Question 25: What factors contribute to your decision to place the regeneration section of a CCR in standby mode when the unit is operating in a low-coke mode? Discuss the advantages and disadvantages of the different standby modes (black-catalyst circulation, hot-shutdown, cold-shutdown, etc.).

Peter Eckels and **Ka Lok** (UOP)

If the coke content is very low in comparison with the coke burn capacity of the CCR unit, the operation can be limited in one of a few ways. A minimum gas flow is required to ensure the catalyst is properly dried before leaving the regenerator and returning for reduction. Sufficient flow must be maintained to protect the electric heaters and heat the catalyst for chlorination at low coke regeneration conditions. In some cases, the regeneration vent gas valve or makeup air valve to the regenerator is/are not in a stable control range. These are the consideration factors operating the CCR in standby mode.

There are several basic means of operation if normal White Burn cannot be maintained continuously. These may not all be available for all units.

Grey Burn mode is an operation with a mixture of nitrogen and air to the bottom of the Regeneration Tower to overcome the low flow limitation of the electrical heater. But the oxygen concentration for oxychlorination will be lower than normal operating conditions, reducing effectiveness of metals redistribution. Oxygen control could be harder in this operation.

Black burn catalyst circulation with regeneration allows an even laydown of coke on the catalyst inventory. Catalyst regeneration is operated in intermittently when coke on catalyst reaching the target level. The CCR will have to start with black burn mode first before switching to white burn mode and therefore a small portion of the whole catalyst inventory may not be regenerated in white burn mode. This operation mode uses 100% of catalyst inventory in the system to build up coke and therefore it maximizes the time interval between intermittent regeneration. This mode allows operation to monitor chloride and coke levels on catalyst and enables operation adjustment accordingly.

No catalyst circulation allows coke laydown of coke on catalyst inventory only in the reactor stacks. The catalyst regeneration is done in intermittent manner. This operation mode allows the regeneration in white burn mode continuously. The advantage of this operation mode is operation simplicity because operation does not require switching between black burn and white burn modes. However, the time interval between regeneration could be shorter due to not all the catalyst inventory in the system is available to build up coke.

Soni O. Oyekan (Prafis Energy Solutions)

The current challenges of low coke naphtha operation for the CCRs have been forced due to low severity operations. The low severity operations have been caused by factors such as ethanol blending

and diesel to gasoline price incentives which have led to lower endpoint cut naphtha and low octane severity operations for catalytic reformers. Operating the catalyst regenerator section in the reactivation of catalyst with low coke can lead to significant catalyst and equipment damage. In addition, over several cycles of catalyst circulation, significant catalyst activity declines would occur due to inadequate catalyst reactivations. The greatest challenges, however, in low coke naphtha reforming in CCRs are operations with attendant risks of significant catalyst and equipment damage in the catalyst regenerator.

Catalyst circulation is typically recommended to ensure minimizing the chances for stagnant catalyst layers in transfer pipes that can become plugged leading to possible additional significant challenges in the reactor section. The methods utilized to manage the low coke operation is usually the preference of a specific oil refinery staff and what they are comfortable with. I also recommend catalyst circulation to minimize catalyst transfer plugs and to permit catalyst fines removal. Catalyst circulation would also permit getting a good assessment of the catalyst coke and when to re-start the regenerator section. One of the CCR technology licensors has recommended that their catalyst regenerator equipment could be modified to permit operating at lower coke levels in the low range of 2.0 to 2.5 wt. % coke and you can avail yourself of their services.

To use a proactive process based novel inventions to optimize low coke naphtha operations in CCR units, please review Oyekan, S. O., Rhodes, K. D., Newlon, N. K., US Patent 8,778,823, July 2014 assigned to Marathon Petroleum Company and Oyekan, S. O., Robicheaux, M. G., US Patent Application 2014/0138282 A-1, May 2014.

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