



Future Directions: Pyrolysis Oil Upgrading and Direct Biomass Liquefaction

Office of Biomass Program – May 2011

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A Honeywell Company

Pyrolysis Oil Upgrading Challenges

- **Upgrade to Transportation Fuels**

- **Challenges:**
 - Contiguous carbon chain length in biomass?
 - Carbon-efficient condensation chemistry
 - Avoiding polymerization

 - Distributed biomass supply
 - On-site H₂ Generation
 - Capital efficient processing – lower pressures

 - Competitive reactions (O removal, oligomerization)
 - Remove phenols, other bad actors
 - Inhibit oligomerization

Biomass cost requires carbon-efficient, low capital solutions

Direct Biomass Liquefaction

- Shell Hydrothermal Upgrading work
- PNNL Hydrothermal Liquefaction from NABC
- Challenges:
 - Carbon efficiency
 - Viscosity
 - Stable catalyst system
 - Analogies with depolymerization?
 - Capital efficiency – one step?
 - Hydrogen must be generated on-site

Characteristic	Fast Pyrolysis Bio-oil	Hydrothermal Bio-oil
Water content, wt%	15-25	3-5
Insoluble solids, %	0.5-0.8	1
Carbon, %	39.5	72.6-74.8
Hydrogen, %	7.5	8.0
Oxygen, %	52.6	16.3-16.6
Nitrogen, %	<0.1	<0.1
Sulfur, %	<0.05	<0.05
Ash	0.2-0.3	0.3-0.5
HHV, MJ/kg	17	30
Density, g/ml	1.23	1.10
Viscosity, cp	10-150@50°C	3,000-17,000 @ 60°C

Intriguing, but must be “Asset Lite” Model