SPOTLIGHT

on the new gold plant at President Brand

by PETER SMITH*

The construction of one of the world's largest gold-recovery plants to treat run-of-mine ore is progressing on schedule at the President Brand Gold Mine in the Orange Free State. Designed to treat 390 kt per month, the plant will recover 96 per cent of the gold from the ore at a capital cost of 160 million rands in terms of January 1983 money. It will replace the existing gold-treatment installation, as well as provide a 30 per cent increase in capacity.

Design of the Plant

President Brand has relied entirely on in-house design, the Design Services Department of Anglo American being utilized for the structural, mechanical, electrical, and instrumentation design, while the civil design was carried out by Anglo American's Civil Engineering Department.

The plant is being constructed in modular form. There are three modules, each one comprising two mills, two thickeners, one leaching and adsorption stream, and one elution/recovery stream.

Two rail ore-transfer bins and 12 ore silos will provide 54 hours of ore-storage capacity for the six trunnion-mounted run-of-mine mills, which will grind ore to about 76 per cent minus 75 μm. The mills are 4,9 m in diameter by 10 m long.

A unique feature of the plant will be the ore-reception facility, which has been designed to eliminate dead storage space, a serious constraint encountered in railway ore-storage bins. Ore will be transported from the shafts to the treatment plant by rail. The railway ore hoppers will discharge individually into one of two concrete rail-lined inverted cones 12 m diameter and 8 m deep. The angle of the cone is 57°. The ore will be withdrawn rapidly from the apex of the cone via a Langlaagte chute, and will be delivered by conveyor belt to the ore-storage silos.

The milling circuit consists of six single-stage run-of-mine mills, which will be controlled on maximum power by the use of programmable logic controllers. Load cells will be incorporated under the outlet trunnion bearings to measure variations in mill load. The mill-feed belt and discharge pump will both have variable-speed drives. Each mill will be in closed circuit with a 1200 mm primary cyclone with mass-flow measurements on the feed. The overflow from the primary cyclone will be screened on a 6 m by 3 m vibrating negative-angle screen for the removal of coarse wood chips and tramp steel. This serves the purpose of protecting both the gravity-concentration circuit and the downstream carbon-in-pulp circuit. The screen underflow will be pumped to two 700 mm secondary cyclones, the overflows passing through an automatic sampler before flowing by gravity to the thickening circuit. The underflows from the secondary cyclone will be split into four Johnson drum concentrators, the concentrates being cleaned on an endless-belt concentrator prior to being transferred to the smelt-house, where gold will be recovered by the intensive cyanidation process developed by Anglo American. The gravity-circuit tailings will be dewatered in a tertiary cyclone, the overflow being used for the dilution of the mill discharge and the underflow being returned to the mill inlet for regrinding.

Thickening will be carried out in six thickeners of 60 m diameter, and the leaching circuit will consist of twenty-seven 800 m^3 draught-tube circulating tanks arranged in three streams and providing a nominal residence time of 24 hours. The feed to the leach will be screened for the removal of wood fibre by three Mintek-type circulating tanks. Air will be injected under the draught-tube impellers to dissolve the oxygen in the pulp.

Carbon-in-Pulp

The dissolved gold will be recovered by the carbon-in-pulp process with an adsorption circuit consisting of twenty-one 300 m^3 contactors with open-tank mechanical agitators arranged in three streams and providing a nominal stage-residence time of 1 hour. At present, the contactors have EPAC-type screens on the periphery of the tank, but tests are proceeding on the development of a mechanically cleaned equalized-pressure screen, and the results have been very encouraging. The interstage movement of carbon will be achieved by the use of recessed impeller vertical-spindle pumps.

Loaded carbon from the adsorption circuits will be stripped by the elution procedure developed at the Anglo American Research laboratories. The elution plant is arranged in three modules with a total design capacity of 11 t of carbon per day, the three elution colums being fabricated from a corrosion-resistant nickel–chromium–molybdenum alloy. This alloy will permit a high-temperature hydrochloric acid wash, followed by a 120°C elution with caustic cyanide and softened water, to be conducted in a single column. The alloy was selected after considerable corrosion-coupon tests had been conducted in an existing carbon-elution circuit at President Brand. The entire acid-washing and elution sequence will be controlled automatically by the use of programmable logic controllers. The elution circuit will be heated by shell-and-tube heat-exchangers using a circulating thermic fluid that will be heated by burners fired by heavy fuel oil. This system was selected as a result of the cyclic demand for heating of the elution circuit and the difficulties that would be experienced with maximum demand had electricity been used. The regeneration circuit consists of three electrically fired rotary kilns with drums of iron–nickel–chromium alloy.

Zinc Precipitation

The gold will be recovered from the eluates by

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precipitation with zinc in single-stage reactors on a batch basis, gold-bearing filtrates from the intensive cyanidation being combined with the eluate from elution. The precipitates will be recovered by the use of three pre-coat rotary-drum vacuum filters. Testwork has shown that deaeration, addition of lead nitrate, and acid treatment are not required. The precipitates will be calcined and smelted in submerged-arc furnaces.

Contracts

The major civil contract for the ore-receiving bins, mill-feed silos, and mill building was awarded in March 1984. In April 1984, a second civil contract was awarded for the thickening plant, and for the leaching and adsorption areas. All this work is virtually complete.

A contract for structural steelwork for the mill building and conveyor gantries started in June 1984 and will be complete by the third quarter of 1985. Work is in progress on the platework in the leaching and adsorption areas, and is due for completion in August 1985. Contracts for piping, mechanical work, and electrical installations have been awarded and are due to start in June 1985. Contracts for the installation of the instrumentation will be allocated in July.

Mintek reports

The following reports are available free of charge from the Council for Mineral Technology, Private Bag X3015, Randburg, 2125 South Africa.

Report M161

Improved recoveries of gold from auriferous calcines and pyrites by fine milling.

Ultra-fine milling of gold-bearing calcines prior to leaching in cyanide is a method that will lead to higher gold recoveries than at present. The economic implications are better for calcines that emanate from refractory ores since they contain more occluded gold.

Milling to between 80 and 90 per cent finer than 11 μm resulted in 36 per cent more gold being extracted from the calcine residues originating from non-refractory gold ores, whereas 40 per cent more gold was extracted from those originating from refractory ores.

For gold-bearing pyrite concentrates, ultra-fine milling resulted in improved gold extractions, but more work on the optimization of the leaching conditions is required. Costs are not available for the ultra-fine grinding of calcines and pyrites since this technique is not currently employed on a plant.

The recovery of gold from the solutions produced by the leaching of finely milled calcine residues and pyrite concentrates requires some consideration. Problems are likely if activated carbon is used in this treatment because of blockage of the carbon micropores by fine calcine or pyrite that is generated in the milling step.

Report M171

The development of a versatile computer programme for the evaluation of batch-flotation results.

The computer programme, which is designed for use with the Apple 64K minicomputer, can evaluate batch-flotation results by the use of any one of five different flotation models and can evaluate the batch-flotation results for more than one valuable mineral species in an ore at a time.

All the relevant results for recovery and grade can be presented in tabular and graphic form to facilitate the comparison of flotation results and of flotation models. Curves for recoveries and grades determined in experiments and those predicted by a model can also be plotted.

Several options are incorporated in the programme, making it versatile and easy for an operator to use.

Report M178

The reduction of chromite in a transferred-arc plasma furnace.

The reduction of low-grade chromite ores by the use of transferred-arc plasma technology instead of submerged-arc technology was investigated. The experiments on chromite were performed 'in bath' in a transferred-arc molten-anode plasma furnace and 'in flight' in a transferred-arc ancillary-anode plasma furnace. The effects of controllable furnace parameters on the reduction are reported and discussed.

Complete in-bath reduction of chromite was readily accomplished when the furnace parameters were balanced correctly since these parameters are related to both the chromium chemistry and the plasma arc. Although the dissolution of chromite into the slag was accomplished each time, the conditions were not always adequate for the complete reduction of chromite from the slag once it had been dissolved. This situation was overcome by the use of chromite and reducing agent of the correct particle sizes, or by control of the arc as a uniform source of heat.

Complete in-flight reduction of chromite was not accomplished. However, when a number of furnace parameters was controlled, 50 per cent of the total chromium and 60 per cent of all the iron oxide were reduced within the arc.

It was found that, besides the expected influence of the chemical reactions resulting from the smelting of chromium, the following parameters controlled the reduction: arc power, arc length, cathode design, flowrate and composition of the primary plasma gas, arc rotation, anode design, and feed rate.

Recommendations are made for further research in this area.

Report M179

Optimization of an inductively coupled plasma by the simplex method.

A 5 kW nitrogen-cooled, argon inductively coupled plasma (ICP) was used in an investigation on the basic and modified simplex methods of optimization. The optimum conditions for plasma operation were found for the analysis for 23 commonly determined elements covering a wavelength range from 180 to 340 nm and including an approximately equal number of atomic and ionic lines.

Initially, the optimization of the operating conditions for the plasma was applied to single-element analysis on