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Development of a mobile 100 kg/h plant for pyrolysis using a mechanically fluidized reactor

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

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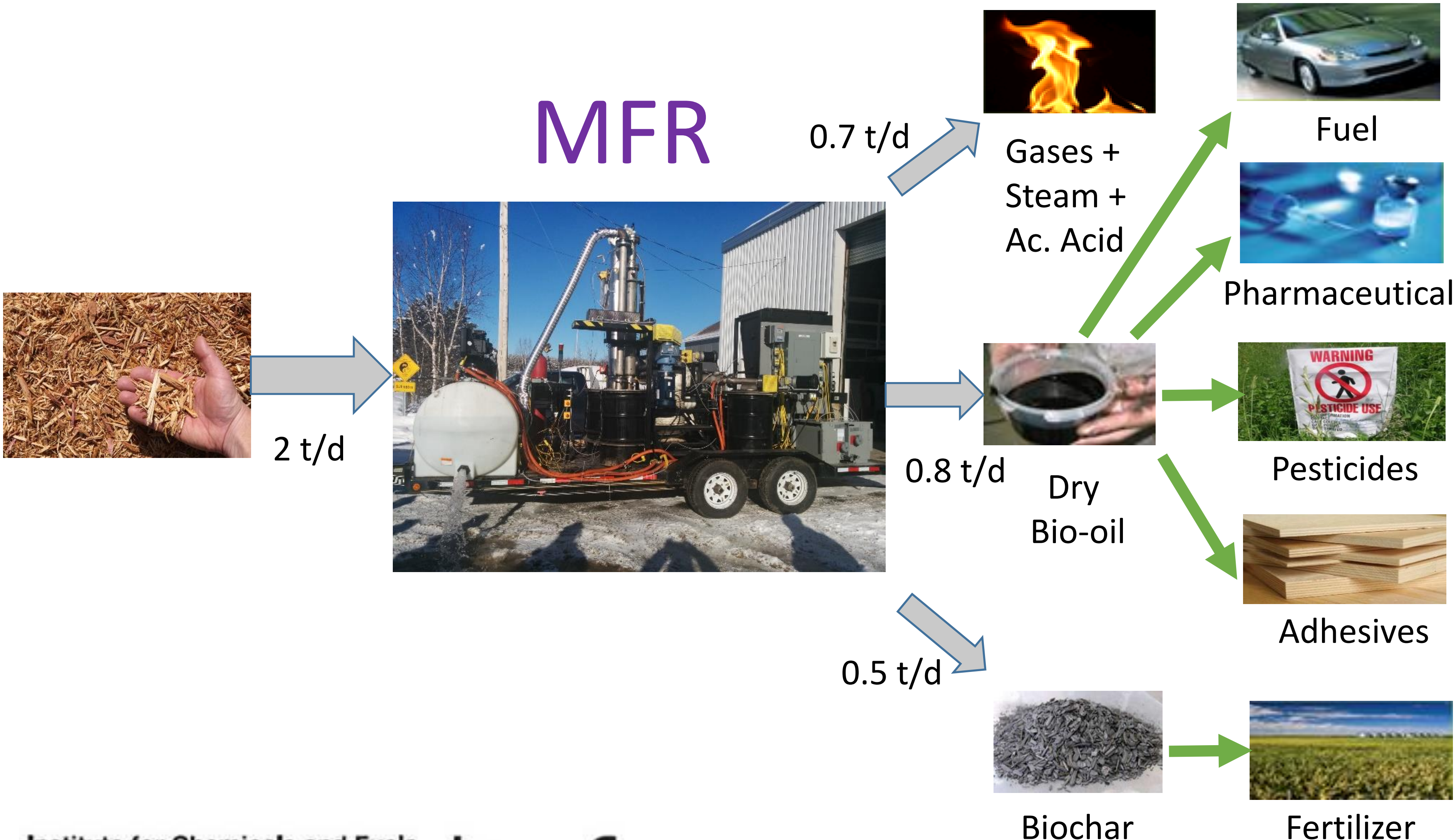

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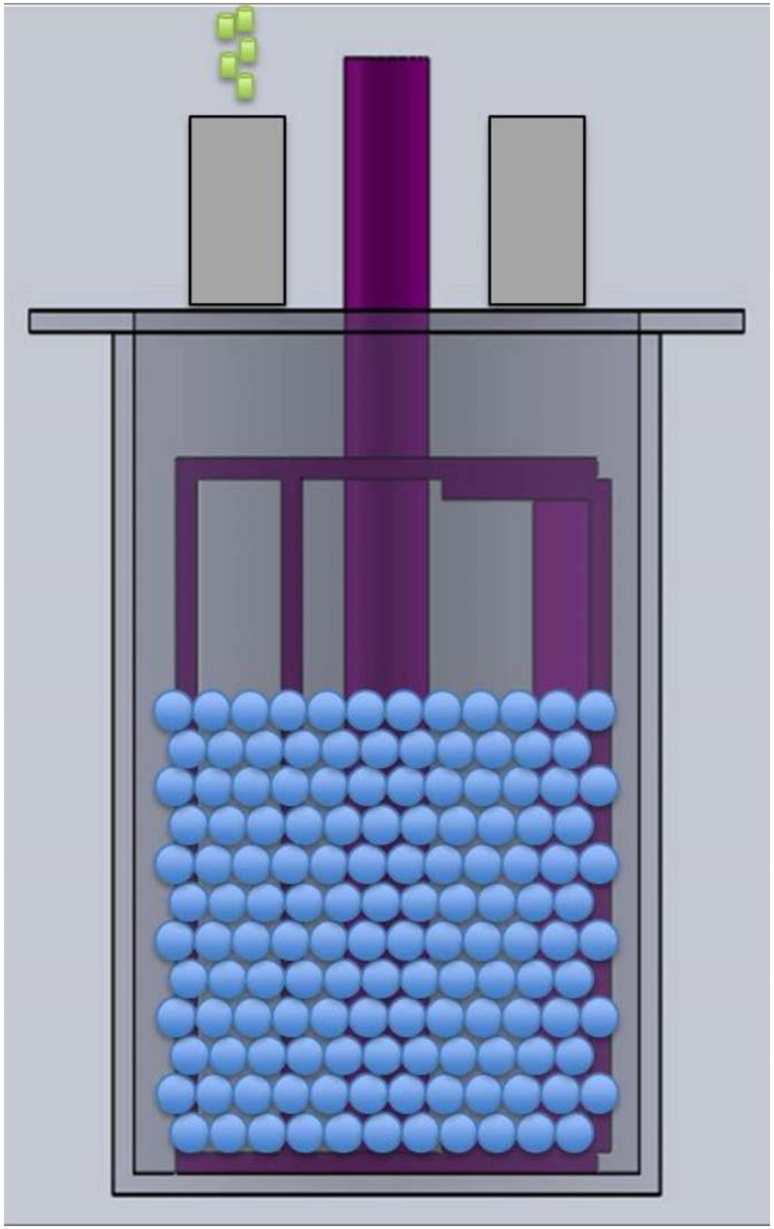
How does the MFR work?

Thesis from Valentina Lago



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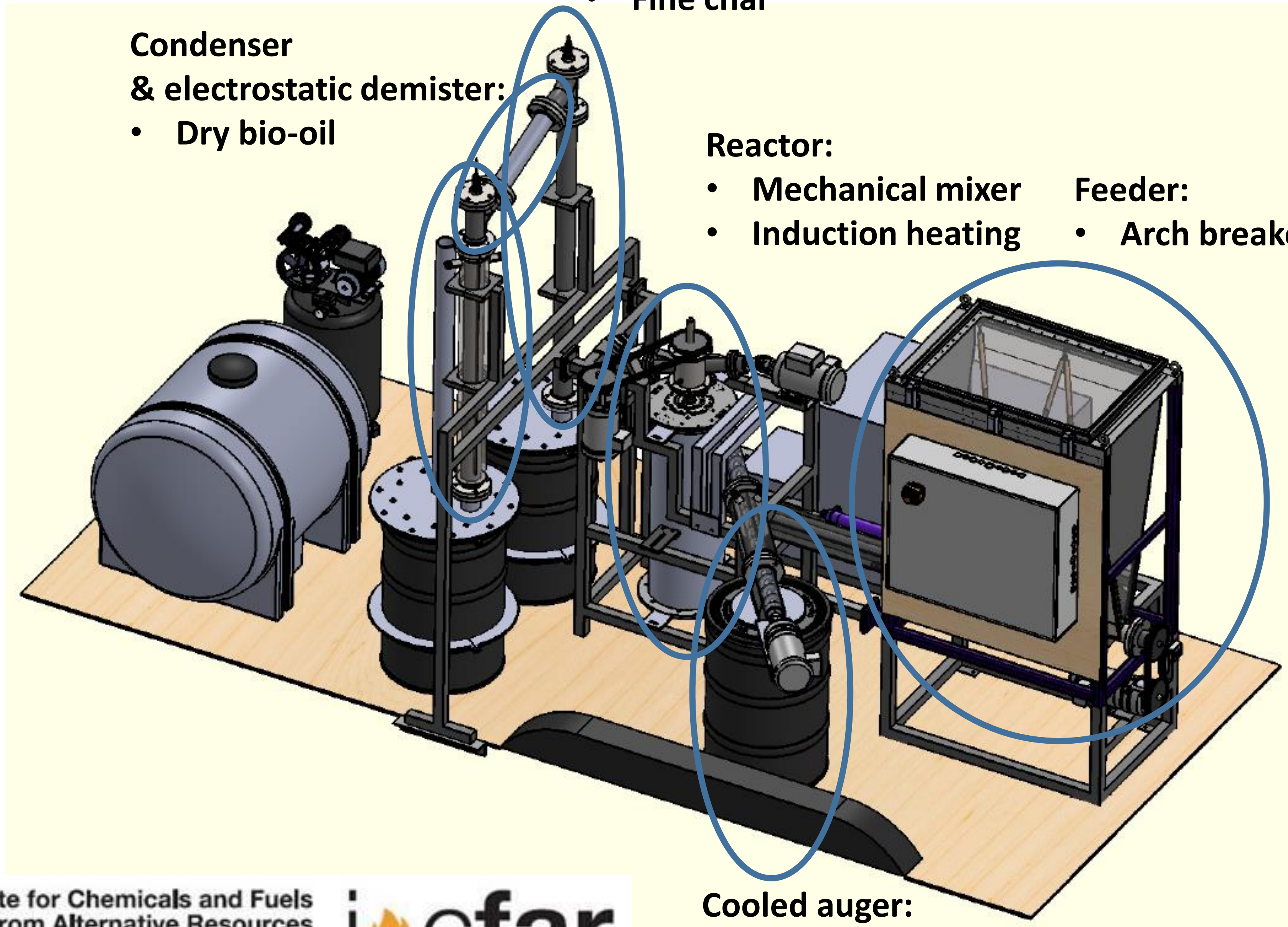

Hot electrostatic precipitator:
• Fine char
Condenser
& electrostatic demister:
• Dry bio-oil
Reactor:
• Mechanical mixer
• Induction heating
Feeder:
• Arch breaker
Cooled auger:
• coarse char

FEATURES	Compact	Easy to Operate	Rapid Heating (20 min)	Feed Flexibility	Pure Char	High value Oil
Mechanical Mixing	☑	☑	☑		☑	
Induction Heating	☑	☑	☑			
Hot Electrostatic Precipitator	☑	☑				☑
Condensation	☑	☑		☑		☑

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:

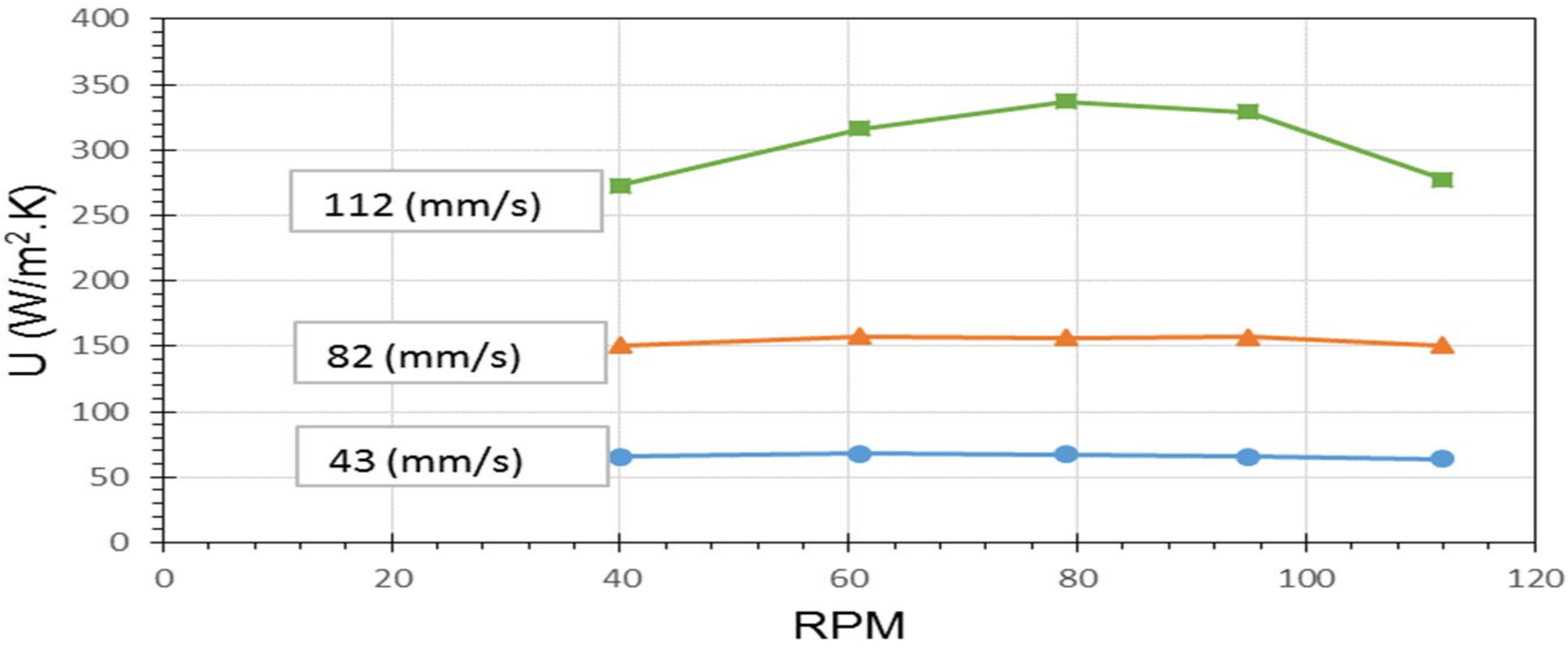
Properties	Units	Sand	Activated carbon
Particle diameter	μm	185	575
Particle density	kg/m^3	2650	750
Heat capacity	J/kg/K	830	1300

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

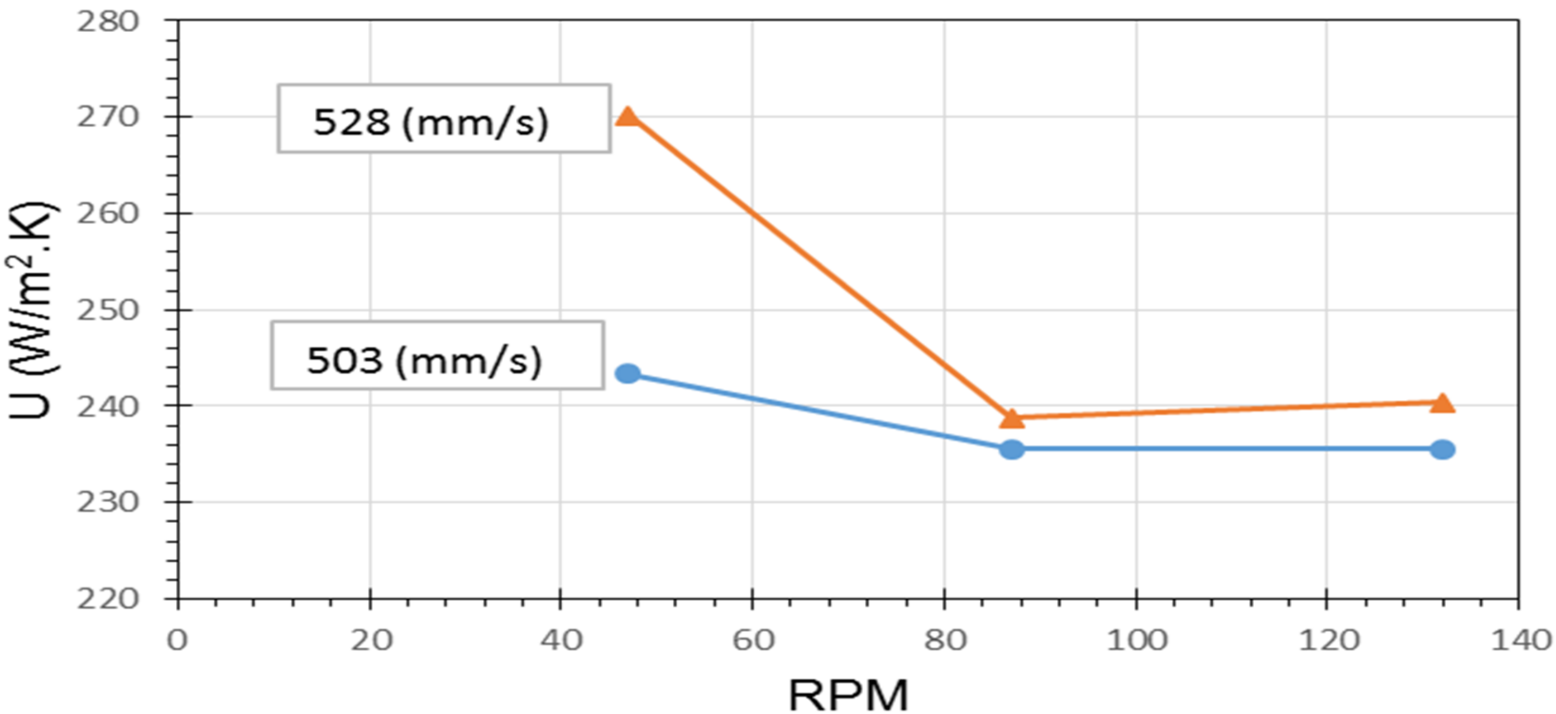
Wall- to-bed Heat Transfer with Sand Bed

FOR SMALL MFR:



Wall- to-bed Heat Transfer with Sand Bed

FOR MFR-1:



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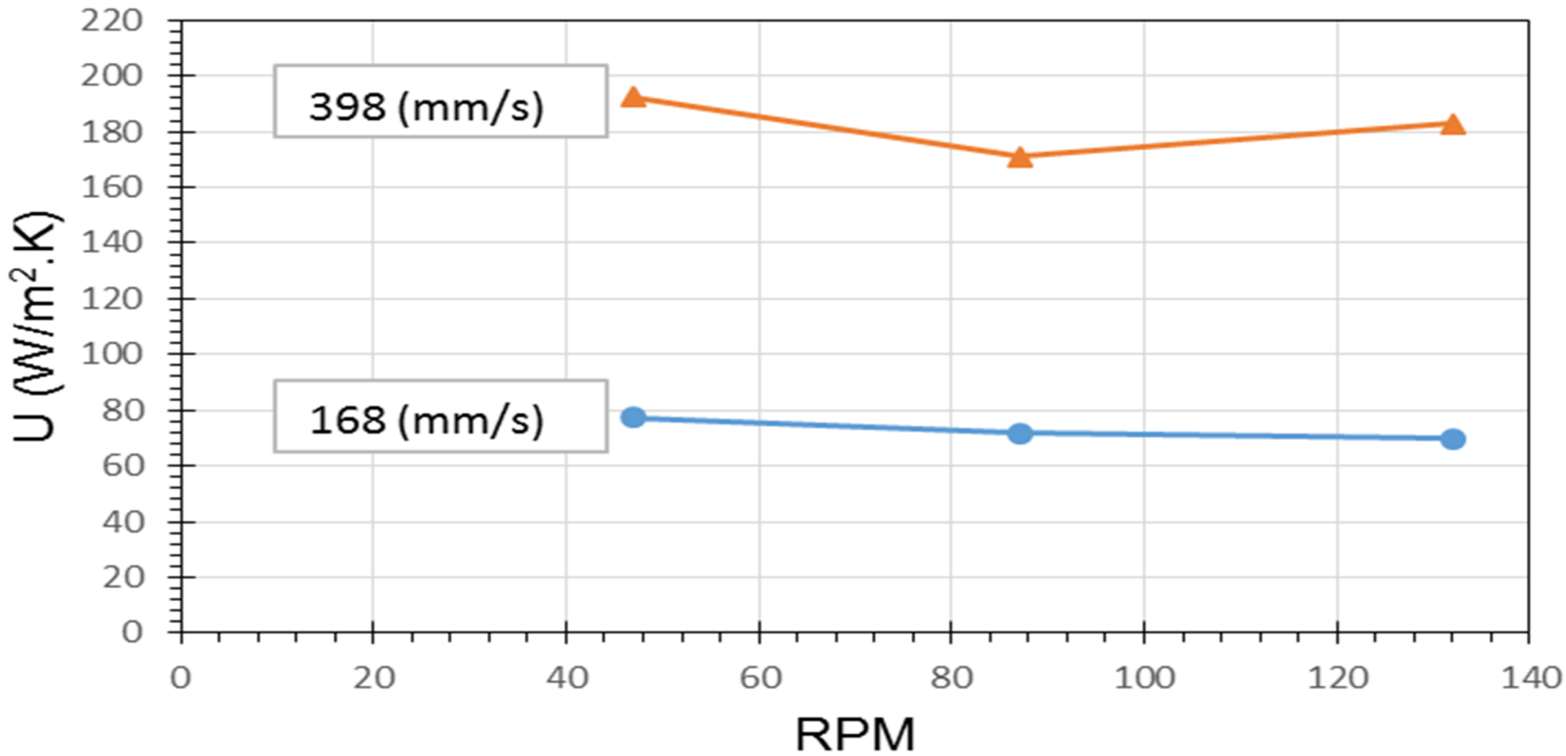
Results:

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:



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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

RÉSEAU BIOFUELNET CANADA

NSERC CRSNG

THANK YOU!

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