

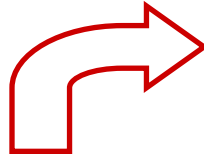


Envergent
TECHNOLOGIES

A Honeywell Company

Pyrolysis Oil Combustion and Co-firing

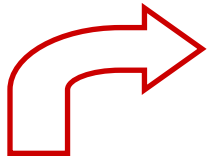
The conversion of solid biomass into a liquid, using the RTP™ pyrolysis technology.



Refined Products

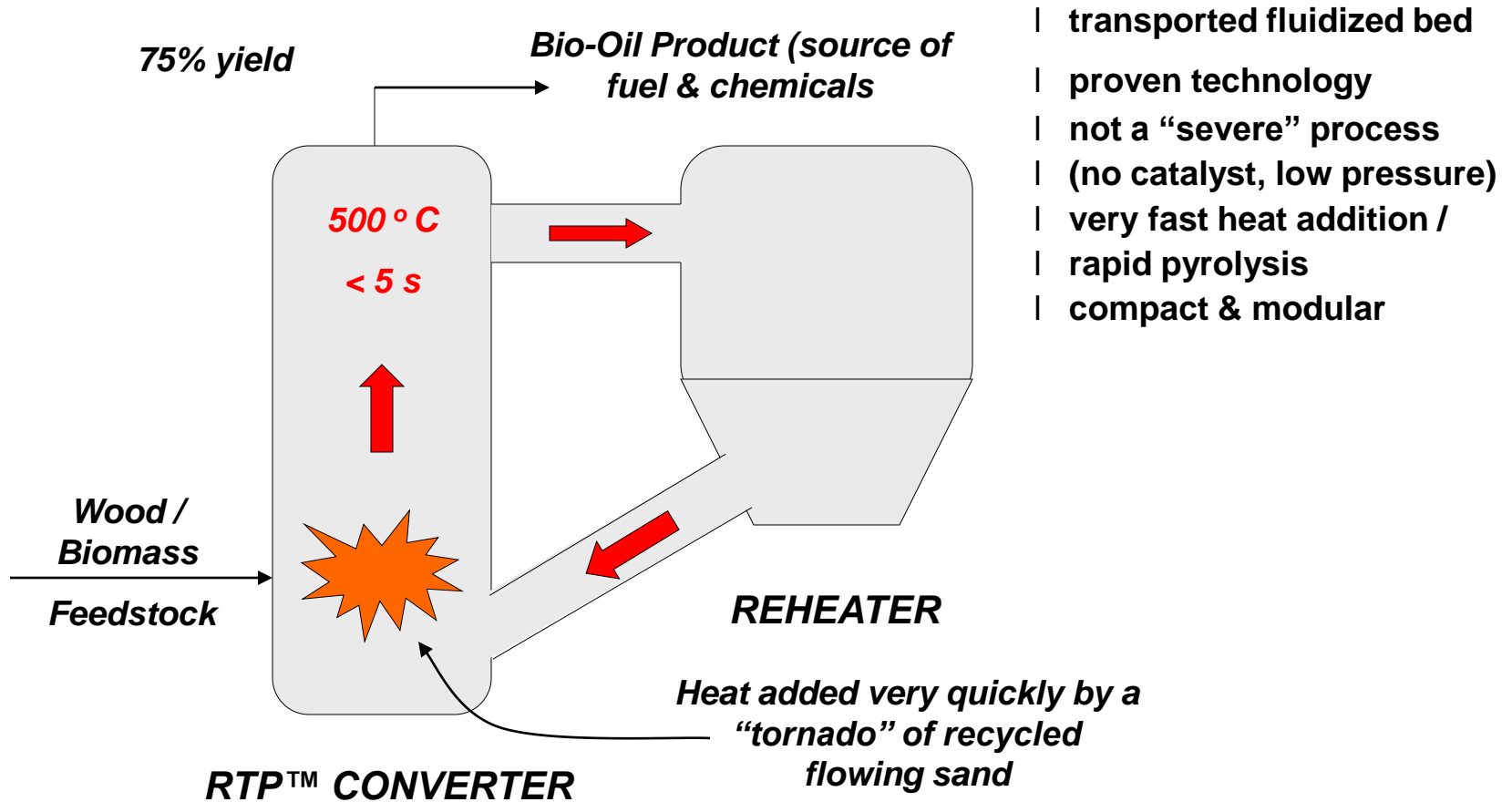
Liquid Wood

(“Py-Oil”)



Wood Residues



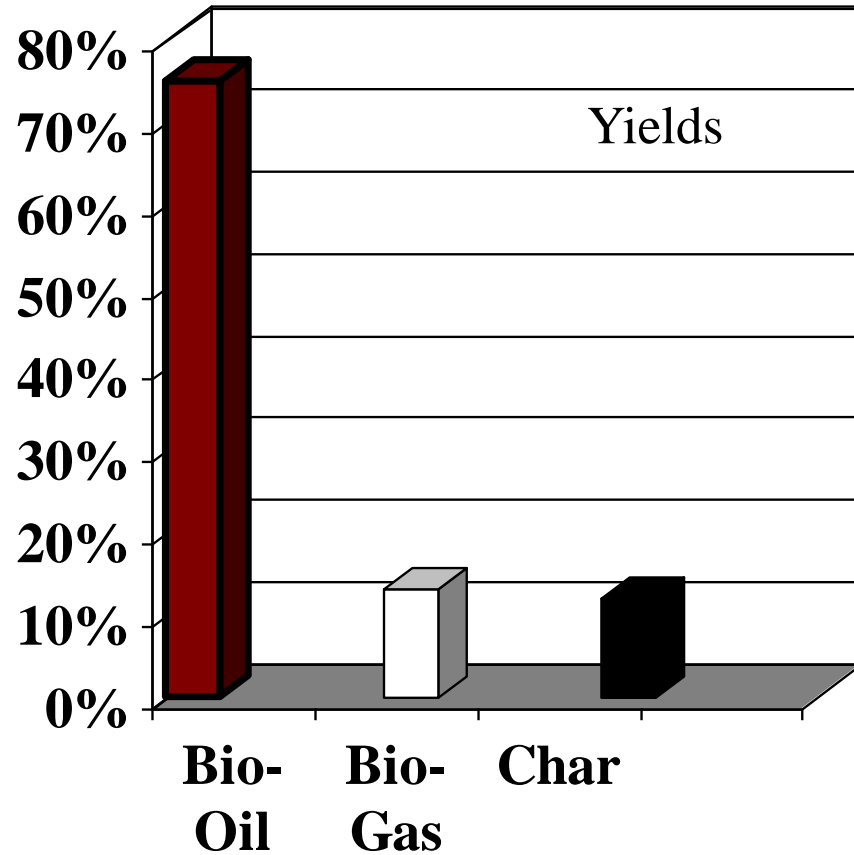
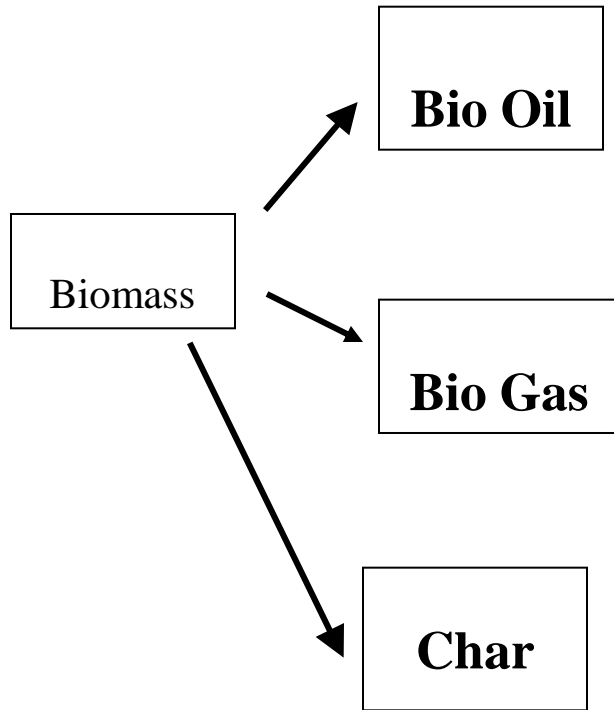


Only company in the world with commercial fast pyrolysis operations

Example of a Commercial PyOil Production Plant



Basic Products



Pyrolysis Oil

RTP BIO-FUEL CHARACTERIZATION

BIO-FUEL PROPERTY	RANGE OF VALUES	TYPICAL VALUES
Moisture (%)	15-31	22-24
Spec.Gravity	1.15-1.25	1.20
HHV (Btu/lb)		
Dry Basis	9500-10400	9890
As-Is (24%MC)	7220-7900	7520
Viscosity (cSt) (at 104°F)	35-53	40
Acidity (pH)	2.8-3.8	3.2
Elemental (%)		
C	51.5-58.3	54.5
H	5.5-6.8	6.4
N	0.07-0.40	0.2
S	0.00-0.07	0.0005
Ash (%)	0.005-0.21	0.05

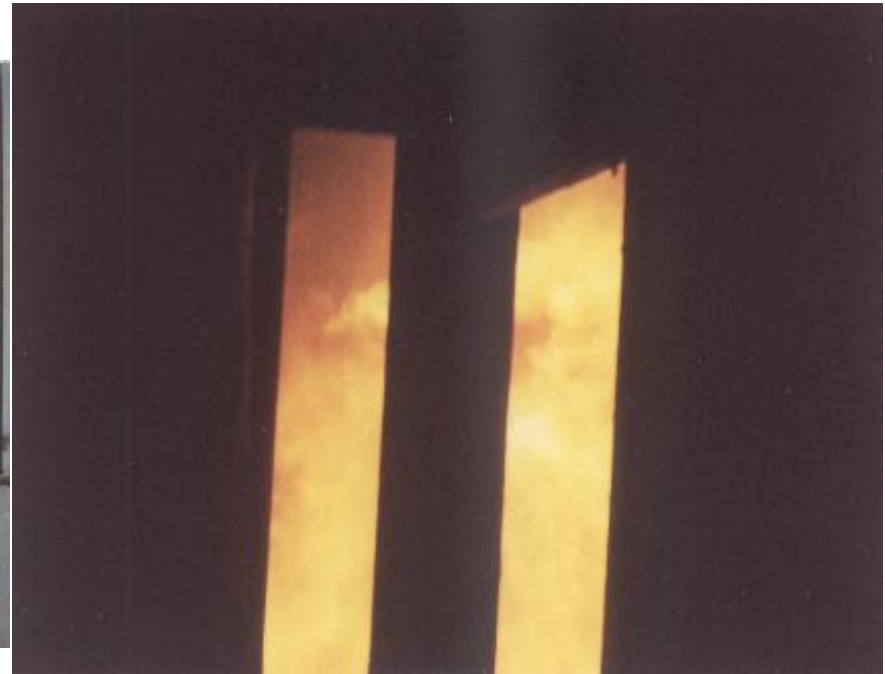
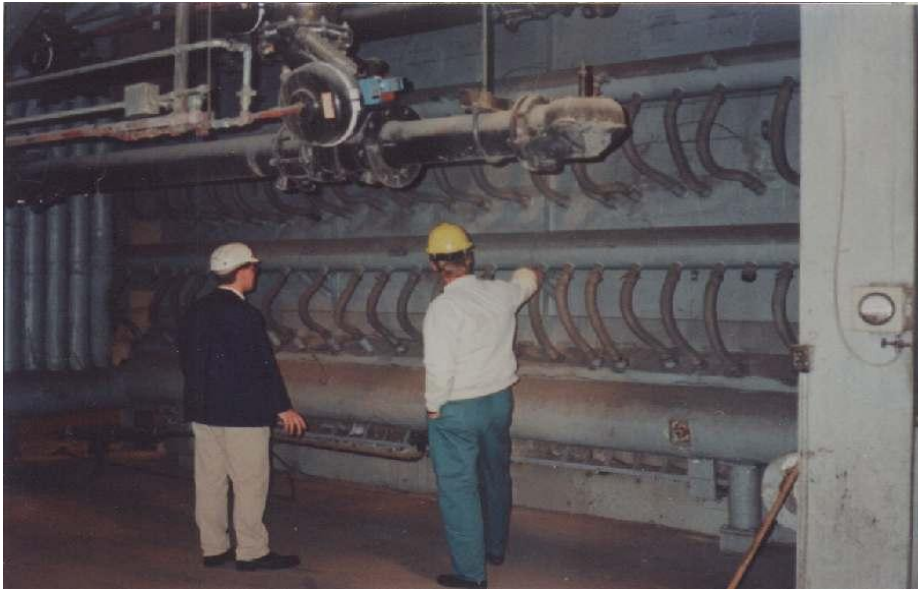
Py-Oil Combustion

- **Py-oil has been combusted commercially for more than 20 years as part of the heating, drying or process steam demands in some facilities using RTP systems**
- **Py-Oil is currently being fired in a pulp mill boiler**
- **Py-oil combustion tests conducted in numerous boiler/combustion systems up to 60 MWth/200 MMbtu/hr**

Manitowoc Public Utilities



Coal Fired Stoker fed Boiler



- **Co-Fired in 20MWe coal-fired stoker fed boiler**
- **Wicks boiler installed in 1954**
- **Bio-Oil Delivered in 4400 USgal tankers**
- **Steam atomized over grate firing of the bio-oil**
- **Approx. 100 USgal/hr firing rate**
- **Total on-stream co-firing time of 370 hours**

Summary and Conclusions

- **A dependable supply of bio-oil was made available to MPU**
- **Simple, cost-effective modifications to the boiler**
- **The combustion of bio-oil was clean and efficient**
- **Bio-oil firing was routine without any power plant inconveniences.**
- **Post maintenance revealed no observed effect to boiler or peripheral equipment.**

Hog Fuel Boiler Co-Firing



Current Industrial Combustion of PyOil

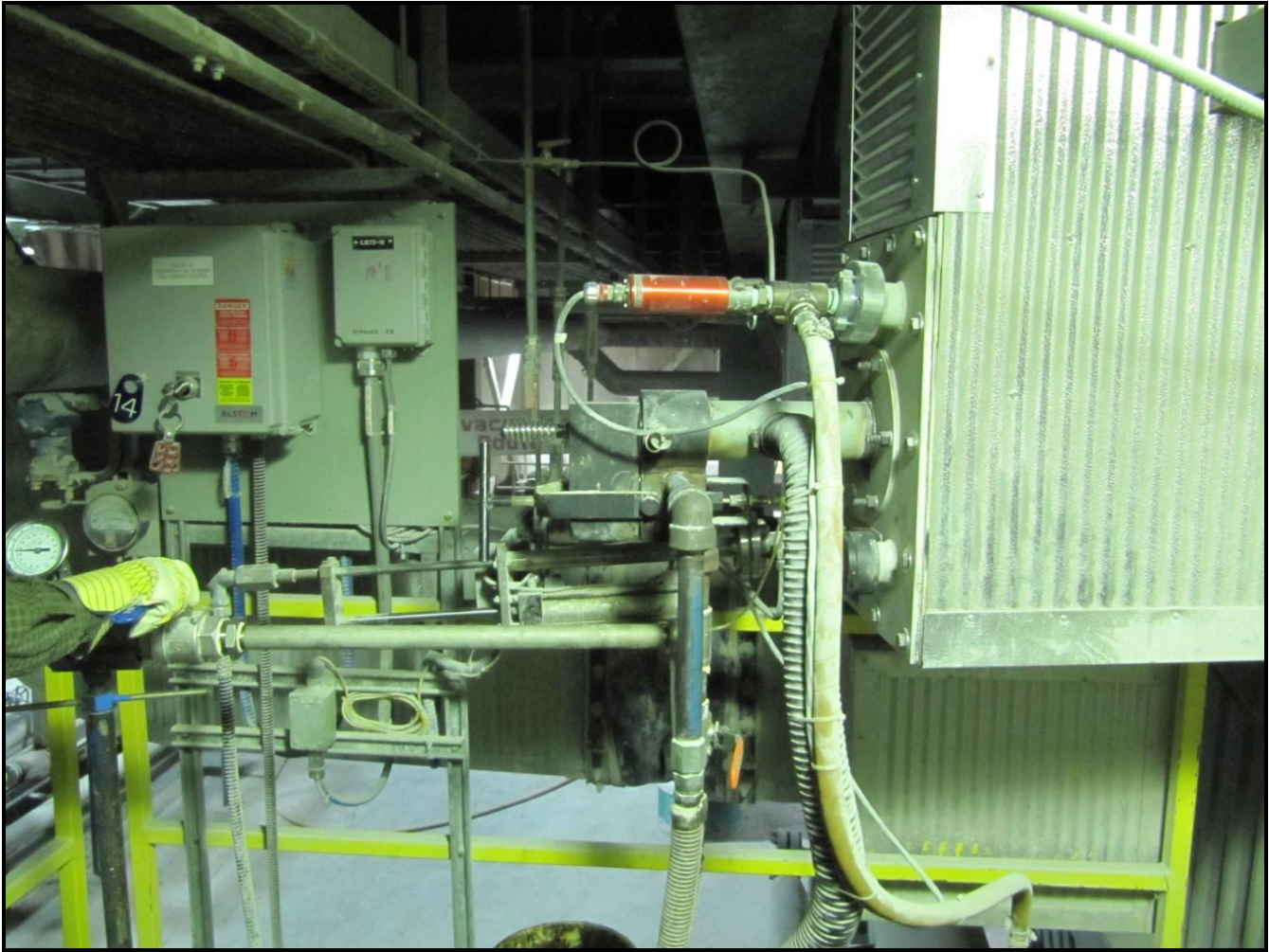
- System and fuel sample sent to a pulp mill in central Canada
- Fuel fired in a power boiler via an existing HFO burner rated at 30MMBtu/hr
- Co-fired with hog fuel
- Produced steam for use in-plant and for expansion in steam turbine for electrical generation (approximately 17MWe total)

Combustion at Pulp Mill

- **Fuel delivery Skid Onsite with Py-Oil Fuel**



Unmodified Burner



- **PY-Oil Flame from site glass behind fuel nozzle**

