CALGON CARBON CORPORATION

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GOLD EXTRACTION FEATURE

Carbon Selection Vital

°°°°°°°°°°°°°*By William D. Faulkner*

The carbon-in-pulp (CIP) process for gold recovery has now been in use for more than a decade.

Based on this experience, carbon companies and metallurgists are addressing several of the early concepts about the selection and performance of the activated carbon, particularly as they relate to soluble gold loss and/or subsequent efforts to being soluble losses into line. Before commenting on several concepts, it would be worthwhile to scan the history and development of carbons for gold recovery.

Activated carbon can be produced from a variety of base materials, including nut shells, fruit pits, wood, bituminous coal, lower rank coals, and coconut shells. Carbons used in South Africa and North America for gold recovery are almost exclusively coconut shell-based granular types which are also very popular in Australia. Typically, 6x12 or 6x16 mesh coconut carbons are used in pulp, and 6 x 16 or 12 x 30 mesh are used in columns.

Use of chars in gold recovery began in the late 1800s. The 1930s and 1940s were periods of experimentation in North America, resulting in new or improved approaches for carbon use, both in pulverised and granular form. A major breakthrough was reported by J.B.Zadra of the US Bureau of Mines in 1950. He demonstrated that adsorbed gold and silver values could be desorbed from the carbon by low cost procedures, thereby allowing the carbon to be recovered and recycled to the adsorption circuit.

Coconut and other shell-base carbons were the only commercial granular carbons available in North America in the 1930s and early 1940s. At that time, the only commercial use for granular activated carbon was for military gas masks. Metallurgical investigators of that era found that gas mask shell carbon worked better than "homemade" varieties for gold recovery. So they proceeded to develop and improve gold recovery processes.

During World War II granular carbons from other base materials became available. In 1970, the US Bureau of Mines investigated bituminous coal-base carbon for gold adsorption. It found that, from an adsorption standpoint, bituminous compared favorably with the best coconut grades. However, the general perception was that coconut carbons would stand up better in a pulp circuit than other base material carbons. Since coconut carbon was available and worked well, there was little incentive to further qualify the capability of other base material carbons. To complete the historical picture of CIP technology, one significant circuit did use bituminous coal base carbon. Climax Molybdenum company used 8x20 mesh bituminous to recover oxidized moly from flotation plant trails in a 16-million-dollar plant at Climax, Colorado, in the late 1960s.

As coconut carbons evolved from the military gas mask program, it comes as no surprise that manufacturing specifications, particularly the carbon hardness test, can be traced to the US Chemical Warfare Service.

After World War II, coconut carbon became popular in several applications including catalyst support, cigarette filters, solvent recovery and odor control. But none of these remotely relate to metal recovery, recovery of high value substances, or even to liquid phase technology. All are gas phase applications.

These factors contributed to a mismatch between orientation of coconut carbon suppliers and the needs of gold process metallurgists. Unknowingly, carbon manufacturers followed the traditional target of carbon surface area and pore volume. Metallurgists hoped those goals would result in a product best suited for gold recovery. This has not consistently been the case. Calgon research has shown essentially no correlation between the traditional parameters of surface and/or pore volume with adsorption capacity for gold. The same has been reported by Dr. Ray Davidson of Anglo American Research Laboratories.

There is also evidence that rates of adsorption, as well as equilibrium capacity, have been inconsistent. A 1983 report from the Western Australian Mining and Petroleum Research Institute contains this statement in reference to two commercial coconut carbons: "Variations (in rate constants) between separate batches of the same carbon from a manufacturer were as significant as differences between different manufacturers' products in this size range."

Seven Conceptions About Activated Carbon

Some users hold that price and hardness are the main considerations in carbon selection. Although this may be true in some cases, this notion does not generally apply and seemingly has been a contributor to higher gold losses or higher cost for gold recovered.

The following is a list of seven preconceptions about activated carbon that could lead one to the above conclusions.

- The research findings mentioned earlier can lead one to ignore carbon manufacturers activity specifications. Carbon manufacturers have become aware of the need to provide plant operators with carbon possessing consistent gold adsorption properties. Calgon, for example, has learned to control adsorption capacity for gold cyanide. Gold adsorption rate data are currently under development, with specifications being the likely outcome.
- Some users believe that carbons with high adsorption capacity for gold will not strip to low levels. Plant performance is the best proof of how well high capacity/fast loading carbon will strip. Type GRC-22, Calgon's best gold carbon, is routinely stripped to 20-30 gm/tonne in several operating plants.
- Some people are concerned that carbons with superior adsorption properties will also accumulate more base metals or be more affected by clays, resulting in no advantage to their use. Relating to this point, President Brand, South Africa's first CIP plant , was filled with carbon having relatively low kinetic properties. Adsorption efficiency was not satisfactory and the plant inventory of carbon was completely replaced with higher kinetics carbon with satisfactory results. While wholesale switch out of carbon is rare once a plant is in operation, the President Brand plant is not an isolated instance of the event or resulting improvement. Plant conversions to carbon with high capacity and kinetics have resulted in reductions in soluble losses (up to 0.05 gm/tonne solution) and/or improved gold loading on carbon (as much as 100 percent increase). This is not meant to indicate that low activity carbon automatically creates high hold loss. There are plants operating with low activity carbon that achieve low soluble losses (0.02-0.03 gm/tonne).
- Some feel that high activity carbon is softer, therefore carbon losses will be higher than for a less active carbon. Again, plant performance data does not suggest a problem. CIP circuits in North America using GRC-22 carbon have an average virgin carbon make-up rate of 40 gm tonne, with a low of 15 gm tonne. These are plants with five to eight CIP tanks each.
- Some initially think that adsorption tests are simple and straight-forward. Because all activated carbons adsorb gold fairly well, laboratory adsorption rate tests are particularly sensitive to experimental wobble. Testing carbons on synthetic solutions becomes necessary at times, but equilibriating them in barren plant solutions is preferable. For rate tests, Calgon has significantly reduced experimental wobble by using mechanically stirred baffled tanks, compared with wrist action shakers. Rate tests performed on narrow mesh fractions such as 8 x 10 or 10 x 12 are preferable to using wider cuts. A 6 x 10 cut from a 6 x 12 carbon versus from a 6 x 16 MPD significantly affects adsorption rate.
- There is also a preconception that other process variables overshadow carbon differences to the point that all carbons would perform similarly. This certainly can be true. For example, use of a better carbon will not result in a 0.01 soluble gold tail if pulp short-circuiting is the problem. Also, air compressor oils that get into the adsorption circuit can foul any carbon. However, on a relative scale, judging from other applications, a low pore volume carbon is most likely choked by organics and rendered ineffective before a high pore volume carbon.
- Some believe that using more of an inexpensive carbon is equivalent to using less of a higher price carbon. This can involve tradeoffs that can result in higher overall costs. Higher carbon concentration will result in higher carbon losses. Also, the gold loading on the carbon removed from the circuit is likely lower, which in-turn affects capital and operating costs for stripping, recovery, and regeneration.

A vicious cycle could be created whereby the carbon concentration is increased to bring down soluble tails. This leads to more demand on the stripping circuit which, if overtaxed, leads to higher residual gold on the carbon returned to the circuit. This leads to lower efficiency in the last adsorption stage, which suggests the carbon concentration should be increased.

It seems the best case for low activity carbon is made for situations where plant solutions are relatively clean - low in other cyanide complexes that will adsorb, such as copper, nickel, cobalt, and use of sodium alkalinity rather than calcium.

Summary

In summary, selection of activated carbon for gold recovery service includes consideration of:

- Presence of other substances that may affect or interfere with loading of carbon.
- Adsorption capacity.
- Rate of adsorption and desorption.
- Residual gold on stripped carbon.
- Resistance to abrasion.
- Reproducibility of test methods.
- Consistency of product for gold recovery service.

Significant advances have been made in the still-evolving carbon-related technology of gold and silver recovery. In the last decade, great advances have been made in understanding the precious metal adsorption and recovery process, and in tailoring carbons for this specific use. The question of what treatments to give the carbon, from the time it is removed from the adsorption circuit until it reenters the circuit, it now receiving high priority with carbon manufacturers and metallurgists. Carbon manufacturers now pay special attention to attrition and carbon undersize characteristics - aiming to keep these at absolute minimums.

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Mr.Faulkner, who has a degree in metallurgical engineering from the Colorado School of Mines, has more than 10 years experience with carbon/gold recovery applications with first hand knowledge of processes in Australia, South Africa and North America.
Calgon Carbon is used extensively in North America and is now being used in operations in Western Australia. Recently, Calgon was one of two companies selected to provide activated carbon for the largest CIP plant in the world, which is under construction in South Africa.

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