

DEVELOPMENTS IN GRAVITY CONCENTRATION CIRCUIT IN ASHANTI GOLDFIELDS COMPANY, OBUASI

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ABSTRACT

The Ashanti ore deposit at Obuasi can be described as double refractory. Mineralogical analysis of the ore reveals three main characteristics namely: very fine gold locked up within the lattice structure of arsenopyrite and pyrite, which can be transitional in nature. Secondly, the presence of graphitic schist (sheared schist) with active carbon which promotes “preg robbing” (adsorption of gold in solution by naturally occurring active carbon) and finally quartz vein with finely scattered free gold with the highest concentration being at the Quartz – Graphitic schist boundaries. In addition, few very fine-grained graphite intergrowths are also present in the gangue.

The importance therefore of an aggressive and effective free gold recovery system cannot be over emphasized for the attainment of a meaningful plant recovery.

Operationally, an effective free gold recovery system is also a requirement to minimize gold lock-ups in the twenty-four (24) BIOX® reactors (895.5m³/tank), seven Edward roasters and in the mills for better gold accounting and reconciliation.

Increasing importance has therefore been given to **gravity concentration systems** at AGC Obuasi plants and significant developments have recently been achieved. The achievement has improved free gold recovery from 8% to 16% of the total gold recovered at the Pompora Treatment Plant (PTP) and the elimination of the nugget effect has significantly improved metallurgical accounting.

The coming online of the PTP upgrade saw dramatic changes in AGC’s free gold recovery philosophy. The PTP Upgrade Gravity Design apart from its aggressive approach to the free gold recovery, focused on key issues including:

- ❑ The need to maximize free gold recovery with minimal capital expenditure.
- ❑ Ability to eliminate lock-ups in the numerous ball mills, leach tanks and BIOX® reactors.
- ❑ Achievement of representative head grade for better gold reconciliation and accounting.
- ❑ Minimize losses to “Preg Robbers”
- ❑ Maximize level of automation to avert the security risk of human involvement.

The paper discusses the various past gravity circuits operated by AGC and their shortcomings. It also discusses the basis of the PTP upgrade gravity circuit design and the proven benefits. The paper finally highlights free gold recovery circuits operated outside the milling circuits and outlines the future objective of AGC gravity circuits.

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INTRODUCTION

Ashanti Goldfields Company Ltd based in Ghana is currently the largest international gold mining company in West Africa with its Obuasi operation as the biggest.

Obuasi has seen continuous mining activities for the past 100 years. Currently from its open pits and underground mines, Obuasi generates a total of 750,000 tonnes of ore and reclaimed tailings monthly at an average grade of 4.35 gpt.

In all five treatment plants namely: Oxide Treatment Plant (OTP), Heap Leach Plant (HPL), Pompora Treatment Plant (PTP) with roasting as means of concentrate oxidation, Sulphide Treatment Plant (STP) with concentrate oxidation by biological means and Tailings Retreatment Plant (TTP) are used to process the variable ore types generated in Obuasi.

Recovery methods after liberation of the gold on the various plants includes cyanide leaching and combined leach and gravity recovery.

The recovery option is determined by the mode of gold occurrence in the various ore types.

With the relatively high free gold content of the Ashanti underground ore supply the importance and inclusion of a very efficient free gold recovery system in the processing circuit cannot be over-emphasized. Obuasi treatment plants would therefore continue to keep pace with technological changes in gravity recovery to ensure optimum free gold recovery.

With no reagent employed gravity recovery will remain a favorite recovery method on Ashanti's treatment plants to meet her chase for environmentally friendly technologies for the processing of gold.

The upsurge of modern and improved centrifugal Gravity Separators saw Ashanti gradually moved from film sizing gravity separation method to the installation and operation of improved centrifugal gravity concentrators like Knelson Concentrators.

OVERVIEW OF PAST LIBERATION AND GRAVITY CIRCUITS

Pompura Treatment Plant (PTP), the oldest of the Obuasi's treatment plants has been in operation for the past 50 years. Major plant expansion and modernization have taken place over the years to bring the plant to its current capacity of 145,000 tpm, which is more than double its original capacity.

The ROM ore from underground resource that comprises 25 – 30% of fines (-3.0 mm) carries about 40% of the free gold content of the ore.

The fines are washed into a thickener at the ore washing plant comprising a scrubber and double-deck screen. (OWP CIRCUIT + CRUSHERS)

The intermediate product of minus 12mm and plus 3mm was used as rod mill feed and the oversize material was subjected to second and third stage crushing using cone crushers to generate rod mill feed.

To achieve a grind of 70 – 75% passing 75 micron (liberation point for sulphides minerals) for flotation, rod mill plus three-stage ball milling were employed with the second and third ball milling stages in closed circuits with 20" Krebs hydro-cyclones.

Free gold liberation was achieved at the end of the second stage B/Milling at about 60% passing 75 microns.

The free gold gravity recovery circuit of old was divided into three main steps to maximize free gold recovery as follows:

- Pre-concentration by straking
- Concentrate cleaning by use of Wilfley shaking table
- An amalgamation of Wilfley table tails

Pre-concentration is a vital stage of free gold recovery since its inclusion and location determine both efficiency and economics of the entire gravity circuit.

Pre-concentration, whether or not planned for, would actually occur in the milling circuits with free gold lock-ups in places like mill liner joints, mill discharge hoppers, mill feed boxes and launders which present opportunities for theft.

PTP has operated different pre-concentration devices which were mostly film sizing based. Notably among them were the strakes that were later replaced by plane tables. Straking was followed by the use of Wilfley table for cleaning and the Wilfley table tails subjected to amalgamation.

Strips of industrial corduroy cloth were employed. This was laid with its ribs across the direction of flow with the nap of strip pointing upward so as to entangle the gold falling to it. At a regular interval of 80 minutes the strips were replaced and the loaded strips washed into a concentrate bunker.

[Diagram]

The straking and amalgamation circuits had the following constraints:

- Labor intensive;
- Human involvement and associated security risk;
- Health and environmental hazard;
- High free gold lock-ups in the mills;
- Lack of controls for optimization.

After several years of running the above circuit PTP replaced the strake tables with plane tables and abolished the amalgamation of the Wilfley tables tails in 1988.

The introduction of the lane tables could not bring about the much-needed change in the face of gravity recovery in Ashanti.

Despite the drastic reduction in labor and the elimination of health and environmental risk, achievement of an enhanced free gold recovery was never realized.

PTP UPGRADE GRAVITY CIRCUIT DESIGN AND DESCRIPTION

The successful commissioning of the PTP upgrade gravity circuit really transformed free gold recovery in Ashanti's Obuasi operation.

The basis of the entire plant upgrade was to:

- Increase plant throughput,
- Improve recovery,
- Improve plant safety conditions, and
- Improve the environmental standards of the plant.

Recovery improvement was to be achieved through increase in the various unit operations' recovery, i.e. flotation, gravity concentration and leach circuit.

The implementation of the PTP upgrade project presented among other things an opportunity for the design and installation of a very efficient gravity circuit to offset the various constraints posed by the previous circuits.

The design was to adopt an aggressive free gold recovery approach, which entails immediate free gold removal upon liberation to minimize free gold lock-ups. With minimal capital expenditure, the designed circuit was also expected to maximize free gold recovery.

To achieve these feats two main challenges were posed namely:

- Selection of the suitable recovery unit, and
- Determination of suitable location of the selected unit on the circuit.

In line with the adopted approach, positive decisions were taken for the realization of positive results. These decisions included the closure of the primary milling circuit with the selected recovery unit to minimize free gold lock-ups. This was also to permit free gold recovery ahead of any other unit operations, i.e. flash flotation, which leads to free gold recovery into the sulphides.

Secondly, the full circulatory load was to be processed by employing a pre-concentration step ahead of the recovery unit. The second decision was to avert the bleeding system of gravity recovery which was mostly due to lack of high capacity recovery units coupled with high cost of installation of more of such units. This option for the past has led to loss of free gold recovery through over-grinding, and high gold lock-ups consequently poor gold reconciliation and accounting.

Flow sheet was developed as follows:

- SAG Mill for the liberation of the free gold
- Flat bottom cyclone (FBC) was used for both classification of SAG mill product and as a pre-concentration unit
- A vibratory screen was selected for the removal of plus 2mm products ahead of the recovery units.
- 2 x 30 KCCD complete with ICS for free gold recovery.
- One Wilfley shaking table with magnetic separation for concentrate cleaning.
- Wilfley table tails to be recycled.

FLWSHEET
(UPGRADE FLWSHEET EMPLOYED)

PTP upgrade was commissioned in April 1997 and, after some circuit modification, has since been running successfully with the following proven benefits:

- Labor savings due to automated operation;
- No human involvement hence minimal operational problems and improved overall security;
- Improved free recovery from 8% to 16%;
- Less free gold lock-up in the milling circuit;
- Better gold reconciliation and accounting.

UPGRADE GRAVITY CIRCUIT MODIFICATION

Four months after commissioning it was realized that few modifications were required for the optimization of the circuit's performance.

The original circuit comprised flat bottom cyclone underflow reporting to 2mm and 4mm double-deck screen of 3.5m x 2m size. FBC underflow to the screen was overloading it leading to inefficient screening hence high SAG mill circulatory load.

Screen overloading could not also permit cut size optimization of the flat bottom cyclone. This led to frequent spike of gold assay values of the FBC overflow stream, which was used in the head grade equation. This often threw off the plant's gold accounting and reconciliation.

The major circuit modification was the further milling of the entire flat bottom cyclone underflow stream ahead of the double-deck screen using one of the four secondary mills.

The modification yielded significant results as follows:

- The intention to upgrade the original double-deck screen was no longer a requirement. In addition, the screen was further reduced to single deck and still gave better washing and screening.
- FBC operation could be optimized and this improved head grade reconciliation and gold accounting.
- Reduction in the circulatory load permitted increased SAG mill throughput.
- The regrinding lead to improved free gold liberation and enhanced free gold recovery.

This was confirmed by the drastic reduction in free gold recovery by the KC-CD20 installed downstream of the gravity circuit as a policeman.

THE FIRST KC IN PTP

With the sulphide mineral content of the PTP RPM ore, PRP operates a flotation plant for the recovery of the sulphides, which are predominately arsenopyrite and pyrite. Consequently a concentrate roast/leach plant is operated for the recovery of gold associated with the sulphides.

The sharp difference in particle temperature during quenching (which follows roasting) results in the liberation of some encapsulated fine free gold. As traditional free gold liberation point shaking table and amalgamation were employed in the past to recovery the free gold. Due high security and environmental risk encountered, the above free gold recovery process was terminated.

For years the quench product was directly leached with cyanide consumption to achieve calcine residues of about 22 gpt. In March 1992 a manual 30" KC was installed ahead of the calcine leach circuit and the concentrate cleaned by use of a Wilfley table.

The installation, apart from recovering about 15% of the total calcine gold as free gold, reduced cyanide consumption by about 14% at the leach circuit.

Plant trial conducted revealed that frequent KC cleaning increased free gold recovery. Based on this finding a motivation for KC-CD30 complete with ICS was put in. In November 1997 the manual KC was placed and free gold recovery at the calcine section shot up as indicated in fig.... (graph). The figure also indicates that before the installation of the KC-CD30 in 1997 free gold recovered was directly related to the total calcine gold recovered.

KC INSTALLATION ON THE BIOX® PRODUCT

AGC's Sulphide Treatment Plant (STP) currently houses the biggest BIOX® plant in the world with 1100 tpd concentrate.

With an initial capacity of 750 tpd, the plant throughput was increased to the current capacity in 1996 after the commissioning of the fourth BIOX train meant for the oxidation of part of PTP generated concentrate.

The absence of a gravity recovery circuit in the STP milling circuit coupled with the treatment of part of PTP concentrate gave rise to the presence of free gold downstream of the STP circuit.

This was confirmed by the 3000 oz of free gold realized from the draining and washout of STP Tank 64 (leach feed conditioning tank).

Erratic BIOX® CIL residues achieved was also an indication of the presence of free gold which was later confirmed by the trial run of 3" KC on leach residues.

The above situations more than justify the need for a free gold recovery circuit. In February 1997, a 30" KC-CD with stainless steel bowl complete with ICS was commissioned on the BIOX® product ahead of the leach circuit.

Initially portion of the stream was bled to feed the KC and between 3% and 5% of the total gold was being recovered by the KC as free gold.

A 20" Krebs cyclone was later installed to pre-concentrate the feed to the KC and recovery shot up to an average of 8%.

Apart from the improved gold accounting realized from the KC installation, consistent leach residues have also been achieved.

CONCLUSION

The success of the PTP upgrade gravity circuit gives a breakthrough in gravity gold recovery in Ashanti.

However, it is worth noting that the upsurge of the new generation of gravity gold recovery systems with improved gravitational forces has played a major role in the achievement of efficient gravity gold recovery.