NABC National Advanced Biofuels Consortium
Biofuels for Advancing America
Developing cost-competitive, sustainable biofuels for today's transportation infrastructure.

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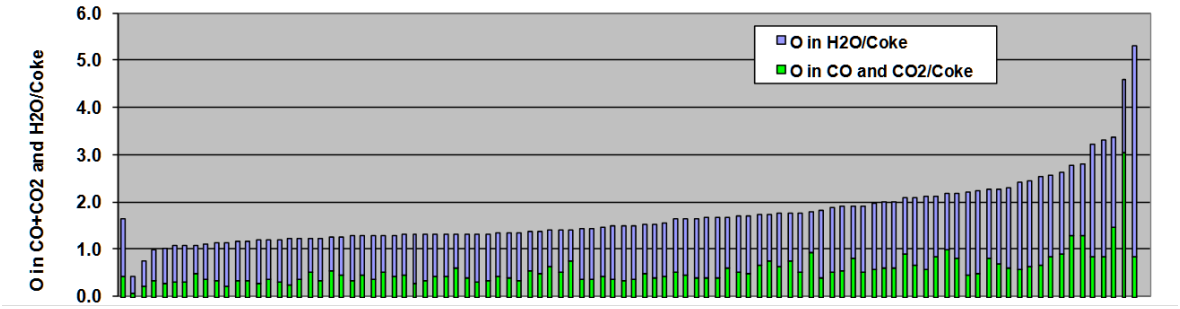
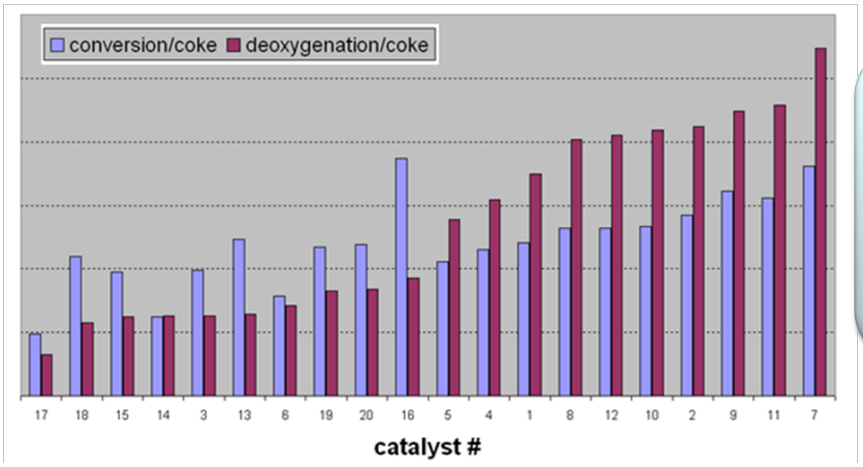
Making Oils with Low Oxygen Content—Catalytic Fast Pyrolysis

The National Advanced Biofuels Consortium is investigating new approaches for producing fuels that can go into gasoline and diesel markets. Catalytic fast pyrolysis (CFP) is one approach that can convert whole biomass into an oil. The goals of the NABC effort are to improve the quality of the oil in two aspects: (1) reduced oxygen content and acidity and (2) reduced hydrogen demand for upgrading the oil to finished transportation fuels.

Oxygen can be removed from biomass catalyzed by three routes. Using hydrogen with a metal-supported catalyst, oxygen can be expelled in the form of water. An acid catalsyt can aid in dehydration routes in which hydrogen is later added to satuate double bonds. Or, oxygen can be expelled as CO_2.

NABC work used fluidized bed reactor systems. At the bench scale a microreactor testing unit located at UOP LLC, A Honeywell Company, was employed to survey and screen catalytic materials' effect on pyrolysis of woody biomass. Close to two hundred materials were evaluated. Many of the catalysts showed high activity for deoxygenation with selectivity toward hydrocarbon products, primarily aromatics.

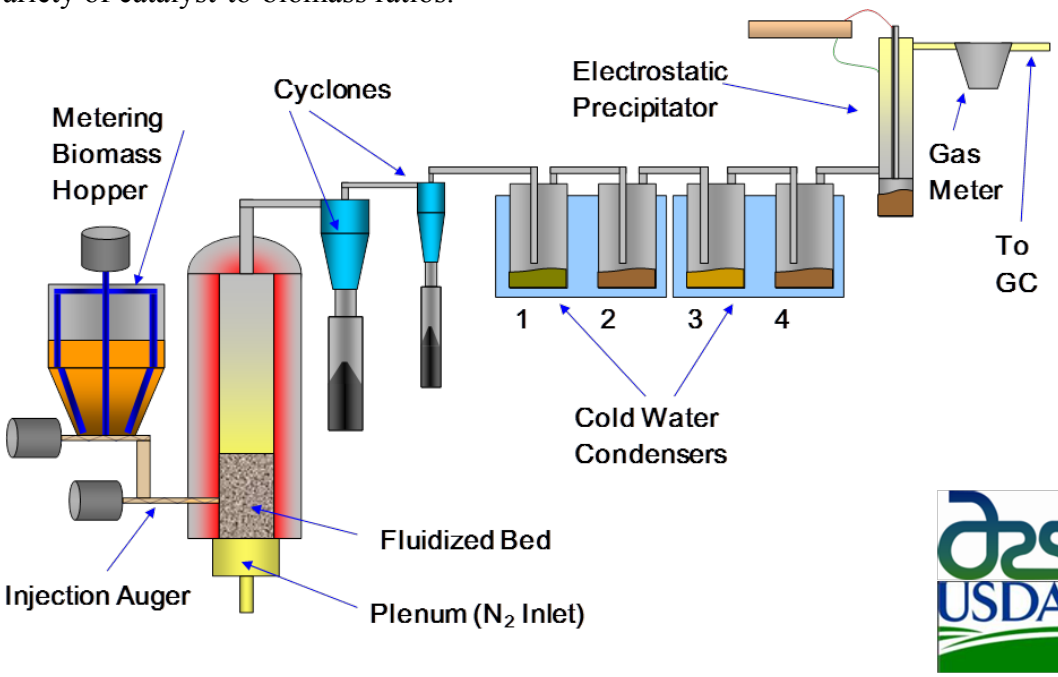




- Examined nearly 200 catalysts
- Tested process variables
- Many showed deoxygenation
- Produced aromatics

The fluidized bed microreactor also provided a tool to test process variables. The two variables of primary interest were temperature and the catalyst-to-biomass ratio. Individual biomass components, such as cellulose, hemicelluloses, and lignin, were also evaluated to determine what types of products were produced from components of biomass.

Larger scale CFP runs were conducted using Ensyn's bench scale pyrolysis unit and an appropriately-scaled pyrolysis unit at the Eastern Regional Research Center of USDA. Since these runs were done at larger scales, the effort focused on catalytic materials available in larger quantities. USDA focused on studying the deactivation and regenerability of selected catalysts. Additional work done at Albemarle, in lab-scale reactors, also studied catalyst deactivation pathways. Runs completed at Ensyn focused on producing larger quantities of CFP product at a variety of catalyst-to-biomass ratios.



Results from these runs successfully demonstrated the high degree of deoxygenation that is possible from CFP. End of run mass balances and product sample analyses from the Ensyn runs were used to calculate both carbon yields and overall mass yields for CFP. Again, these results showed a high degree of success for producing a liquid hydrocarbon product at reasonable yields. Liquid product samples as well as upgraded samples from the Ensyn CFP runs were also supplied to BP and Tesoro for refinery compatibility analyses.

In summary, NABC research on catalytic fast pyrolysis has been done on lab-scale microreactor units and larger bench-scale units. High quality data, with tight mass balance, from the Ensyn reactor adds confidence to the mass yields and selectivities that were obtained. Products produced from this process include aromatic rich oils. UOP, in partnership with Albemarle and Envergent Technologies, is poised to move the technology to commercial practice drawing upon the successful demonstration of the technology under the NABC program.