Observations to latest RECOPE Project Revision

1) Blending Specifications (Coker-HCU, Case 10)

Specs on most of the products cannot be achieved with the components and the properties of them in the blending. Those properties are either a result of the process configuration or a definition of them.

Gasoline Blending

UOP checked gasoline octanes using the recipes and individual blendstream qualities provided in the study. This check indicated that the proposed gasoline will not meet specification for either regular or premium gasoline. With the existing component properties, the blends where at least 5 octane numbers below the spec for RON and 7 for DON.

CASE 10 - BLEND E95

COMPONENT	WT. %	VOL %	RON	DON
Ethanol	0.08	0.08	111.00	95.00
REF gasoline	0.53	0.50	98.00	94.00
HC Light Naphtha	0.07	0.08	76.00	73.00
DHT naphtha	0.03	0.03	63.00	60.00
HC Heavy Naphtha	0.19	0.19	68.00	63.00
ISO oil	0.10	0.12	80.00	75.00

	RON	DON	AROM VOL.%
Calculated Blend	**89.3**	**83.2**	
Volume Average Blend	88.2	83.1	32.5
Spec	95	91	32.5

The study indicates gasoline will meet aromatics specification, but only shows aromatic content for just two of the blendstreams and using this aromatic content only of two components given by the designer, the aromatic spec is nearly achieved.

In actuality, most of the blendstreams will contain some aromatics. For example, commercial ethanol is not pure, but denatured and will contain some aromatics, same thing happens with hydroprocessing product naphthas, etc.

Reformate cannot be increased significantly in the gasoline blends to correct the octane problem or aromatics will be violated.

The following table indicates how could be affected the aromatic contents, having specs above of 35 vol % (38 vol %) by means of realistic aromatic content in all blendstocks.

CASE 10 - BLEND E95

COMPONENT	WT. %	VOL %	RON	DON
Ethanol	0.08	0.08	111.00	95.00
REF gasoline	0.53	0.50	98.00	94.00
HC Light Naphtha	0.07	0.08	76.00	73.00
DHT naphtha	0.03	0.03	63.00	60.00
HC Heavy Naphtha	0.19	0.19	68.00	63.00
ISO oil	0.10	0.12	80.00	75.00

	RON	DON	AROM VOL.%
Calculated Blend	**89.4**	**83.3**	
Volume Average Blend	88.2	83.1	**35.6**
Spec	95	91	32.5

Additional blending exercises were done using Tables 2 and 3 -Properties for Gasoline Blending Components- and Table 4 -Blending components for Gasoline Pool for 2 cases-from the designer comments.

As a result of the Table 2 in the designer's comments, the table below shows a very different composition of the blendstock used for formulate the gasoline. Even using that recipe, it is clear that all the specs cannot be achieved.

FROM TABLE 2 FROM COMMENTS RECEIVED

CASE 10

COMPONENT	WT. %	VOL %	RON	DON
Ethanol	0.10	0.10	111.00	95.00
REF gasoline	0.61	0.58	98.00	94.00
HC Light Naphtha	0.06	0.07	76.00	73.00
DHT naphtha	0.12	0.12	63.00	60.00
HC Heavy Naphtha	0.00	0.00	68.00	63.00
ISO oil	0.11	0.13	80.00	75.00

	RON	DON	AROM VOL.%
Calculated Blend	**91.3**	**85.1**	
Volume Average Blend	91.1	86.0	**38.4**
Spec	95	91	32.5

As is understood by us, tables 3 and 4 from the designer comments, show the production of 2 types of gasoline in the project, E95 and E91, for case 10 (and 5 also, but not covered here), completely out of specs, as it can seen below.

FROM TABLES 3 AND 4 FROM COMMENTS RECEIVED

CASE 10 - E95

COMPONENT	WT. %	VOL %	RON	DON
Ethanol	0.10	0.10	111.00	95.00
REF gasoline	0.60	0.56	98.00	94.00
HC Light Naphtha	0.00	0.00	76.00	73.00
DHT naphtha	0.07	0.07	63.00	60.00
HC Heavy Naphtha	0.00	0.00	68.00	63.00
ISO oil	0.24	0.28	80.00	75.00

	RON	DON	AROM VOL.%
Calculated Blend	**91.3**	**84.9**	
Volume Average Blend	92.0	86.6	**36.3**
Spec	95	---	35

FROM TABLES 3 AND 4 FROM COMMENTS RECEIVED

CASE 10 - E91

COMPONENT	WT. %	VOL %	RON	DON
Ethanol	0.10	0.10	111.00	95.00
REF gasoline	0.63	0.60	98.00	94.00
HC Light Naphtha	0.12	0.14	76.00	73.00
DHT naphtha	0.16	0.17	63.00	60.00
HC Heavy Naphtha	0.00	0.00	68.00	63.00
ISO oil	0.00	0.00	80.00	75.00

	RON	DON	AROM VOL.%
Calculated Blend	**91.2**	**85.0**	
Volume Average Blend	90.3	85.5	**38.9**
Spec	>91	---	35

In Case 10, the most important specs of octane number and aromatic content for the Premium gasoline are off the limits as can be observed.

E91 spec of octane is achieved, but aromatic content is well off limits.

Finally, the configuration as shown in the LP results will violate gasoline benzene specification if reasonable and real benzene values are used for the gasoline blendstreams. Follow-up information indicated that this problem would be solved by adding a reformate splitter with benzene saturation unit. Although this approach could technically solve the benzene problem, it adds capital and operating cost, reduces octane, and will not resolve the aromatics/octane issues. The naphtha block in this study needs a comprehensive revision.

Jet and Diesel Blending

The cetane value of HCU diesel used in the study may be unrealistic given the expected quality of HCU feed. This may cause finished diesel specification issues which might be resolved by reducing the amount of kerosene processed at the DHT and increase Jet production. In fact, Jet values in the study were higher than diesel so that directionally this move is economic anyway. The constraint appears to be the KHT unit which is at the capacity limit. It may be worthwhile to evaluate de-bottlenecking the KHT unit or considering and additional kerosene Merox treater unit.

2) Light and Heavy Naphtha Splitting

The proposed naphtha split clearly routes the benzene precursors to the reformer feed in cases where gasoline benzene content is a limiting constraint. The given explanation for this is that the new isomerization unit will be built from existing equipment and will be capacity limited such that the benzene precursors must route to the new CCR. This conclusion should be challenged.

Capital and operating costs per unit of throughput are much higher for a CCR than for an Isom unit and especially if the CCR must also include a reformate splitter and benzene saturation unit. Most likely it would be lower capital and operating expense to build a larger Isom unit that takes in the benzene precursors along with a smaller CCR and eliminate the need for a reformate splitter and benzene saturation.

Under these circumstances and especially for a new unit design, it is quite possible to reduce reformate benzene content to extraordinarily low values sufficient to meet gasoline benzene specification. The Isom unit capital costs could still be reduced to the extent possible by using as much of the existing equipment as practical.

3) Coker

The current plan is to build a large oversize Coker with a high recycle rate (up to 50%) in order to convert Coker gasoil to distillate and minimize “investment in HCU unit”. This plan should be reviewed since usually a low recycle/smaller Coker and larger HCU will be far more economic by producing a higher refinery margin at similar or even lower capital cost.

The proposed plan converts some Coker gasoil to distillate, but the distillate will be very poor quality and much of the coker gasoil also converts to coke and fuel which have very low value. The capital cost for this option is high since the Coker is roughly 50% oversized relative to a low recycle operation and requires a larger DHT and NHT.

The high recycle option will have a smaller HCU, but very roughly only about 10% smaller which implies that the high recycle option will have higher capital cost. Finally, the high recycle option will produce lower refinery margin since net refinery coke yield is higher and high value HCU product rates are lower.

4) DHT
In case 10, yields and properties are still incorrect.

For example, in the specific case of Sulfur, less than half the feed sulfur can be accounted for in the products + H_2S.

There should be a correspondence with H_2 uptake and feed quality which was mentioned last time and has been changed. However, there should also be a correspondence between the amount of H_2 uptake and the amount of API/SPG change and cetane upgrade across the unit. This relationship is not properly represented in the study.

5) Reformer

Yields are incorrect with respect to magnitude and direction.
Between Cases 7 and 8, the reformer feed changes significantly with a nearly 50% increase in feed richness (N2A). The yields indicated in the study only change a few tenths of a percent and the indicated changes are in the wrong direction.

It appears that no variation in operating severity was allowed in the analysis. Normal reformer operation includes severity variation which can significantly impact case results.

6) Economic Performance

Only the total combined capex for all processes for a couple of the cases was provided which is insufficient for meaningful review.

In any case, since the preferred option is not feasible with respect to product specifications and some process size and configuration issues are uncertain, the value of further review in this matter is in question.