GOLD SORB ACTIVATED CARBON

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Jacobi CARBONS

Activated Carbon for Precious Metals Recovery

Jacobi Carbons manufactures the GoldSorb® range of activated carbons from high grade coconut shell raw material in modern purpose built facilities using horizontal rotary kiln activation techniques. GoldSorb® activated carbons are highly uniform granules, which are specifically designed for use in precious metal recovery circuits. These materials are proven adsorbents which are used extensively in carbon-in-leach (CIL), carbon-in-pulp (CIP) and heap leach/carbon-in-column (CIC) circuits.

- High rate of gold loading
- Maximum rate of gold elution
- Excellent resistance to attrition
- Low platelet content
- Trace undersize content

Tailor-made products can be manufactured to meet individual plant operating requirements. Specialist information and specification data for the full range of GoldSorb® adsorbents are available on request.

PROPERTIES OF GOLDSORB® ACTIVATED CARBON (AARL METHODS)

Grade	Type	Form	K-value	R-value	Attrition %	Platelets %	Comment
4000	Coconut	Granular	22	45	1.0	5	Excellent product hardness – minimum attrition
4500	Coconut	Granular	26	50	1.0	5	Medium activity carbon – widely used in CIP/CIL
5500	Coconut	Granular	28	60	1.5	5	High activity carbon - used in CIP/CIL and CIC
6000	Coconut	Granular	32	65	1.5	5	Maximum rates of gold loading

GOLDSORB® – PARTICLE SIZE SPECIFICATIONS, US SIEVE (ASTM D2862)

Particle Size, USS	+6 %	+8 %	-12 %	-14 %	-16 %	-30 %	Comment
6x12	3	-	1				Used in CIP/CIL circuits
6x16	3	-	-	-	1		Used in CIP/CIL and CIC circuits
8x16		3	-	-	1		Used in CIP/CIL and CIC circuits
12x30			3	-	-	3	Used in CIC circuits

GoldSorb® activated carbons are used extensively in CIL, CIP and CIC gold recovery operations around the world.

The Heap Leach/Carbon-in-Column (CIC) Circuit

Carbon-in-Column circuits are employed to recover gold from heap leach operations. Heap leaching is used as a low capital and operating cost method of recovering gold from low grade surface deposits and waste rock.

The process involves building heaps of crushed and agglomerated ore and dripping sodium cyanide solution through the heap to leach the gold into solution. The gold bearing solution runs into the pregnant solution pond. Two major variables must be considered when selecting a heap leaching process: the permeability of the ore and the percolation of the leach solution through the heap.

CIC TYPICAL DESIGN PARAMETERS

Treatment capacity	100000 t per month
Gold head grade	1.6 g t^{-1}
Pulp flowrate	180 m^3 h^{-1}
No. of CIC contactors	6
Diameter of CIC contactors	2.0 m
Depth of activated carbon	1.3 m
Mass of activated carbon	2 t per contactor
GoldSorb® gold loading	4000 gAu t^{-1}
Adsorption efficiency	99.0%
Comment	Data based on GoldSorb® 6000 12x30 US Sieve

For easy conversion to imperial units, please visit www.jacobi.net and use FastConvert™.

The pregnant solution resulting from a heap leach is pumped to a series of columns containing GoldSorb® activated carbon. The adsorption columns must be correctly designed to ensure efficient contact of the GoldSorb® activated carbon with the solution to obtain optimum adsorption efficiencies. If correctly designed, the losses of GoldSorb® activated carbon due to attrition are usually lower in CIC circuits than in CIP and CIL circuits.

Most solutions resulting from heap leach operations are unclarified and consequently CIC adsorbers are operated in upflow mode. CIC can also be used to recover gold from return dam solutions, uranium plant primary filtrates and spent regeneration aqueous streams. The loaded GoldSorb® activated carbon in CIC adsorbers is usually acid washed, stripped and thermally regenerated.

THERMAL REGENERATION

During the adsorption process, the activated carbon is contaminated with organics which are present in the circuit. These may be naturally occuring in the gold ore, or due to contamination from gearbox motor oil, flotation reagents or similar sources. The effect of these organics deactivates the GoldSorb® activated carbon and therefore they have to be removed prior to returning the GoldSorb® activated carbon to the adsorption circuit.

Thermal regeneration is used in CIL, CIP and CIC circuits to remove the organic contamination using kilns operating at 600–700°C. After regeneration the GoldSorb® activated carbon is cooled in a water quench tank, screened to remove undersize material and returned to the circuit.

Gold is eluted from GoldSorb® activated carbon and recovered using zinc precipitation or electrowinning and smelted to produce gold bullion.

The Carbon-in-Pulp (CIP) Circuit

The initial processing step involves milling of the mined ore, generally to 75% < 200 US mesh in order to enable efficient leaching of the gold. Classified ore/water slurry from the milling circuit is treated by thickeners where the underflow pulp is controlled to typically 50% w/w.

The gold bearing pulp is then pumped to a series of leach vessels where the gold is leached out of the ore using sodium cyanide (NaCN) solution. Sodium hydroxide (caustic soda) or calcium carbonate (lime) is used as a cyanide guard to maintain the pH at >10.5.

CIP TYPICAL DESIGN PARAMETERS	
Treatment capacity	125000 t per month
Gold head grade	4 g t^{-1}
Pulp flowrate	240 m^3 h^{-1}
No. of CIP contactors	6
Volume of contactors	160 m^3
Mass of GoldSorb®	5 t per contactor
Rate of GoldSorb® transfer	2.75 t per day
GoldSorb® gold loading	6000 gAu t^{-1}
Adsorption efficiency	99.9%
Comment	Data based on GoldSorb® 4500 6x12 US Sieve

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Air is sparged into mechanically agitated leach vessels, providing a source of oxygen which is essential for the dissolution of gold. The reaction which takes place under normal conditions of cyanidation, can be represented as: $4Au + 8NaCN + O_2 + 2H_2O = 4NaAu(CN)_2 + 4NaOH$. Gold leach times are usually of the order of 24–36 hours. The leached pulp is transferred to a series of mechanically agitated CIP contactors, each containing GoldSorb® activated carbon. Interstage screens are fitted to each contactor. The screens allow the pulp to flow, by gravity, through each CIP contactor and retain the GoldSorb® activated carbon within each contactor.

GoldSorb® activated carbon is transferred, counter-current to the flow of pulp, using recessed impeller pumps or air lifts. The loaded GoldSorb® activated carbon is acid washed before being transferred to the elution circuit.

ELUTION – ZADRA METHOD

ZADRA OPERATING CONDITIONS	
Loaded GoldSorb®	6000 gAu t^{-1}
Temperature	120°C
Pressure	2.5 bar
Flow rate	3.5 bed volumes per hour
Total bed volumes	24
Stripped GoldSorb®	45 gAu t^{-1}
Stripping efficiency	99.3%
Comment	Data based on GoldSorb® 4500 6x12 US Sieve

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The loaded GoldSorb® activated carbon is stripped in a continuous recirculation system, with the loaded stripped solution from the column being fed directly to the in-series electrowinning cells. The gold depleted solution is then returned to the stripping column. A 0.5% NaCN + 1% NaOH solution is used to strip the carbon at a flowrate of 2–4 bed volumes per hour at a temperature of 120°C and a pressure of 2.5 bar.

The resulting strip solution, leaving the column, is cooled and passed to the electrowinning cells. Upon leaving the electrowinning cells the solution is recirculated through the stripping column. This continuous recirculating technique is commonly used to elute gold from GoldSorb® activated carbons used in CIL, CIP and CIC circuits.

GoldSorb® activated carbon is used to recover minute traces of gold from mined ore in CIL, CIP and CIC circuits.

The Carbon-in-Leach (CIL) Circuit

The initial processing step involves milling of the mined ore, generally to 75% < 200 US mesh in order to enable efficient leaching of the gold. Classified ore/water slurry from the milling circuit is treated by thickeners where the underflow pulp is controlled to typically 50% w/w.

The gold bearing pulp is then pumped to a series of CIL contactors where the gold is leached out of the ore using sodium cyanide (NaCN) solution. The leached gold is simultaneously adsorbed onto GoldSorb® activated carbon.

CIL TYPICAL DESIGN PARAMETERS	
Treatment capacity	250000 t per month
Gold head grade	4 g t^{-1}
Pulp flowrate	475 m^3 h^{-1}
No. of CIL contactors	8
Volume of contactors	1780 m^3
Mass of GoldSorb®	20 t per contactor
Rate of GoldSorb® transfer	5.5 t per day
GoldSorb® gold loading	6000 g t^{-1}
Adsorption efficiency	99.9%
Comment	Data based on GoldSorb® 4500 6x12 US Sieve

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A series of mechanically agitated contactors are employed and interstage screens are used to allow the pulp to flow from one contactor to another while at the same time retaining the GoldSorb® activated carbon in the individual contactors. The GoldSorb® activated carbon is transferred, countercurrent to the flow of pulp, using recessed impeller pumps or air lifts.

Loaded GoldSorb® activated carbon is then transferred from the CIL contactors and after washing, on a vibrating screen, is transferred to the acid wash tank. In this operation the GoldSorb® activated carbon is contacted with dilute acid to remove calcium and other base metals which have become loaded in the CIL contactors.

The final washing is then undertaken to neutralize the GoldSorb® activated carbon, which is subsequently transferred to the elution circuit.

ELUTION – AARL METHOD

AARL OPERATING CONDITIONS	
Loaded GoldSorb®	6000 gAu t^{-1}
Temperature	120°C
Pressure	2.5 bar
Flow rate	2 bed volumes per hour
Total bed volumes	4
Stripped GoldSorb®	45 gAu t^{-1}
Stripping efficiency	99.3%
Comment	Data based on GoldSorb® 4500 6x12 US Sieve

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The loaded GoldSorb® activated carbon is pretreated with approximately 0.6 – 0.8 bed volumes of 2 – 3% NaCN + 2% NaOH solution and soaked for up to one hour. The gold is then stripped from the GoldSorb® activated carbon with 4 – 6 bed volumes of pure water at a flow rate of two bed volumes per hour at a typical temperature of 120°C and a pressure of 2.5 bar.

The resulting concentrated strip solution is treated by either zinc precipitation or electrowinning to recover the gold. This batch treatment technique is commonly used to elute gold from GoldSorb® activated carbons used in CIL, CIP and CIC circuits.

Jacobi CARBONS

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Sales and Marketing

Jacobi Carbons AB – Sweden
Headquarters of the Jacobi Carbons Group, coordinating worldwide sales and marketing

Jacobi Carbons (Suomen Siv.) – Finland
Sales and marketing of activated carbon in Finland and the Baltic States.

Jacobi Carbons GmbH – Germany
Sales and marketing of activated carbon in Germany and Continental Europe.

Jacobi Carbons Ltd – United Kingdom
Sales and marketing of activated carbon in the United Kingdom and Republic of Ireland

Jacobi Carbons, Inc. – United States
Sales and marketing of activated carbon in the United States and Canada.

Jacobi Carbons Agents – Worldwide
A diverse network of agents and distributors strategically located around the world.

Production and Engineering

Jacobi Carbons Co. Ltd. – China
The manufacture of extruded and granular coal based activated carbons – ANSI/NSF 61 facility.

Jacobi Carbons (Pvt.) Ltd. – India
The manufacture of granular coconut shell based activated carbon.

Jacobi Carbons AB – Sweden
Powdered activated carbon manufactured from coal, coconut shell and wood.

Jacobi Carbons Ltd – United Kingdom
Specialist impregnation facility, technical activated carbons, media handling and adsorption equipment.

BVQi ISO 9002

Jacobi Carbons operate in full accordance with approved ISO-9000 quality control procedures

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