NABC National Advanced Biofuels Consortium

Biofuels for Advancing America

Developing cost-competitive, sustainable biofuels for today's transportation infrastructure.

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Comparing NABC Products to Petroleum Refinery Intermediates, Blend Components, and Finished Fuels

The NABC Refinery Integration team utilized the Stage 1 product analytical results to characterize the biomass-derived materials from NABC processes relative to typical petroleum refinery intermediates, blend stocks, and finished fuel blends. Specific objectives for this analysis were to (1) compare bulk properties of NABC products to those of refinery streams using published literature sources for refinery properties and (2) based on the comparisons, identify probable insertion points (processing units) for introduction and integration of NABC intermediates into the petroleum refinery. This analysis was based solely on the bulk properties (i.e., boiling curves, gravities/densities, overall elemental compositions) presented in the Stage 1 analytical results. API gravity is a parameter representing a materials density [API gravity = (141.5 / specific gravity) – 131.5].

An example of the means of comparison for this analysis is presented in Figure 1, a data plot of API gravity vs. volume average boiling point (VABP). Using pure component data for paraffins, olefins, naphthenes, and aromatics, constant carbon number lines can be drawn on the plot to explore how varying the hydrogen to carbon ratio (for a constant carbon number) impacts the bulk properties of the material. This plot shows that API gravity decreases with decreasing hydrogen to carbon ratio, while the average boiling point remains nearly constant with constant carbon number (represented by VABP).

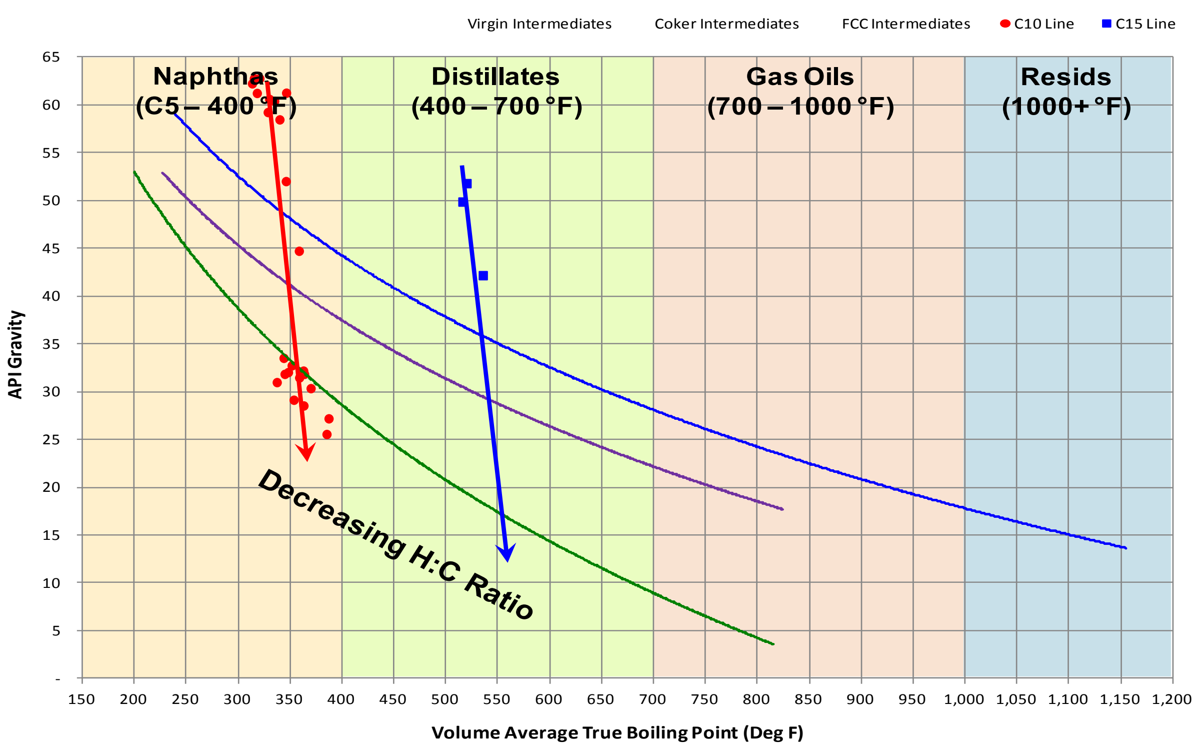

Figure 1. Sample plot with constant carbon number lines for pure hydrocarbon components

Refinery stream data points from published literature sources [1, 2, 3, 4, 5] serve as the basis for comparing the NABC materials. Data from the following refinery intermediates, blendstocks, and finished products are referenced throughout the analysis: virgin or straight run (crude unit) intermediates, fluid catalytic cracking (FCC) intermediates, coker intermediates, gasoline blend components and target finished fuel blend, and diesel blend components and target finished fuel blend. The dashed trend lines shown in Figures 1 and 2 are correlations based on these refinery streams.

NABC Stream Comparisons with Refinery Streams

The first objective of the analysis was to compare the bulk properties of the NABC streams with those of typical refinery streams. Figure 2 presents a comparison of all NABC naphthas, distillates, and heavies fractions with refinery intermediates and typical finished fuel blends (gasoline, kerosene/jet fuel, diesel).

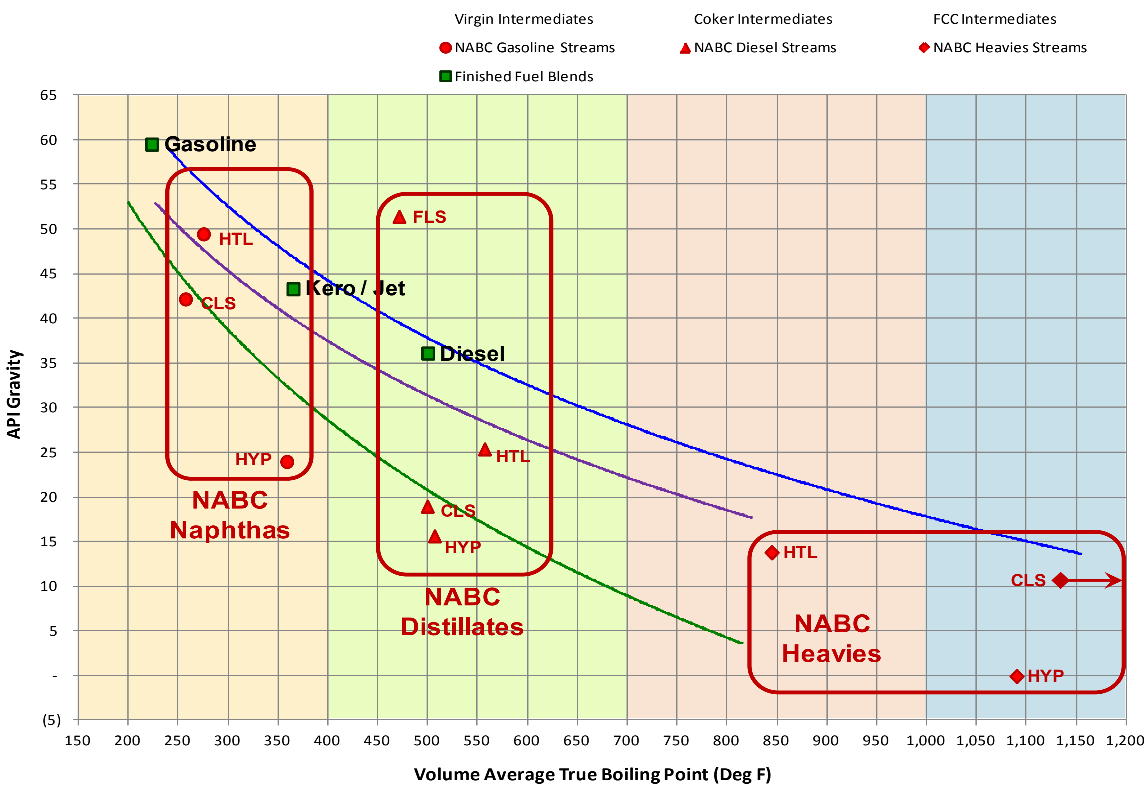

Figure 2. NABC stream comparisons with petroleum refinery materials

Figure 3 provides a comparison of the NABC naphtha and distillate fractions relative to typical refinery blend components for gasoline and diesel products. Blend components and NABC streams utilized in the comparison are as follows:

Refinery Gasoline Blendstocks

LSR = light straight run naphtha
LCN = light cracked naphtha
MCN = medium cracked naphtha
Alky = alkylate
Ref = reformate

NABC Naphtha Streams

CLS = catalysis of lignocellulosic sugars
HTL = hydrothermal liquefaction
HYP = hydropyrolysis

Refinery Diesel Blendstocks

HT SR Kero = hydrotreated straight run kerosene
HT SRD = hydrotreated straight run distillate
HT CD = hydrotreated cracked distillate
HC Kero = hydrocracker kerosene
HC Dist = hydrocracker distillate

NABC Distillate Streams

CLS = catalysis of lignocellulosic sugars
FLS = fermentation of lignocellulosic sugars
HTL = hydrothermal liquefaction
HYP = hydropyrolysis

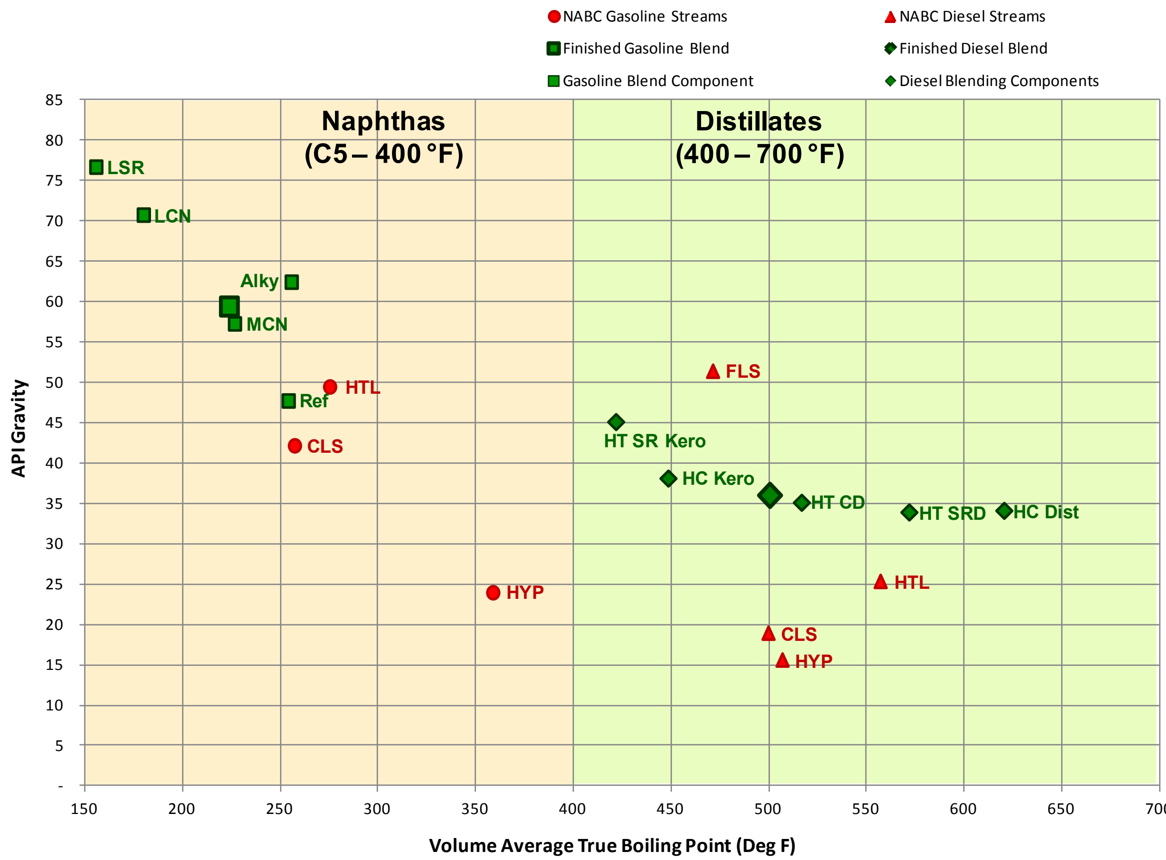

Figure 3. Naphtha and distillate stream comparison with typical refinery blend components

Refinery Integration Assessment

Based on the results from the NABC stream comparisons, the tables below present a preliminary assessment of NABC product cuts and probable refinery process locations for insertion of the NABC Stage 1 materials.

NABC Naphthas	Stream Assessment	Process Unit
Catalysis of lignocellulosic sugars (CLS)	Similar in properties to a refinery reformate material. Possibly directly blended based on bulk properties but mild hydroprocessing may be required to blend appreciable volumes in gasoline pool.	Mild Naphtha Hydroprocessing or Blending
Hydrothermal liquefaction (HTL)	Possibly directly blended based on bulk properties but mild hydroprocessing may be required to blend appreciable volumes in gasoline pool.	Mild Naphtha Hydroprocessing or Blending
Hydropyrolysis (HYP)	Highly aromatic material as it possesses significantly lower hydrogen to carbon ratio relative to typical refinery cracked naphthas (coker and FCC). The material would likely join heavy cracked naphtha refinery streams for hydroprocessing.	Cracked Naphtha Hydroprocessing

NABC Distillates	Stream Assessment	Process Unit
Catalysis of lignocellulosic sugars (CLS)	Resembles the properties of FCC light cycle oil (LCO). Would likely follow the same processing path as FCC LCO.	Hydroprocessing or Hydrocracking
Fermentation of lignocellulosic sugars (FLS)	Highly paraffinic material likely to possess desirable diesel blending properties. Can potentially represent significant diesel blending volumes based on bulk properties.	Diesel Blending
Hydrothermal liquefaction (HTL)	Resembles the properties of FCC light cycle oil (LCO). Would likely follow the same processing path as FCC LCO.	Hydroprocessing or Hydrocracking
Hydropyrolysis (HYP)	Likely to be more highly aromatic than FCC light cycle oil (LCO), which suggests significant hydrogen addition would improve potential for diesel blending.	High-Pressure Hydroprocessing or Hydrocracking

NABC Heavies	Stream Assessment	Process Unit
Catalysis of lignocellulosic sugars (CLS)	Resembles a high boiling point residual material such as vacuum tower bottoms.	Resid FCC, Coker or Asphalt / Lubes
Hydrothermal liquefaction (HTL)	Possesses similar bulk properties to coker gas oil.	Resid FCC or Hydrocracker
Hydropyrolysis (HYP)	Properties resemble FCC heavy cycle oil (HCO) or unconverted bottoms (slurry oil).	Hydrocracker, Coker, Asphalt or Bunker Fuel Blending

References

[1] Parkash, Surinder. *Refining Processes Handbook*. Burlington, MA: Elsevier, 2003.

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[5] GPSA Engineering Data Book