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EXTRACTION METALLURGY DIVISION

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ABSTRACT

A sample of lignite char from Manitoba-Saskatchewan Coal Co. adsorbed monovalent gold up to 100 oz/ton char. However, this lignite char is not as efficient as commercially available carbons for industrial gold recovery from alkaline-cyanide solutions. There would be no economic advantage in using char because it would be necessary to process an estimated four times more char than carbon to recover the same amount of gold.

*Research Scientist, Solution Treatment Section, Extraction Metallurgy Division, Department of Energy, Mines and Resources, Ottawa, Canada.

INTRODUCTION

In the cyanidation of one Canadian gold ore, activated carbon, manufactured at temperatures of 1500 to 2000°F, is used to recover soluble monovalent gold from alkaline-cyanide leach solutions. Gold bullion is then produced by burning and smelting the loaded carbon. Giant Yellowknife Mines Ltd.[1] loads a Norit* activated carbon to 466 oz Au/ton carbon to recover soluble gold from an alkaline-cyanide slurry of 30% slime solids. In this case, the cost of recovering the gold by smelting is estimated at $2.50 to $3.00/oz of gold. This includes the cost of the carbon, transportation and processing charges. J.B. Zadra[2] has loaded activated carbon to 640 oz Au/ton carbon. Laboratory work at the Mines Branch has shown that trace amounts of soluble gold in flotation waste effluents will load activated carbon to about 400 oz Au/ton[3].

In this investigation, a sample of lignite char from the Manitoba-Saskatchewan Coal Company was tested to determine its capability to adsorb monovalent gold from cyanide solutions and from an industrial flotation waste effluent. This work was done at the request of Mr. W.J. Montgomery of the Fuels Research Centre, Department of Energy, Mines and Resources.

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*Available from Norit Sales Company of Canada.

PROCEDURE

The lignite char, a product of the Manitoba-Saskatchewan Coal Company, was heat-treated, sized to minus 8 plus 20-mesh, then submitted by the Fuels Research Centre of the Mines Branch. An analysis of the lignite char submitted is shown in Table 1.

TABLE 1

Analysis of Dry Sample of Lignite Char from Manitoba-Saskatchewan Coal Company

Proximate Analysis		
Moisture	%	0.00
Ash	%	13.57
Volatile Matter	%	9.49
Fixed Carbon (By Difference)	%	76.94
Ultimate Analysis		
Carbon	%	80.27
Hydrogen	%	2.53
Sulphur	%	0.92
Nitrogen	%	1.05
Ash	%	13.57
Oxygen (By Difference)	%	1.66
Calorific Value	Btu/lb Gross	12620

Two tests were done to show the gold adsorption capability of lignite char. In a column adsorption test, 50 grams of the lignite char had a bed volume of 75 ml and a bed depth of 17 inches in a 100-ml Pyrex burette 5/8 inch in diameter. A synthetic gold solution, prepared from a $KAu(CN)_2$ solution to a concentration of 2.06 oz Au/ton solution, was fed upflow

to the lignite char bed continuously for 82.5 hours. The flow of 2 ml/min was equivalent to a contact time of 15 minutes, assuming a 40% void volume.

In a second test, a 200-gram sample of the char was agitated for 24 hours in 4 litres of an industrial flotation plant waste effluent, containing 0.003 oz Au/ton and 0.074 lb Cu/ton solution.

The column effluents and periodic solution samples from the batch agitation tests were analyzed by atomic adsorption methods. The lignite char after column adsorption was vacuum dried to a constant weight and then analyzed for gold by the fire-assay method.

RESULTS

The effluent in the column adsorption test after 2 bed volumes (150 ml) analyzed 1.07 oz Au/ton solution. This means that only 48% of the available gold was adsorbed at the beginning of the test. The effluent concentration after 115 bed volumes increased to 1.45 oz Au/ton solution. The composite effluent of 132 bed volumes, collected over 82.5 hours, analyzed 1.50 oz Au/ton solution. The lignite char contained 100 oz Au/ton which means that an average of only about 25% of the available soluble gold was adsorbed by the char during the test.

In the batch agitation test with a char to solution ratio of 1/20, the lignite char lowered the gold and copper concentration of the flotation plant waste to 0.001 oz Au/ton solution in 2 hours and 0.04 and 0.006 lb Cu/ton solution in 6 and 24 hours respectively. These values are equivalent to 66% Au extraction in 2 hours, and a copper extraction of 46% and 92% in 6 and 24 hours, respectively. In contrast, Norit activated carbon[4] at a char to solution weight ratio of 1/62.5, adsorbed 90% of the gold and 30% of the copper in 15 minutes from a similar type of solution. This shows that the metal adsorption of the commercial activated carbon was considerably more efficient.

By observation, the lignite char appeared to be harder and less susceptible to attrition than the Norit activated carbon. However, no hardness tests were performed on either of these adsorbents.

DISCUSSION

The results of the column adsorption tests show that even under the most favorable adsorption conditions, which exist at the start of the cycle, less than 50% of the gold passing through the column is removed. This early breakthrough in the adsorption cycle is naturally an undesirable feature. Towards the end of the test only about 10% of the available gold was adsorbed. The resulting overall removal of only 25% of the gold

and the char loading that was obtained suggests that if the amount of lignite char was increased by a factor of about four, the gold adsorbed would probably be similar to that removed by activated carbon.

Although the estimated cost of the lignite is about $10/ton compared to about $600/ton for the Norit activated carbon, there would probably not be any economic advantage in using char because the increased amount of char required would greatly increase the processing and transportation costs per ounce of gold recovered.

The amount of environmental pollution caused by the burning and smelting has to be considered. Air contaminants of nitrogen and sulphur compounds would be evolved during the smelting due to the 18.4 lb of sulphur and 21.0 lb of nitrogen contained in a ton of lignite char. Because of the activation temperature of about 2000°F used in the production of Norit carbon, the nitrogen and sulphur content is conceivably less than that of the lignite char which had been heated only lightly.

Only one mine in Canada uses activated carbon in the recovery of gold and therefore the potential market for char is relatively small. A greater potential market exists in the processing industries where organic compounds are presently removed from gaseous waste streams by activated carbon. Assuming that the char is as effective as activated carbon in this role,

it could be employed as an adsorbent for the recovery of strong toxic odours[5] from the hydrocracking of by-product oils. The char, as with adsorption/desorption techniques used with industrial activated carbon, potentially, could be thermally regenerated. The commercial value of any organic recovered thermally might help offset equipment and power costs of the adsorption/desorption process with lignite char.

CONCLUSIONS

A brief laboratory examination has shown:

1. Lignite char from the Manitoba-Saskatchewan Coal Company adsorbs up to 100 ounces of gold per ton.
2. As an adsorbent of soluble gold from cyanide solutions, lignite char is much less efficient as some commercially activated carbons, in terms of adsorption time and loading capacity.
3. The burning and smelting of loaded lignite char to produce gold bullion would produce environmental pollutants of nitrogen and sulphur compounds.

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