PRODUCT BULLETIN

GRC 20 and GRC 22

Gold Recovery Granular Activated Carbon

Description

The Calgon Carbon Corporation Gold Recovery Carbons (GRC) family of products are coconut–shell–based granular activated carbons specifically designed for gold recovery operations. GRC was developed to be a consistent, high performance, high activity, gold recovery carbon product line. The activated carbon's ability to achieve high gold loadings and the relative ease with which they can be stripped enables gold processors to obtain the highest possible yields from ores with high silver/gold ratios, carbonaceous ores, and ores containing other metals that complex with cyanide, for example copper and nickel.

In Carbon in Leach (CIL), Carbon in Pulp (CIP), and Carbon in Column (CIC) circuits, it is essential that the activated carbon provides excellent process performance, minimal losses due to attrition, and minimal maintenance problems. Through the years, Calgon Carbon Corporation has continually upgraded its manufacturing processes to ensure that it continues to provide high quality products. Steps have been added to the manufacturing process which have improved the carbon's resistance to abrasion and reduced its tendency to plug retention screens in adsorption tanks. Platelets (flatter granules which are relatively long and wide while not particularly thick) can end up oriented in the fluid in such a manner that they pass through the retention screens. This results in a loss of gold-containing carbon, which directly affects percent recovery and profitability. In order to have a product that has less tendency to plug screens with "platelets," GRC is also processed through a vee-wire screen and de-dusted.

GRC products are manufactured specifically for gold adsorption. As a result, the quality of the carbon is extremely consistent and tailored to gold recovery applications. GRC activated carbon can enable the extraction of even trace amounts of gold from every ton of ore, even when processing average or low-grade ores. Calgon Carbon Corporation's expertise in activated carbon application technology is a valuable resource for designing and optimizing your recovery process for transporting, handling, specifying, and regenerating activated carbon.

Features

When GRC carbons are utilized, the features shown below provide individual and combined associated benefits for operating plants:

- High Adsorption Rate – Reduces soluble gold losses, adjusts to ore tonnage and grade. GRC allows a shorter contact time and a faster processing rate for the same activated carbon bed volume.
- Tight Undersize and Screen Distribution Specification – Very low carbon fines and, therefore, minimized gold losses due to undersized carbon particles escaping from the circuit.
- High Hardness Specifications – Lower carbon losses and, therefore, lower gold losses.
- Easily Regenerated – Low operating cost, low carbon makeup, capability to return product to near virgin activity.
- Coconut–Shell–Based Material – High resistance to fracture due to structural stability inherited from the shells.
- Low Concentration Adsorption – The ability to achieve high gold loadings from pulps/solutions containing extremely low concentrations of gold.
- De-Dusted – This extra manufacturing step results in lower carbon losses in the circuit.
- Easy to Strip – Because GRC does not hold the gold complex too strongly, lower soluble tail losses and the maximum efficiency through each stage of the recovery process can be observed.
- Internal Screen Standards – Consistent particle size for steady operation. Kinetics are more repeatable than for carbons with widely varying internal screens.
- Uniform Gold Capacity – Consistent performance means that the circuit parameters don't need to be adjusted as often.
- Bulk Bags or Super Sacks – Easy to handle and store, even outdoors.

Specifications	GRC 20	GRC 22	Test Method ID
Butane Activity by Weight *	17.5% (min)	23.3% (min)	ASTM D5742
Ash Content by Weight	4% (max)	4% (max)	ASTM D2866-83
Moisture Content by Weight**	5% (max)	5% (max)	ASTM D2867-70
Hardness Number	98 (min)	98 (min)	ASTM D3802
Platelets by Weight	5% (max)	5% (max)	Anglogold 1998

*Butane activity correlated to CTC by the equation CTC=2.55xButane Activity

**As packaged

Screen Sizing by Weight		GRC 20/22
Test Method ID		ASTM D2862
6x12	**Min**	**Max**
>6 US Mesh	—	5%
8 US Mesh	50%	70%
12 US Mesh	15%	50%
<12 US Mesh	—	3%
6x16	**Min**	**Max**
>6 US Mesh	—	5%
8 US Mesh	30%	60%
12 US Mesh	20%	55%
16 US Mesh	—	15%
<16 US Mesh	—	3%

- **Butane Activity** (ASTM Method D5742) the ratio (in %) of the mass of butane adsorbed by an activated carbon sample when the carbon is saturated with butane under conditions of the test method.
  - Principle of Method: An activated carbon bed of known volume and mass is saturated with butane vapor. The mass adsorbed at saturation is measured and reported as mass of butane per unit mass of carbon on a percentage basis. The Butane Activity test can be used as a non-ozone depleting substitute for the Carbon Tetrachloride test.
- **Carbon Tetrachloride Number** (ASTM Method D3467-76) the determination of the carbon tetrachloride activity and retentivity of activated carbon.
  - Principle of Method: Pre-dried air is saturated with carbon tetrachloride vapor and passed through a bed of granular activated carbon until there is no further increase in the weight of the carbon. The percentage increase in the weight of the carbon is the Carbon Tetrachloride Number. This method was previously utilized to specify GRC, but due to environmental and health hazards is now determined via an ASTM correlation to butane activity.
- **Hardness Number** (ASTM Method D3802) the determination of the Hardness Number of activated carbon.
  - Principle of Method: A sample of carbon is subjected to the action of steel balls in a pan agitated in a sieve shaker. The resistance of the carbon to degradation by this action is termed the Hardness Number.
- **% Platelets** (Anglogold 1998) the platelet content of 8x16 or larger mesh size coconut shell based activated carbon.
  - Principle of Method: A representative portion of the activated carbon is screened to remove the fines, which are discarded. A sample of carbon is the placed on the wedge wire screen. The screen is mechanically shaken for ten minutes. The quantities of carbon that remain on the screen, that passed through the screen and that are retained in the screen are measured. The Platelet Content is defined as the % through the screen.

Applications

Gold is not always able to be directly recovered. Often the ore is crushed to release the gold which is then recovered using cyanidation. This process is characterized by the following chemical reaction.

4 Au + 8(NaCN) +O2 + 2 H2O = 4 NaAu(CN)2 + 4 NaOH

GRC will adsorb the gold/cyanide complex from the gold bearing stream (pregnant liquor). GRC is selective to gold versus silver, copper, nickel, and similar metals, so it can be used to process ores that contain high quantities of base metals.

Activated carbon is generally employed to extract gold from ores or tailings, including carbonaceous ores which are not recoverable via conventional cyanidation techniques. Among the process applications where activated carbon has demonstrated its adsorption effectiveness are:

- Carbon In Pulp (CIP)
- Carbon In Leach (CIL)
- Carbon in Column (CIC)
- Heap Leaching

- **Carbon In Pulp (CIP)** – The activated carbon granules are added directly to the pulp (cyanated ore slurry). Crushed, ground, and leached pulp is mixed with activated carbon, which flows countercurrent to the pulp in a series of semi-batch adsorbers. Because of their superior hardness, GRC exhibits low attrition during movement/flow, agitation, and activation. The high adsorption rate and capacity of GRC permit gold recoveries as high as 98%.

- **Carbon In Leach (CIL)** – The activated carbon is added directly to the vessels in which the cyanidation process is taking place. Adsorption with GRC can result in recoveries of 97-98% of the gold. This compares with a recovery rate of 50% with conventional cyanidation techniques. Naturally present carbon competes with the activated carbon for the gold. Therefore, after oxygenation, the cyanidation process is carried out simultaneously as activated carbon is brought into contact with ore in the mixers. The superior initial adsorption rate of the GRC minimizes interference with gold recovery associated with "preg robbers" in the ore and thereby results in improved leaching efficiency.
- **Carbon in Column (CIC)** – Appropriate for cases where the gold is already in solution (such as with runoff, soluble gold in a water source, overflow, return water from a tailings dam, etc.), activated carbon columns in series or parallel flow mode are used to collect the gold using packed beds or a fluidized bed (if there is excessive Total Suspended Solids). Packed beds can achieve gold recovery efficiencies greater than 95%; efficiencies of 50-70% per stage are noted with fluidized beds.
- **Heap Leaching** - Low-grade surface deposits and waste rock are candidates for heap leaching. Recoveries of up to 85% can be achieved using GRC.

GRC enables gold mines to take advantage of the economic benefits of activated carbon based gold recovery, which has been demonstrated as being more cost effective than the Merrill-Crowe process.

Calgon Carbon Corporation's Technical Sales Representatives can assist in determining the best use of one of the GRC products for specific applications.

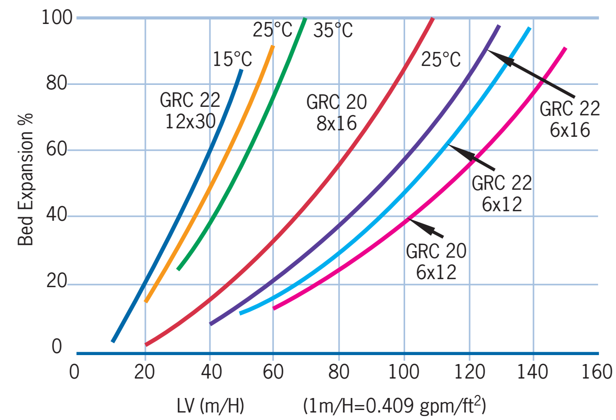
Reactivation

GRC can be more effectively re-used in the gold recovery process after it has been reactivated. This helps to reduce operating costs associated with virgin carbon makeup.

After stripping gold by elution, the carbon's capacity for gold can be restored by thermal reactivation at temperatures in the range of 1100 -1400°F. This process destroys adsorbed organic contaminants without significantly affecting the internal structure of the carbon. This will eliminate any organics such as oils, process chemicals, flotation reagents, and natural organic matter. Reactivation will desorb these contaminants which will then free up the carbon's adsorption pores for the adsorption of the gold-cyanide complex.

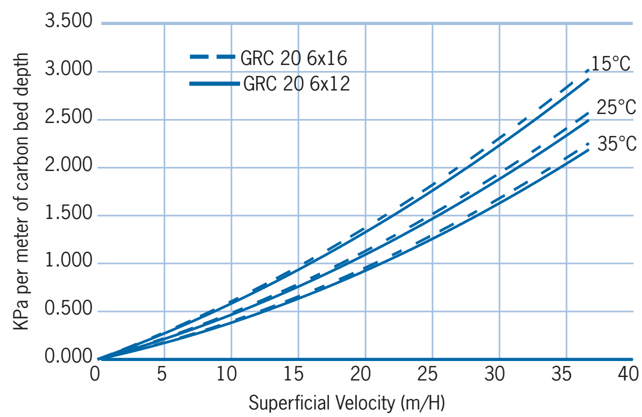
Typical Bed Expansion of GRC Type Carbons

Figure 1



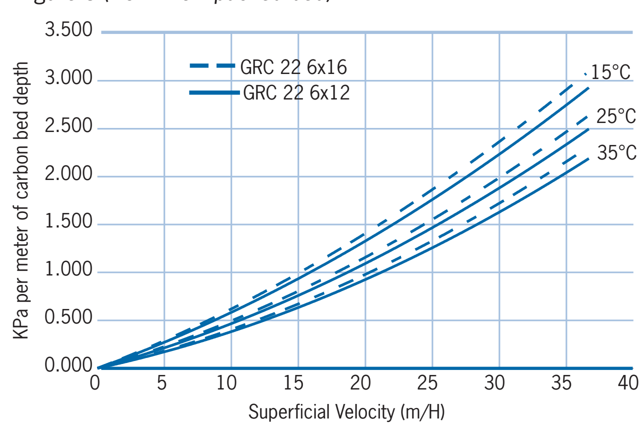
GRC 20 CIC Pressure Drop Curves

Figure 2 (Down flow packed bed)



GRC 22 CIC Pressure Drop Curves

Figure 3 (Down flow packed bed)



Design Considerations

Certain points should be considered when designing a gold recovery operation with granular activated carbon.

- Carbon's Adsorption Equilibrium
- Gold Concentration
- Hardness and Attrition Resistance
- Other Metals - Ag, Cu, & Ni
- Temperature
- pH (Adsorption / Displacement)
- Free Cyanide Concentration
- The Rate of Adsorption
- Regenerability of the Carbon
- Stripping Efficiency
- Particle Size
- Seasonal and Ore Variability

Packaging

1100 lb/500 Kg super sacks also known commonly as bulk bags

Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low-oxygen spaces should be followed, including all applicable federal, state, and local requirements.

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