Precious metals are perhaps among the most recycled commodities on Earth, mainly because their value usually makes it worthwhile to spend time and effort to recover them. The process of recovering and refining precious metals has been around for a long time, but even today it remains somewhat of a ‘hidden’ industry. This article aims to clear up some of the most common myths surrounding what is considered both a science and an art for recovering maximum value from spent precious metal-bearing catalysts.

When spent precious metal-bearing materials are reclaimed, there are really only two essentials to consider: accurate sampling and precise analysis of the entire catalyst lot. That is because there are still organisations (or even individuals) who will offer to pay you for the remaining precious metals in your spent process catalysts based upon some unknown (mythical?) and unproved premise instead of actual precious metal content and an accurate assay during the recovery and refining process. A catalyst owner must be aware of this kind of transaction; do your homework, and check your quotes and contracts carefully.

Another area that feeds this myth concerns the recovery and refining process itself: the methods and procedures that ultimately extract the remaining precious metals from spent catalyst lots.

Two methods for PGM recovery

Precious metals refiners typically use one of two methods to recover and refine platinum group metals (PGMs) from spent catalysts. PGMs include platinum (Pt), palladium (Pd), ruthenium (Ru), and rhodium (Rh). Rhenium (Re), which is not considered a PGM, is also present in many spent catalysts and is a valuable precious metal too. These refining methods are pyrometallurgical and hydrometallurgical technologies. There is a clear distinction between these technologies that affects the outcome with regard to capturing the highest possible amount of remaining precious metals in the spent catalyst lot, including Re, now worth about $3000/kg.

Sampling is a series of processes used by precious metals refiners to create a homogeneous mass from spent catalyst lots

After a batch of spent precious metal-bearing catalysts is homogenised and a representative sample drawn, a series of laboratory instrument analysis procedures is conducted, commonly known as assaying. Sampling is a series of processes used by precious metals refiners to create a homogeneous mass from spent catalyst lots which are randomly sampled in order to determine the type and percentage of precious metals remaining in the entire lot. However, in cases where the lot size is large (as it usually is in the petroleum and petrochemical industries), sampling is accomplished from a moving stream (auto sampling). Assaying ultimately enables the precious metals refiner and the catalyst owner to agree on the value of the recoverable precious metals contained in the spent catalyst. Once this is done, the actual refining – the processes that extract the precious metals by one of the two previously mentioned techniques – can begin.

Pyrometallurgical vs hydrometallurgical processing

What happens when spent catalysts contain a significant quantity of Re? Re is usually present in about a third of PGM-bearing hydrocarbon processing catalysts; for example, in combination with Pt for reforming naphthas into other desirable products. While all precious metals refiners are capable of recovering most of the Re content from spent process catalysts on soluble alumina carriers, until recently none has been able to recover virtually all of the Re content. There are many reasons for this, but the main reason concerns the inability to separate the remaining Re with a practical process for its recovery and subsequent refining. This is because refiners recover Re by dissolving their carriers (typically gamma-aluminum oxide) with strong caustic or acidic chemicals (the hydrometallurgical or ‘digesting’ process). While this process is capable of recovering the soluble PGMs and Re content in spent catalysts, an unknown portion of the desirable pay metals, sometimes as
much as 20%, may remain behind due to the insolubility of their substrates or carriers. Insolubility occurs because the substrate may change phase as a result of overheating during years of operation, preventing dissolution, even with strong solvents.

A refiner who uses pyrometallurgical technology (for example, Sabin’s Pyro-Re process) can recover virtually all the Re content from spent catalyst lots (semi-regenerative and cyclic fixed bed), particularly from catalysts on substrates that cannot be dissolved with caustic chemicals. The Pyro-Re process also offers advantages with regard to maximising the return value of all precious metals in the catalyst lot, including PGMs.

Cheaper is not better
Cheapness usually proves to be false economy. Take, for example, a precious metals refiner’s recovery/refining reclamation contract that is five cents lower per kilo than the next lowest quote. The myth here lies in the fact that many refiners are middle men who simply broker materials out to third party vendors. In the precious metals refining industry, there are essentially three categories of refining organisations: full service refiners (those organisations that provide full in-house recovery and refining capabilities, including transport logistics to eliminate transshipping charges and delays for settlement returns); samplers/processors (those organisations which partially process materials, perhaps upgrading them somewhat and combining smaller lots into larger lots); and brokers (companies or individuals who simply buy and sell refining services and use off-site, third party refiners). We have seen some of these organisations promise returns as high as 99.9% of remaining precious metals. The question arising here is: 99.9% of what? We have seen this happen many times over the years, where major refiners award recovery/refining contracts on the basis of a few pennies per pound difference in processing fees. In fact, there are organisations that require the lowest bidder to get the business, no matter what the cost. While they are understandably trying to cut costs, this strategy has little to do with the real money involved; the actual returned value of precious metals in the spent catalysts.

This is another good reason why catalyst owners should consider working with a refiner who provides full in-house processing capabilities, beginning with storage and shipping arrangements and continuing through in-house sampling and assaying, with an open line for the catalyst owner or its representative to be present at any of stage of the process. Middle men simply add margin but no value. Many times, large lots of spent catalysts are sent to two or three different processing facilities, obviously adding costs and delays along the way. When this happens, settlements are delayed, and the catalyst owner may have to finance replacement metals for new catalyst to ensure a seamless process flow.

‘Quality’ precious metals recovery and refining requires skilled people, sophisticated equipment and many years’ experience

The second key issue is the amount of water the catalyst contains prior to a processing campaign which typically lasts for a number of years. The average water content may be listed on the certificate when the catalyst was purchased, but there is no way for the catalyst owner to accurately determine the average water content after the catalyst’s life cycle. The difference here can be significant with regard to total precious metals recovered.

Adding to the myth of actual precious metal-bearing catalyst composition are the other elements that accrue during processing such as coke, carbon, sulphur, and perhaps additives that may have been used to extend their life cycles. All these elements have an effect with regard to final recovery at the precious metals refiner.

However, when the spent catalyst lot is processed by hydrometallurgical techniques, these factors become more critical since they can interfere with the ‘digesting’ method and its ability to capture all of the lot’s remaining precious metals and its Re content as well. This should be clearly understood by the catalyst owner with regard
to which technique – pyrometallur-
gical or hydrometallurgical – is
used for recovery and refining. Also, when conventional pyromet-
allurgical processes are used, everything in an electric arc furnace
melts but the Re may be lost by
vapourisation of its oxide. Sabin’s
Pyro-Re process eliminates this
loss.

Are you getting your original
precious metals back?

Precious metals refiners of any
significant size receive thousands of
customers’ spent catalyst lots every
year. It is obviously not cost-effect-
tive to refine each lot separately;
that is, after the sampling stages are
completed and remaining values
are agreed upon with the catalyst
owner. Instead, think of the entire
recovery/refining process as you
would think about how a bank
works. You deposit your money,
but when you withdraw it you do
not get the same cash back.
Obviously, it is irrelevant that you
get the same cash back because that
is not what matters. What matters
is that your money was counted
properly when you made the
deposit, and that is why proper
sampling and analysis is critical to
help assure maximum returns of
remaining precious metals.

Accurate sampling for maximising
returns

In order to determine commercial
value, the materials must first be
treated or processed to allow them
to be homogenised. Once the mate-
rials are rendered homogeneous,
samples are drawn that represent
the actual precious metals content
of the entire bulk materials lot.
There are a number of ways of
doing this: melting, dissolving into
solution, and blending are a few
examples. Suffice to say that the
method chosen to achieve this
uniform state must be fit for
purpose. The goal is to eliminate
anything that can get in the way of
obtaining that representative
sample, because without that even
the best analytical lab in the world
will be of no use.

Once a precious metals refiner
and the catalyst owner have agreed
on a value, or ‘settled the lot’ as it
is known in the industry, the
money can change hands. Usually
this money is in the form of
high-purity metals returned to a
pool account with a catalyst manu-
facturer so the customer can order
another parcel of fresh catalyst, but
other options are typically available
for the final commercial transac-
tions including replacement metals
and/or payment.

In other words, the catalyst
owner does not receive the same
metal back, only its equivalent in
new metal or cash. In the end,
mathematical calculations deter-
mine the values, and the

Finding and
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Enhancing corporate profitability

Most hydrocarbon and petrochemi-
cal processors operate precious
metals asset recovery departments
in one form or another. These are
typically managed as independent
profit centres which, because of
global economic uncertainties, have
assumed more important roles in
the past few years. Finding and
working with the right refiner can
make a significant difference in
returns, thus enhancing overall
corporate profitability.

There are more than a few unfor-
tunate stories about organisations’
selection of, and relationship with,
its precious metals refiner. There
may be serious legal implications if
the refiner violates environmental
regulations when processing spent
catalysts.

With the dynamics of cost, profits
and possible legal issues, it is

Conclusion

The key to selecting and working
with a precious metals refining
organisation hinges upon due dili-
gence on the owner’s part with
regard to determining all of its
policies and procedures, including
point-to-point transport logistics
which will also reduce costs and
speed processing and thus return
materials’ values quickly. Key
emphasis must be placed on the
refiner’s environmental policies and
procedures.

Pyro-Re is a trademark of Sabin Metal
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