Direct Coal-to-Liquids (CTL) For Jet Fuel Using Biomass-Derived Solvents

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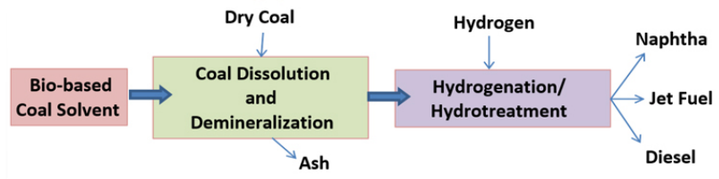
Project Objective

Demonstrate a direct, coal-to-liquids (CTL) process using novel, biomass-derived solvents to produce jet and other distillate fuels, to:

- Promote the use of coal in the face of environmental regulations
- Implement a straightforward path to near-term commercial jet-fuel production
- Conduct pre-pilot-scale testing to demonstrate that the process can substantially reduce capital and operating costs while achieving a substantial reduction in GHG emissions without requiring carbon capture and storage (CCS) at coal-utilization sites

Proposed Technology



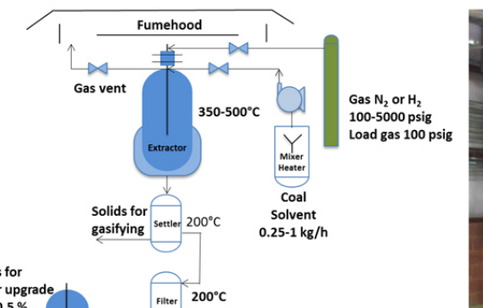
- Straightforward integration of proven subsystems with novel chemistry
- Significant reduction in the capital and operating costs due to mild operating conditions (500 vs. 2500 psi)
- Elimination of CCS at coal liquefaction site and minimization of CCS at the syncrude refining site reduces H2 demand
- Meet jet fuel specifications without blending with petroleum-based jet fuel

Project Schedule

TASK/SUBTASK	Time by Phase and Quarter: Budget Period 1 (FY15) Q1	Q2	Q3	Q4	Budget Period 2 (FY16) Q5	Q6	Q7	Q8
1.01 Project Management and Planning for Phase 1	1							
Monthly								
Quarterly Progress Reports								
Annual Report								
1.02 Lab-Scale Coal Liquefaction & Syncrude Hydrogenation								
1.02.01 Feedstock Selection	2							
1.02.02 Quick Screening Liquefaction								
1.02.03 Bench Coal Liquefaction		3						
1.02.04 Screening of Hydrogenation Catalysts			4					
1.02.05 Down Selection of Operating Conditions				5				
1.03 Pre-Pilot-Scale Coal Liquefaction					6			
1.03.01 Feedstock Procurement								
1.03.02 Syncrude Production								
2.01 Project Management and Planning for Phase 2								
PMP								
Quarterly Progress Reports								
Final Report								13
2.02 Pre-Pilot-Scale Syncrude Hydrogenation					7,8	9		
2.02.01 Pre-Pilot Hydrogenation							10	
2.02.02 Jet Fuel Characterization								
2.03 Process Economics								11
2.04 GHG Analysis								12

◆ Milestones ● Decision Point ◇ Major Deliverable

Liquefaction Facilities



PennState Bench Scale Liquefaction System

Quantex 1 TPD Continuous Coal Liquefaction System

Coal Liquefaction

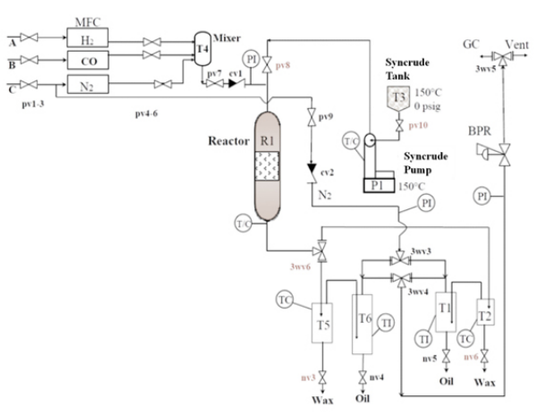
The Battelle Team has identified biomass-derived solvent (bio-solvents) that can achieved greater than 80% coal solubility.

Coal Type and Number of Bio-Solvent Identified that Can Achieve Greater Than 80% Solubility		
West Virginia (High Volatile A Bituminous)	Ohio (High Volatile A Bituminous)	Wyoming (Subbituminous)
12	3	1

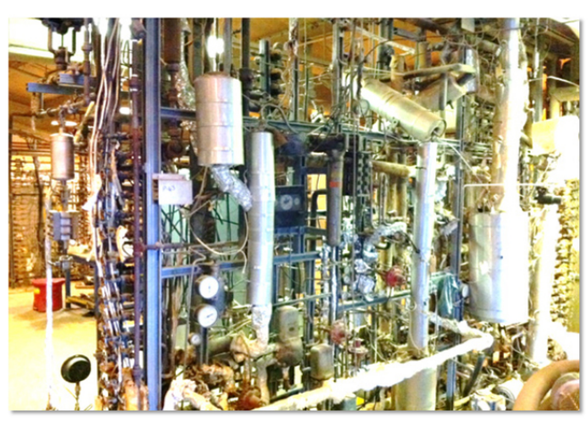
The solubility results were in many cases equal to or greater than liquefaction with tetralin (a typical hydrogen donor solvent).

The process was scaled up to the 1-TPD Syncrude scale.

Upgrading Facilities



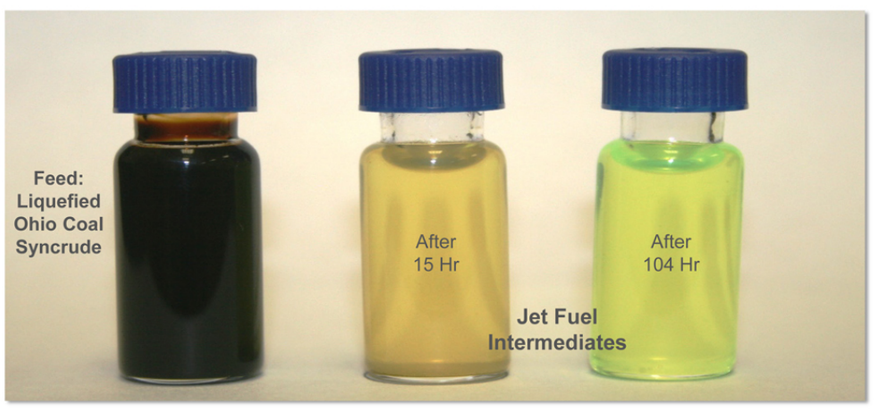
UDRI Bench Scale Hydrotreating System



Intertek's 1 BPD Continuous Syncrude Upgrading System

Syncrude Upgrading – Step 1

The Battelle Team has identified multiple catalysts capable of removing S, N, and O from the Coal Syncrude



Syncrude Upgrading – Step 2

Team has identified catalysts to convert intermediates into jet and diesel fuels