THE CARBON NEGATIVES

Bradford Cook, Sabin Metal Corp., USA, looks at the impact of increasing carbon and coke in spent precious metals catalysts.

A trend has emerged in the petroleum and petrochemical refining industry over the past five years or so as an ever-increasing percentage of carbon is being found within alumina and silica-alumina precious metals (PM) catalysts sent in for reclaim. Some of the material arriving is over 40% carbon, and this has been corroborated by many PM refining companies around the world. This high-carbon trend is creating processing backlogs for precious metals refiners, which is resulting in long delays in metal returns to catalyst owners. This article hopes to raise awareness in petroleum and petrochemical leadership teams, and open further dialogue between the catalyst owners and precious metals refiners to find and implement solutions to this dilemma.

It is unclear whether this high-carbon trend is a result of less in-situ pre-reclaim burning to save time/money on turnarounds, longer process run times, or simply more difficult feedstocks. The most likely answer is that it is a combination of all of these factors. The decision to delay maintenance and turnarounds during the COVID-19 crisis has been quite common, but this high carbon issue pre-dates the virus. The issues of feedstock choice and the analysis of run-time lengths being far more technically motivated decisions, this article will instead focus for the moment on the bottom line that must be addressed: the removal of the carbon.

Not that long ago, it was standard operating procedure for just about every precious metals catalyst user to remove the majority of the carbon, moisture, trace solvents, etc. when

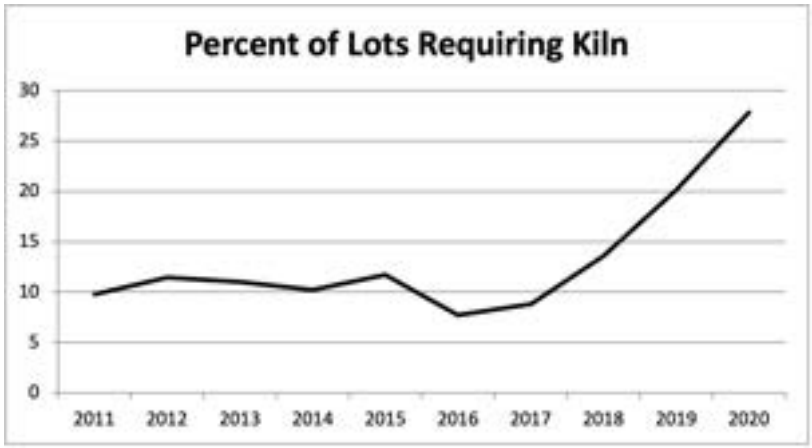

Figure 1. Remaining at or around 10% for at least six years prior to 2011, the rise to the present day is dramatic and clear: three times more carbon and coke than just a few years ago.

change-out was imminent. This was accomplished in one of two ways: the user would either conduct their own pre-reclaim burn in-situ, or the spent catalyst would be sent off-site to a vendor specialising in regen and thermal reduction.

Unfortunately, it has now become much more common for the user to dump the spent catalyst and send it out to the PM reclaimers dirty. The increase in carbon-loaded lots shipped to Sabin (those that must be kilned) is shown in Figure 1.

In-situ pre-burn and the perception of cost savings

Two petroleum customers have provided pre-reclaim burn cost case studies from units with different catalyst types. Although both case studies used essentially the same timeline, for discussion purposes the in-situ regen time has been rounded up to an even 24 hours. Each unit in the study contained 200 000 lbs of catalyst, but different products were being made, so the revenue per day varied – and therefore so did the cost:

US$550 000 revenue/d reactor = in-situ burn at US$2.75/lb

US$945 000 revenue/d reactor = in-situ burn at US$4.73/lb

Average: US$3.74/lb

Suffice to say, precious metals reclaimers charge significantly less than US$3.74/lb for kilning. It would certainly appear from the front-end view that outsourcing the carbon removal is cost-saving, as it allows a faster refinery return to production. This is probably one of the main factors driving catalyst users to choose to forego the in-situ burn, drop the dirty catalyst and send it off for kilning at a much lower rate. These high levels of coke, carbon, and other contaminants are creating significantly higher operating costs for the reclaimers, storage issues, and (not so obviously) the carbon negatives presented in this article.

Why kilning?

Basic sampling theory rightly stresses homogeneity, so there is no getting around the necessity of kilning. The contamination levels within the catalyst, whether they are carbon, moisture, etc., must be eliminated or greatly reduced to make it possible to properly sample. Inaccurate sampling would result in erroneous precious metal content calculations – which is bad for everyone. Additionally, both hydro- and pyrometallurgical precious metals recovery methods require low-carbon feed for best precious metals recoveries and overall efficiency.

Reclaimers are doing what they can to handle this growing need for excessive kilning. The construction of Sabin's third kiln is complete in North Dakota, US, and theoretically this will eliminate approximately one-third of the backlog. The problem is that the dirty stuff just keeps coming; and now the repercussions are being felt by the catalyst owners and the PM marketplace.

The carbon negatives

Increased wait times for final precious metals return

Catalysts that are received clean (that is, with carbon, benzene, moisture, etc. all within acceptable tolerances) can proceed directly to sampling. The typical settlement time for these relatively clean materials (from receipt at the reclaimer facility to final delivery of the precious metal value to the client) is generally three to four months. This includes all processing, laboratory analysis of the samples, and final paperwork agreement and execution. These so-called 'clean' catalysts may have come from a product line that does not generate carbon, benzene, etc., or they may have been burned in situ (the pre-reclaim burn) or sent out for burn at a specialised vendor before shipping to the precious metals reclaimer.

The settlement time when kilning is required is at least twice that long. In some extreme cases, heavily coked catalysts (over 40% or so) require second or third runs through the kilns to reduce the carbon sufficiently. This timeframe includes waiting in line for kilning and the kilning time itself.

Lease rates on platinum (Pt) are currently around 3.5%; however, lease rates on palladium (Pd) are less easily sourced, as it is in sparse supply. Standard platinum content of 0.3% means that leasing costs can exceed US$1000/d. It is not unusual for some catalyst owners to spend closer to US$2000/d on lease fees. In either case, it closes the perceived savings gap by a significant amount.

'Trapped' precious metals

If a PM reclaimer has a backlog at the kilning pinch-point, all of the material waiting in line is just sitting in the warehouse. All of the platinum group metal (PGM) ounces contained have been removed from circulation for the length of the backlog.

Silicon carbide, tungsten and other materials added to automotive catalyst recycling have created similar issues.

Specialised processing is now necessary in the preliminary recycling stream, and there are only a few places that can mitigate the 'contaminants'. Meanwhile, an untold number of PGM ounces remain trapped in inventories waiting their turn. This problem will continue for many years as improvements and changes in catalytic convertor engineering and design are usually done a decade in advance, and therefore the autocatalyst in vehicles hitting the market now will not be returned to the recycling market until those cars are junked – an additional 10 years down the road.

China has effectively closed its export of any PGM catalysts in the last few years. Over 80% of purified terephthalic acid (PTA) production is in China, to name just one market example.

Lastly, the details of the mining industry cannot be ignored. PGM comes from South Africa and Russia almost exclusively. The ore quality in these regions is deteriorating, it is getting more expensive to pull each ounce out of the ground, and demand is not falling.

Call to action

There would appear to be a limited number of possible corrective actions. One solution would be for PGM reclaimers and regen vendors to add more kiln capacity. This is ongoing, but at best can only achieve partial correction. The time constraints created by the excessive carbon content will continue to result in higher lease costs.

Additionally, if the PGM reclaimers raise their kilning prices to near or the same level as the cost of in-situ pre-reclaim burning, the catalyst users will re-evaluate shipping the catalyst dirty. This should have the desired effect over time.

Competition is always encouraged, as long as it can be done on a level playing field. In precious metals, a 'lowest-bidder mentality' is problematic: its consequences are incorrect sampling, inaccurate assay, improper disposal of wastes, or other improper behaviour.[1]

Catalyst owners must calculate the full cost of skipping the in-situ burn and start making this process the norm again. When perceived savings to catalyst owners appear within a single area of fiscal responsibility, and the future repercussions remain somewhat clouded, the type of decision required would have to come from a higher level of management. In short, the 'big picture view' of the upper echelons is critical.

A greater sharing of information between catalyst users and precious metal refiners will help to gain greater understanding of this problem, and industry forums such as the American Fuel and Petroleum Manufacturers (AFPM) and International Precious Metals Institute (IPMI) conferences would seem logical venues to do so. It is advisable to get involved in this kind of industry stewardship and work together to achieve the 'win-win'. HE

Reference

1. COOK, B., 'Protecting the Precious', *Hydrocarbon Engineering,* (June 2019), pp. 41 - 43.