October 13, 2017

Mr. Sam Wade
Branch Chief
California Air Resources Board
Industrial Strategies Division
Transportation Fuels Branch

Re: Staff Draft Discussion Paper "Co-Processing of Low Carbon Feedstocks in Petroleum Refineries"

Dear Mr. Wade,

I am writing to raise some concerns that I have with the Staff Draft Discussion Paper "Co-Processing of Low Carbon Feedstocks in Petroleum Refineries." While I commend the California Air Resources Board (ARB) for its efforts to include increasing amounts of bioenergy in the transportation infrastructure, co-processing has unique characteristics that must be carefully monitored to avoid the creation of unintended but detrimental consequences.

Fluid catalytic cracking of biomass-derived compounds can yield high quantities of coke products

Fluid catalytic cracking (FCC) has an extensive research history as a pathway for the conversion of biomass-derived liquids such as bio-oil (aka biocrude) to renewable hydrocarbon-based fuels such as gasoline and diesel. The literature has widely recognized the tendency for bio-oil, with its thermal instability and polycyclic aromatics content, to yield large quantities of coke when undergoing FCC. While the development of proprietary catalysts that are capable of achieving reduced coke yields has been the subject of much research, these have yet to achieve success at the commercial scale. The bankruptcy of catalytic pyrolysis firm KiOR has been publicly associated at least in part to its inability to reduce the amount of coke yielded by its proprietary process, for example. Furthermore, the literature has also shown that fuel yields and process efficiencies tend to be highest at the bench- and pilot-scales but lower at the demonstration- and commercial-scales where low-value product (such as coke) yields increase.

A concern with co-processing is that, if the feedstock provenance of coke yielded by the reaction is not accurately traced, biomass could be utilized simply to "greenwash" a fraction of the fossil-derived refined fuels produced at a refinery. In other words, biogenic feedstocks could be utilized with co-processing to claim the production of renewable fuels when, in reality, the biogenic feedstock is being converted to low-value coke while the supposedly partly-biogenic refined fuels yielded via co-processing are in fact completely fossil-derived. Such a development would damage the public's trust in all renewable fuels, not just those obtained via co-processing, to the potential detriment of the larger renewable fuels industry. I would suggest that the ARB needs to be completely confident in the accuracy of the analytical method(s) employed to ascertain the provenance of the fuels yielded via co-processing. Given the uncertainties associated with using both

the mass balance and ^{14}C analytical methods, I would further suggest that ARB should consider requiring the product allocation process to be verified via a second analytical method.

A biogenic to petroleum feedstock ratio of ≤10% is too ambiguous

The draft discussion paper's discussion of coke formation during co-processing concludes that "*the approaches discussed here are appropriate for coprocessing with lower biogenic/low CI feedstock to petroleum feedstock ratios (≤ 10%). For higher ratios (>10%), these approaches may need to be modified*" (italics in original) (p. 3). However, Ensyn's public response to the draft discussion paper dated July 6, 2017 states that "as biocrude proportion increases above 10%, and in some cases 5%, many of the conclusions in the ARB draft are correct" (p. 3). While the distinction between 5% biogenic feed and 10% biogenic feed can appear to be a minor one, Ensyn's response points to research published by Petrobras, NREL, and Honeywell UOP in support of the claim that biogenic feedstocks can achieve coke yields via co-processing that are comparable to the yield from petroleum feedstocks, but "typically when less than 5% of biocrude is added" (pp. 2-3). "Less than or equal to 10%" is quite different than "less than 5%" when the distinction determines whether biocrude is converted to coke or high-value fuel. It is important for the ARB to take a conservative approach when establishing the biogenic carbon threshold allowed for co-processing given potential ramifications to both the renewable fuels sector and the Low Carbon Fuel Standard (LCFS) of using an approach that allows a higher threshold but yields more coke.

.In conclusion, I strongly support the ARB's broader effort to increase bioenergy utilization under the LCFS, and I believe that the inclusion of co-processing biogenic feedstocks in petroleum refineries has the potential to contribute to this effort. Given the challenges of accurately assessing the provenance of refined fuels in such mixed-feedstock systems, however, I encourage the ARB to adopt an especially rigorous approach that is confirmed by more than one analytical methodology for the determination of co-processing yields. I also encourage the ARB to take a conservative approach when establishing the maximum ratio of biogenic feedstock to petroleum feedstock. Coke production has been a major hurdle to the commercialization of thermochemical processing technologies to date and, until the ARB is able to thoroughly and comprehensively establish that the fraction of refined fuels that is categorized as renewable fuels is derived from biogenic feedstock, a conservative approach is warranted.

Best regards,

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