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March 22, 2017

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sent via email: LCFSworkshop@arb.ca.gov

Re: WSPA Comments on ARB February 7, 2017 2nd Refinery Co-Processing Working Session

Dear Sam,

The Western States Petroleum Association (WSPA) appreciates this opportunity to provide initial feedback on the California Air Resources Board (ARB) staff presentation at the 2nd Low Carbon Fuel Standard (LCFS) - Refinery Co-Processing Working Session, held on February 7, 2017 in Sacramento, CA. WSPA is providing these comments as part of a continuous effort to provide feedback on the LCFS-related items presented by ARB. WSPA is a non-profit trade association representing companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California and four other western states. On January 16, 2017, WSPA provided feedback on the ARB staff presentation at 1st LCFS Refinery Co-Processing Working Session, held on December 13, 2016. Therefore, the comments provided below augment that prior feedback.

WSPA reiterates the following suggestion made in our January 16, 2017 letter and asks for a response:

"In addition, WSPA suggests adding an element to the Refinery Co-Processing discussion related to co-processed fuel distribution and the challenges related to tracking fuel beyond the process units where the co-processing takes place. Because there is limited ability for verification in a fungible system (for imports and exports), this element deserves discussion. WSPA would not want to see a reporting and verification system that impedes co-processing opportunities."

General Comments

- WSPA believes that co-processing of biogenic feedstock should not have a 10% limit. While there are economic tradeoffs that may place a commercial limit on the amount of biogenic feedstocks co-processed, assessing these tradeoffs is part of normal refinery operations. As long as the product obtained is found to be fit for motor fuel application, there should be no limit on co-processing percent.

- Applicants should not be required to test for ^{14}C to demonstrate the presence of renewable carbon in the products of any units where co-processing occurs, unless the stoichiometric fundamentals of the proposed processing pathway are not clearly elucidated, demonstrated and independently confirmed in the scientific literature.

- A computer model with yield and energy balance of co-processing, calibrated to actual operating data, should be an acceptable method for establishing the renewable content of products from a co-processing

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unit. ARB should accept the utilization of a computer process model with yield and energy balance, calibrated to operating data, to develop renewable content for a co-processing unit. The computer model can be used to determine incremental yields, energy and utility consumption with the biogenic feedstocks.

- As noted in previous WSPA comment letters, ARB should define an acceptable tolerance on CI certification. For instance, if CI is verified to be +/- 5% of the certified CI (or +/- 2.5 CI), there should be neither penalty nor credit reduction associated with the CI discrepancy.

ARB Draft Staff Discussion Paper[1]

Linear Programming Modeling

In the Draft Staff Discussion Paper, *"Co-processing of biogenic feedstocks in petroleum refineries"* (Discussion Paper), Section 7.2.2, it reads: "*The use of Linear Programming (LP) modelling can be a useful tool for calculating incremental emissions."* Experience suggests that LP models are economic models that can be used once there is a good understanding of process yields but LP models are typically not used to infer incremental emissions on new processes or new feedstocks. WSPA requests that ARB verify that the Discussion Paper intends to mean process simulation models instead of LP models.

Refining Process Schematics

It is also suggested that ARB use more realistic refining process schematics when developing illustrations and examples in support of the various allocation methods. For example, Figure 7 of Discussion Paper shows the FCC naphtha intermediate being routed to an alkylation unit to produce high octane gasoline which is not the case. This schematic is further discussed in a subsequent comment. A useful reference regarding process schematics is *"Petroleum Refining: Technology and Economics"*[2].

Volumetric Yields for Co-processed Renewable Diesel, Jet Fuel or Kerosene

WSPA suggests that ARB use more realistic volumetric yields for co-processed renewable diesel, jet fuel, or kerosene. For example, Table 3 of the Discussion Paper cites an assumed volumetric yield of 85% for hydro-treated vegetable oil and tallow. However, the realistic volumetric yield lies very close to 100% due to the difference in density between the biogenic feedstock and the renewable product. Pertinent references on triglyceride hydro-treating are as follows:

- Diesel Fuel Production by Catalytic Hydrogenation of Light Cycle - Toth et al - Top Catal 58 (2015) 948 http://dx.doi.org/10.1007/s11244-015-0463-0

- Effectiveness of CoMo and NiMo catalysts on co-hydroprocessing - Bezergianni et al - Fuel 125 (2014) 129 http://dx.doi.org/10.1016/j.fuel.2014.02.010

- Co-hydrotreating light cycle oil – canola oil blends – H. Wang et al. - Front. Chem. Sci. Eng. 2015, 9(1): 64–76 http://dx.doi.org/10.1007/s11705-015-1504-8

- Hydrotreatment of Vegetable Oils to Produce Bio-Hydrogenated Diesel and Liquefied Petroleum Gas Fuel over Catalysts Containing Sulfided Ni-Mo and Solid Acids – Y. Liu et al. - Energy Fuels 2011, 25, 4675–4685 dx.doi.org/10.1021/ef200889e http://dx.doi.org/dx.doi.org/10.1021/ef200889e

[1] https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/020717_staffdiscussionpaper.pdf
[2] J.H. Gary et al, CRC Press, fifth edition, 2007

- Catalyst evaluation for waste cooking oil hydroprocessing - Bezergianni et al - Fuel 93 (2012) 638 http://dx.doi.org/10.1016/j.fuel.2011.08.053

Other useful literature references are:

- **Hydrotreating of Triglyceride Based Feedstocks in Refineries.** David Kubička, Vratislav Tukač, Advances in Chemical Engineering, Volume 42, 2013 Elsevier, Pp. 141-; ISSN 0065-2377 http://dx.doi.org/10.1016/B978-0-12-386505-2.00003-1

- **Utilization of Triglycerides and Related Feedstocks for Production of Clean Hydrocarbon Fuels and Petrochemicals: A Review.** Iva Kubičková, David Kubička, In Waste and Biomass Valorization, September 2010, Volume 1, Issue 3, pp 293–308 Kubičková, I. & Kubička, D. Waste Biomass Valor (2010) 1: 293. doi:10.1007/s12649-010-9032-8

- **Hydroconversion of Triglycerides into Green Liquid Fuels.** Rogelio Sotelo-Boyás, Fernando Trejo-Zárraga, and Felipe de Jesús Hernández-Loyo http://dx.doi.org/10.5772/48710 in ***Hydrogenation,*** Edited by Iyad Karamé, ISBN 978-953-51-0785-9, 338 pages, Publisher: InTech, Chapters published October 10, 2012 under CC BY 3.0 license DOI: 10.5772/3208

Selection of Preferred Methodology for Co-processed Feedstock Yield Determination

After reviewing all the potential variations of mass-balance and carbon balance accounting offered at the workshop, and the limitations associated with carbon dating analytical methodologies at low levels of co-processed bio-feedstock, WSPA suggests that ARB employ the incremental yield approach based on material/mass balance calculations for co-processed feed rates up to 10% of total unit feed. We recognize that this approach:

- Assumes that the yields of the petroleum based feedstock to co-processing unit remain unchanged as a result of introducing the bio-based feedstock.

- Assumes that the observed overall yield shifts are attributable entirely to the presence of the bio-feedstock.

- Requires adjustment to the above default premise if actual data indicates that the bio-feedstock is substantially impacting base petroleum-based feedstock yields, particularly at the upper limits of any proposed pathway.

- Invites a discussion on how the material balance envelope should be drawn for co-processing pathway applications given the significant variations in feedstocks and processing configurations that are involved. While each application will feature its own individual parameters and conditions, we suggest that, in general, the material balance envelope should be drawn narrowly. Units downstream of where the co-processing occurs (i.e., where the bio-feedstock is introduced) should be excluded from the material balance envelope unless a significant composition and/or yield change occurs to the co-processed product(s) at such downstream process units. For example, a gasoline hydro-treater or "sweetening" unit whose primary purpose is to further reduce the sulfur content of the co-processed product(s) should be excluded from the co-processing material balance calculation envelope.

- Allows ARB staff the flexibility to augment material balance data with additional analytical testing results to establish the bio-feedstock yield profile and its consistency over the entire blend range

comprehended in a pathway application during the application review process and provisional pathway issuance.

- Encourages ARB staff to establish the monitoring plan for co-processing feedstock as part of the pathway application process (including critical path parameters to be included in future validation reviews) and the definition of a "tolerance" (i.e., +/- 5% of the certified CI or +/- 2.5 CI) around co-processed pathway validation results versus the officially-issued (provisional or permanent) CI values in place at the time of an audit.

Validation Frequency and Guidelines for Co-processing Pathways

WSPA requests that an annual pathway validation frequency be recommended once a permanent co-processing pathway CI value is issued. ARB auditors should review the entire preceding 12-month period averages in developing the CI value for comparison with the official CI pathway value. Adjustments should be made to exclude adequately documented non-representative periods from the audit's "annual" average calculation. Similarly, a six-month validation frequency is recommended during the period that a co-processing provisional CI is in force. When assessing the potential follow-up actions associated with the results of validation audit findings, ARB staff should provide auditors with clear guidance that:

- If the audit is part of the recommend 6-month frequency during the provisional period, regardless of whether the calculated average CI value is above or below the issued provisional CI value, there should be no action required of the pathway holder beyond the audit report. The findings will be sufficient to incentivize the co-processing provisional pathway holder to adjust operations as necessary to avoid a sizeable "true-up" at the end of the provisional period where credits may have to be purchased to compensate for the actual (higher) CI values. Similarly, the audit findings should be sufficient to alarm the provisional pathway holder to a potentially significant unfavorable pathway CI number revision as the pathway becomes permanent at the end of the two-year provisional period.

- If the audit is part of the recommended annual audit after the pathway becomes permanent, the pathway holder must buy credits to offset any adverse CI differential identified during the audit within 90 days of the issuance of the final audit report.

Definition of Semi-processed Biogenic Oils

The definition of "semi-processed biogenic oils" needs to be clarified and used consistently. From the Discussion Paper, the following is stated in Section 3.1 (Co-processing):

> Co-processing refers to the simultaneous transformation of biogenic feedstocks and intermediate petroleum products such as vacuum gas oil (VGO) in existing petroleum refinery process units to produce renewable hydrocarbon fuels. Co-processing involves cracking, hydrogenation, or other reformation of semi-processed biogenic oils, vegetable oils and fats in combination with petroleum intermediates to obtain finished fuels such as diesel, gasoline and jet fuels. Research literature suggests that co-processing may provide a significant pathway for utilizing existing refining infrastructure to process biomass, mainly lignocellulosic feedstocks, and increase the supply of drop-in biofuels to the market.[5] Semi-processed biogenic feedstocks that have been identified as likely to be suitable for co-processing include pyrolysis oil from pyrolysis, and triglycerides such as virgin vegetable oils, used cooking oils, and fat-based oils. In addition, lignin and sugars may be co-processed in existing refineries.

The first highlighted sentence suggests that semi-processed biogenic oils are different from vegetable oils and fats; while the second highlighted sentence suggests that the semi-processed biogenic feedstocks (oils?) include

vegetable oils and fats. The definition of "semi-processes oils" needs to be clearly stated if it will be used to refer to a specific set of biomass feedstocks in the future.

Treatment of Alkylation in Co-processing Models

WSPA believes that the treatment of Alkylation in co-processing models needs to represent actual refinery operations. Alkylation is mentioned in several instances in the Discussion Paper. As shown in Figure 7 (below), the Discussion Paper presents a potentially confusing schematic (as noted in a previous comment) where one could assume that the naphtha from the effluent of the FCC unit is injected into an alkylation unit and reacts with petroleum-based isobutene to form alkylates (high octane gasoline blend stocks). The LPG stream from the FCC unit is treated as a finished product and sold as a NG substitute for its energy content.

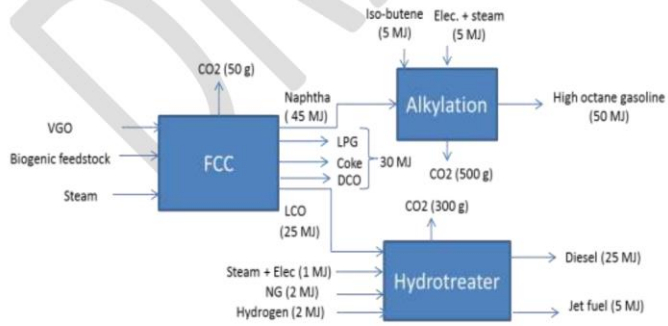

Figure 7. Process level energy inputs, outputs and CO_2 emissions for illustrating process unit level energy and CO_2 allocation

In reality, olefin feed from an FCC unit's Unsaturated Gas Plant (butylene, propylene, amylene) is directed to the Alkylation Unit which also receives isobutene feedstock (some from the FCC but mostly imported). The C7-C9 paraffinic alkylate product is a gasoline blendstock directed to finished product blending. Since the LPG stream from the FCC effluent is typically sent to the alkylation unit and converted to premium gasoline blend stock, the assumption that it will be sold as a process fuel product is inappropriate.

As shown in Table 5 (below), LPG takes up ~11% of total FCC products (CO, CO_2 and coke included). The treatment of LPG in refinery CI modeling is important and should be carefully considered.

Table 5. Estimation of renewable mass of co-processed products (10% pyrolysis oil + 90% VGO example)

Product	M_i (tpd)	X	Renewable mass (tpd) $Mi \times Xa_{dj}$ (%)
LPG	11	0.09	0.99
Gasoline	50	0.09	4.5
LCO	25	0.09	2.25
DCO	6	0.09	0.54
Coke	5	0.09	0.45
Other gases	2	0.09	0.18

Biogenic to Petroleum Feedstock Ratio

WSPA suggests that the Biogenic to Petroleum Feedstock Ratio be more clearly defined. There appears to be a gap between experimentally tested biogenic to petroleum feedstock ratios and those proposed for compliance. The Petrobras pilot data for ^{14}C testing shown by NREL are at very low blend level (<1%). The blend level that ARB used to estimate co-processing potential is 5%. During the Workshop, participants raised the question of the definition of "low blend level", which will potentially become the basis for screening/selecting appropriate biogenic carbon accounting and LCA methodologies. WSPA recommends that biogenic to

petroleum feedstock ratio be clearly defined as the mass ratio between the two feedstocks and that the upper bound for that ratio comprehended in any pathway approval be similarly identified.

As indicated earlier, we are recommending the mass balance (based on incremental yield) approach for co-processed bio-feedstock rates up to 10%. This is an appropriate definition for the upper bound of "low blend level" the basis for which is based on the underlying assumption that the introduction of the bio-feedstock does not change the fundamental yield structure of the petroleum-based feedstock to the referenced refinery processing unit. We feel comfortable that this assumption is valid for such low rates of co-processed bio-feedstock. Nevertheless, WSPA believes that supporting this methodology selection with actual data at blend levels close to the upper bound (10%) is appropriate for low level co-processing pathways and a necessary prerequisite for higher levels of co-processing (>10%).

Hybrid Marginal Allocation Approach

In the Discussion Paper, ARB selected a different system boundary to illustrate the hybrid marginal allocation approach in Section 7.2.2. It is not clear on how a co-processing unit will have two separate streams – renewable fuel and petroleum fuel (as shown in Figure 9 below). The approach outlined in Section 7.2.2 for carbon intensity estimation is not suitable for implementation until properly validated. The hybrid marginal allocation approach may be theoretically sound. However, obtaining the carbon intensity values for refinery baseline for FCC, alkylation, and hydro-treating units requires a tremendous and costly effort, and the variabilities due to different operating conditions may cause significant biases in the biofuel carbon intensity assessments. ARB suggests using the hybrid approach if "biogenic feedstock consumes disproportionately more energy and inputs like hydrogen". The Discussion Paper should specify the minimum quantitative threshold to define the disproportionate energy use.

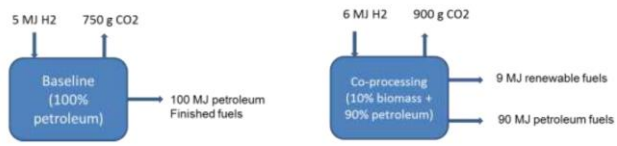

Figure 9. Illustration of the hybrid marginal approach

The steps to calculate the carbon-intensity of renewable fuels using the hybrid marginal allocation approach are as follows:

1. Incremental emissions (A) = $GHG_{CP} - GHG_B$
   Where,
   GHG_{CP} = GHG emissions in Baseline
   GHG_B = GHG emissions in Co-processing

Note: these Figure 9 equations appear to be misidentified.

Co-processing of Higher Levels of Biogenic Oils

While the preceding discussions have focused primarily on low level (<10%) co-processing, it is recognized that additional discussion should occur around how these parameters and methodologies may need to be altered for higher levels (>10%) refinery bio-feedstock applications. It is anticipated that ARB staff will broach this subject in the upcoming co-processing workshops and we look forward to engaging in such a discussion. The Discussion Paper introduces the topic briefly in Section 6 (Summary):

> However, technological and market challenges remain. There are concerns regarding feedstock storage and handling owing to lower stability of pyrolysis and vegetable oils. Also, corrosive properties of biogenic feedstock and presence of impurities such as alkali metals may corrode process equipment and poison catalysts raising production costs. Relatively higher costs of biogenic materials in a period of low crude oil prices may impact economic competiveness of co-processing. However, these problems are not insurmountable. By limiting the amount of biogenic feedstocks to 10% or below and upgrading of pyrolysis oil, it may be possible to diminish the

problems regarding material integrity and catalyst deactivation.

We believe that the highlighted statement is not intended to limit co-processing to 10% biogenic feedstocks in co-processing or only allow co-processing of pyrolysis oil, but merely an attempt on ARB's part to suggest that one of the ways refiners can address potential issues with biogenic feedstocks is to remain at relatively low co-processing levels. At the same time, WSPA believes that it is important for ARB to continue to delineate between the co-processing of pyrolysis oils and other biogenic materials (particularly as it pertains to higher levels of co-processing) and to reiterate that co-processing higher ratios of bio-feedstocks in the future is a desirable objective that should not be impacted by this rulemaking.

Recordkeeping Requirements for Exported Products

With regard to recordkeeping requirements for Exported Products containing blendstocks produced through co-processing operations, ARB has proposed guidance for renewable content in exported gasoline or diesel. WSPA has commented previously on the problematic nature of this potential guidance and its impact on ethanol, biodiesel, and renewable diesel blending. When it comes to the co-processing of renewable biomass, this proposed guidance is even more challenging. Tracking the content of co-processed material through the supply chain would be nearly impossible and canceling out the benefit of co-processed product that may be in exported fuels would be detrimental to the compliance benefit of co-processing. WSPA continues to urge ARB to forego the proposed guidance on accounting of the renewable content of exported gasoline and diesel blends and only consider restrictions related to exports of neat renewable fuels where there is a realistic risk of double counting should these exports re-enter the state. WSPA believes that this is particularly important for co-processed products which, by definition, cannot be separated from their petroleum-based counterparts either at the refinery or downstream in the product distribution chain.

WSPA appreciates this opportunity to provide our initial input regarding the 2nd Refinery Co-Processing Working Session. If you have any questions, please contact me at (805) 701-9142 or via e-mail at tom@wspa.org.

Sincerely,

cc: Catherine Reheis-Boyd, WSPA

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