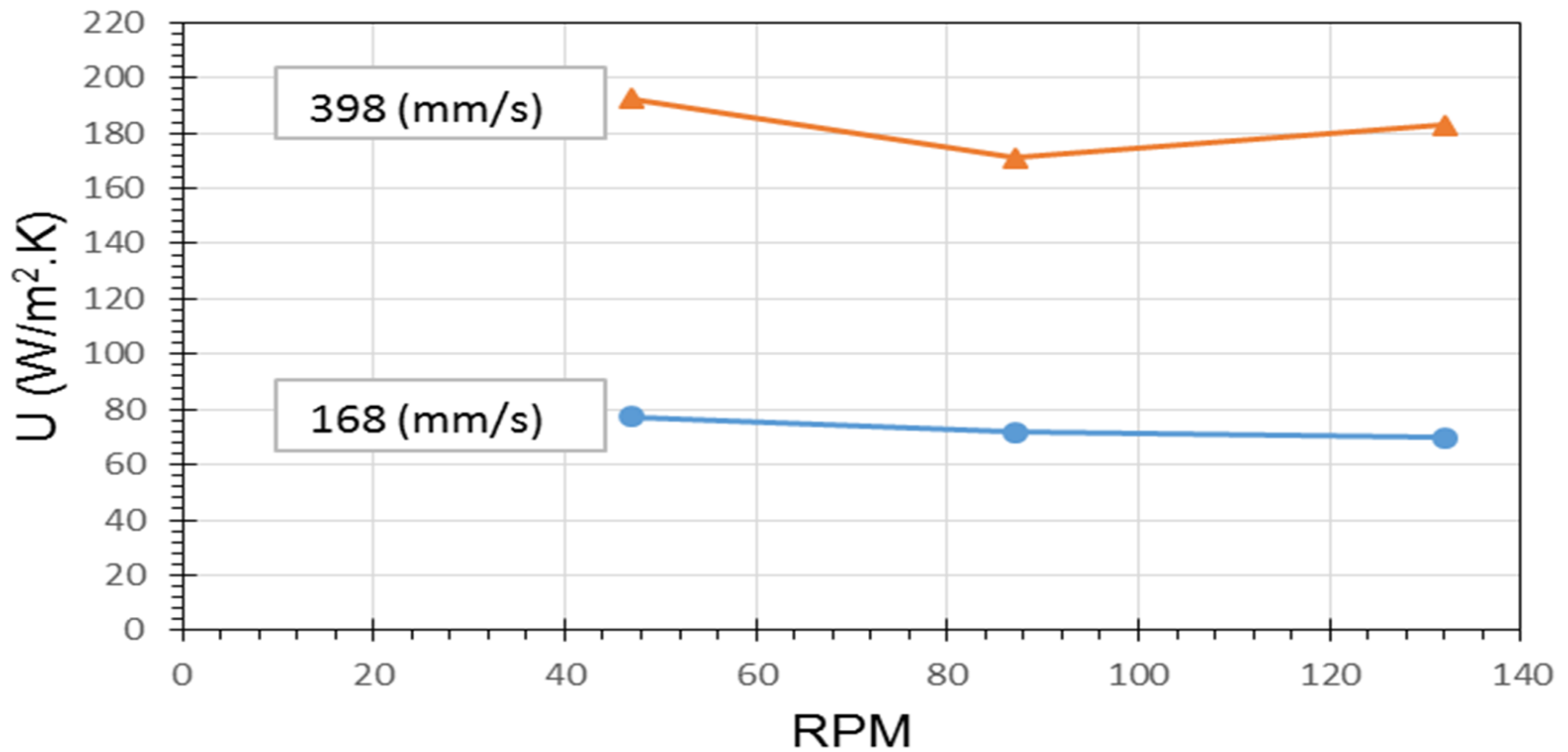
Results:

FOR SMALL MFR		
Superficial Steam Velocity (mm/s)	U_{AVERAGE} for all RPM (W/m ² .K)	U from Correlation (W/m ² .K)
43	66	142
82	154	344
112	307	428

FOR MFR-1		
Superficial Steam Velocity (mm/s)	U_{AVERAGE} for all RPM (W/m ² .K)	U from Correlation (W/m ² .K)
503	238	280
528	250	261

Wall-to-Bed Heat Transfer with Activated Carbon Bed

FOR MFR-1:



Results:

FOR MFR-1		
Superficial Steam Velocity (mm/s)	U_{AVERAGE} for all RPM (W/m ² .K)	U from Correlation (W/m ² .K)
168	73	104
398	182	124

Conclusions:

- High wall to bed heat transfer coefficient, comparable to regular fluidized beds
- Capability to produce high quality products
- Versatility of the products / process flexibility
- Easy operation
- Open avenues for new applications in biorefinery

Acknowledgement



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THANK YOU!