NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Pyrolysis Oil Stabilization: Hot-Gas Filtration

Cooperative Research and Development Final Report

CRADA Number: CRD-09-333

NREL Technical Contact: Robert M. Baldwin

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Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA Number: **CRD-09-333**

CRADA Title: Pyrolysis Oil Stabilization: Hot-Gas Filtration

Parties to the Agreement: UOP, LLC

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources
Year 1	$ 150,000.00
Year 2	$ 00.00
Year 3	$ 00.00
TOTALS	$ 150,000.00

Abstract of CRADA work:

The hypothesis that was tested in this task was that separation of char, with its associated mineral matter from pyrolysis vapors before condensation, will lead to improved oil quality and stability with respect to storage and transportation. The metric used to evaluate stability in this case was a 10-fold reduction in the rate of increase of viscosity as determined by ASTM D445 (the accelerated aging test). The primary unit operation that was investigated for this purpose was hot-gas filtration. A custom-built heated candle filter system was fabricated by the Pall Corporation and furnished to NREL for this test campaign. This system consisted of a candle filter element in a containment vessel surrounded by heating elements on the external surface of the vessel. The filter element and housing were interfaced to NREL's existing 0.5 MTD pyrolysis Process Development Unit (PDU). For these tests the pyrolysis reactor of the PDU was operated in the entrained-flow mode. The HGF test stand was installed on a slipstream from the PDU so that both hot-gas filtered oil and bio-oil that was not hot-gas filtered could be collected for purposes of comparison. Two filter elements from Pall were tested: 1) porous stainless steel (PSS) sintered metal powder; 2) sintered ceramic powder. An extremely sophisticated bio-oil condensation and collection system was designed and fabricated at NREL and interfaced to the filter unit.

Summary of Research Results:

The test campaign on vapor-phase filtration of biomass-derived pyrolysis oil demonstrated that a bio-oil with substantially improved properties can be obtained by application of hot-gas filtration. The ceramic

filter element and test stand supplied by Pall Filter Corp. and the vapor condensation and collection system designed and fabricated by NREL both demonstrated very good operability. Application of periodic blowback was shown to be effective in maintaining the filter element pressure drop within acceptable limits and filter plugging was never experienced. A bio-oil with greatly reduced alkali metal and very low solids content was produced.

Bio-oil obtained by hot-gas filtration with a porous sintered stainless steel (PSS) element had elevated iron content, suggesting that the material of construction is not suitable for this application. The PSS-filtered bio-oil also did not pass the viscosity metric of a ten-fold reduction in the rate of viscosity increase as determined by the accelerated aging test at 80C. Bio-oil obtained by hot-gas filtration with a ceramic (Dia-Schumalith™ sintered ceramic powder) filter element was also low in alkali metals and total solids, and did not exhibit high iron content. The ceramic-filtered oil passed the viscosity metric indicating that this oil should be much improved with respect to storage and transport stability. Total mass loss due to hot-gas filtration was estimated to be in the range of 10 to 30% by weight.

Subject Inventions Listing: none

Report Date: May 3, 2012 **Responsible Technical Contact at Alliance/NREL**: Robert M. Baldwin

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