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HYDROPROCESSING
Questions 28-53

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HYDROPROCESSING

Tier 3 Fuels

Question 53: How are you planning to meet Tier 3 gasoline specifications? Please share your strategies for post-treat and pretreat options, feedstock selection, and catalyst technology? Can renewable feedstocks be co-processed with traditional diesels in an existing ULSD (ultra low sulfur diesel) unit, and how does this impact RINs (renewable identification number)?

[There were no responses to this question during the live session.]

Question 53: Answer Book Responses

ROBERTO AMADEI (Chemical & Energy Development srl.)

A precondition to be carried out of the optimum strategy for compliance with Tier 3 gasoline specifications and ULSD renewable and traditional diesel specifications is the following (already outlined above in our response to Question 7).

The naphtha catalytic reforming unit has to be partially unloaded by subtracting, from its traditional feedstock, the higher-boiling C6 hydrocarbons including naphthenes, benzene, and hexane. Typically, the optimum allocation of this material unloaded from reforming is the isomerization unit. The deriving setup of reforming and isomerization has the potential of generating value in several ways and in no way destroys any value. However, also in case of an allocation of the above material different from the isomerization, its unloading from reforming keeps a significant potential of generating value.

The main components of the optimum reforming plus isomerization setup generated value are the following:

- Hydrogen net production gain;
- Gasoline yield gain;
- Gasoline octane number gain, changeable at will into an additional gasoline yield gain;
- Compliance, with margin, with the most severe limits of gasoline benzene content in the world, such as the 0.62 vol% content required by the United States Environmental Protection Agency, in the U.S. resulting in saleable benzene content credits;
- Significant energy savings, besides the hydrogen net availability gain one;

- Emissions reduction of all of the pollutants and greenhouse gases types, in addition to the above, both in the gasoline production and consumption segments, also carrying out a gasoline lifecycle emission reduction of a few percent of CO_2 equivalent; and

- Higher octane gasoline production capacity increase and improvement of the engine operation and maintenance.

The case study experimental results pointing out the above and the relevant theoretical explanation can, for instance, be seen in the *PTQ* and *Digital Refining 2013 Q1* article, “*Improved Hydrogen Yield in Catalytic Reforming*”, or in the *Gasoline Processes* transcript from the 2011 NPRA Q&A and Technology Forum.

Referring to the particular North American case, we premise that the optimum setup of reforming and isomerization carries out the production of gasoline and hydrogen in lieu of fuel gas. With this due premise, we can conclusively deduce that the above hydrogen gain is much more convenient than the hydrogen production carried out by means of special units consuming the cheap shale gas (SMR).

Precisely, neglecting here the gasoline-fuel gas replacement value, said hydrogen production gain is over three times cheaper, as far as the variable (operating) costs alone are concerned. In fact, in the case of the optimum reforming/isomerization setup, the shale gas should be used, for combustion in the furnaces, in order to replace the fuel gas no longer produced by reforming. In such a way, the rate of substitution of fuel gas by shale gas is 1:1. On the contrary, any use of shale gas for producing hydrogen would require the consumption of more than three units of shale gas (taking into account all of the energy flows, both consumed and produced by the SMR unit) per each unit of produced hydrogen (rate of substitution is >3:1).

Moreover, depending on the specific refineries, the relevant hydrogen gain can even avoid the capital costs of either installations or revamps or even duplications of the special, highly energy-consuming, hydrogen-generation units.

The FCC-gasoline pre-treat and post-treat options, as well as the ULSD processes, consume hydrogen and energy. Furthermore, the FCC-gasoline post-treating causes a reduction of the FCC-gasoline octane number and yield due to saturation of high octane olefins.

It is apparent that the optimum setup of reforming and isomerization – as it provides hydrogen gain, reduction of energy consumption and gasoline octane plus yield gain – counteracts the FCC pre-treat and post-treat options and the ULSD processes’ negative effects. Plus, it provides additional very low sulfur combined reformate-isomerate gasoline blending component due to its yield gain, thus allowing a higher sulfur content of the FCC-gasoline for a given full gasoline sulfur content: this allows you to carry out a further reduction of the FCC pre-treat and/or post-treat options negative effects.

The two last paragraphs outline the qualitative aspect of the matter. As far as the quantities in play are concerned, HOP (Hydrogen OPtimization) analyzes and optimizes the operation and any asset of the specific refinery as a function of the specific refinery plant structure, refinery supply slate, and predicted upcoming additional needs of hydrogen, energy, gasoline octane, and gasoline yield, also providing alternative cases results.

Here we owe an explanation: HOP is an Alliance established between Chemical & Energy Development and Prometheus, rendered very suitable by the worldwide hydrogen thirst that deserves the maximum management efficiency. Chemical & Energy Development brings to the new Alliance its deep knowledge and practice of the specific, above-indicated, technology, and Prometheus brings its deep knowledge and practice of planning and optimization procedures and of refinery engineering design.

The resulting project gives a substantial contribution to meeting the Tier 3 gasoline and ULSD specifications.