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Industrial application of ammonia-assisted cyanide leaching for copper-gold ores

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ABSTRACT

A description of the agitation leach plant used for treating gold-copper ores at Anglo Asian Mining's Gedabek mine in Azerbaijan is given. The plant employs a unique resin-in-pulp system for gold recovery. The integration of the agitation leach plant into the existing heap leach/ADR/SART operation is described. Operational problems caused by increasing amounts of copper in the Gedabek gold ores are outlined. Previous work on the use of ammonia in copper-gold cyanide leach systems is reviewed. The test work leading to the introduction of ammonia in the industrial leaching plant is described. In the plant it was found that the extraction of copper was halved by the use of ammonia, thus leading to significant reductions in the amount of cyanide consumed in the full-scale leaching system.

1. Introduction

In July 2013, Anglo Asian Mining inaugurated a new agitation leach and resin-in-pulp gold ore processing plant at its Gedabek gold mine in western Azerbaijan. A few months after the start-up of this plant, changes in the ore mineralogy resulted in higher copper grades in the feed than originally envisaged. Although the resin-in-pulp plant coped adequately with the resulting high copper concentrations in the leach liquors, so that gold production was not adversely affected, consumption of cyanide by the soluble copper caused unacceptably high operating costs. In order to alleviate this situation, ammonia was introduced into the leaching circuit to reduce the cyanide consumption. This paper describes both the design and operation of the new leach-RIP plant and the successful incorporation of ammonia into the process.

2. Agitation leach-RIP plant

2.1. Background

In May 2009, Anglo Asian Mining started open pit mining for gold on its Gedabek property in the Lesser Caucasus mountains in western Azerbaijan. The ore body at Gedabek is a complex copper-gold porphyry deposit. Ore from the Gedabek mine, which initially was mainly oxidic in nature, was treated by cyanide heap leaching to produce a pregnant leach liquor, from which gold was extracted by fixed-bed resin ion exchange. Resin ion exchange was used at Gedabek, instead of conventional activated carbon, because of the elevated copper concentrations in the leach liquors from the heaps, which typically contained about 1000 mg/L Cu. In spite of the high Cu/Au ratios in the Gedabek leach liquors, which usually ranged from 500 to 1000, the excellent selectivity of the Minix resin used in the process was such that the Cu/Au ratio on the loaded resin was about one. In order to prevent copper from building up in the recirculating leach liquors, a SART plant (Sulphidisation-Acidification-Recycling-Thickening) was incorporated in the circuit to remove copper from solution as a copper-silver sulphide precipitate. A full description of the operations at Gedabek, prior to the introduction of the agitation leach plant, has been published (Hedjazi and Monhemius, 2014).

As mining progressed at Gedabek, the ore became less oxidised and harder in nature, with the result that gold recoveries in the heaps started to decrease. In 2012, it was decided that agitation leaching should be introduced to operate in parallel with heap leaching, with high grade ore (> 1 g/t Au) going to agitation leaching and low grade ore (< 1 g/t Au) going to heap leaching. Accordingly, a 100 t/h stand-alone agitation leach plant, including resin-in-pulp solution processing, was designed, built, and commissioned by July 2013. In the next section, the design of this plant and its incorporation into the existing heap leach process circuit is described.

2.2. Leaching-RIP plant

The flow sheet of the agitation leach plant at Gedabek is shown in

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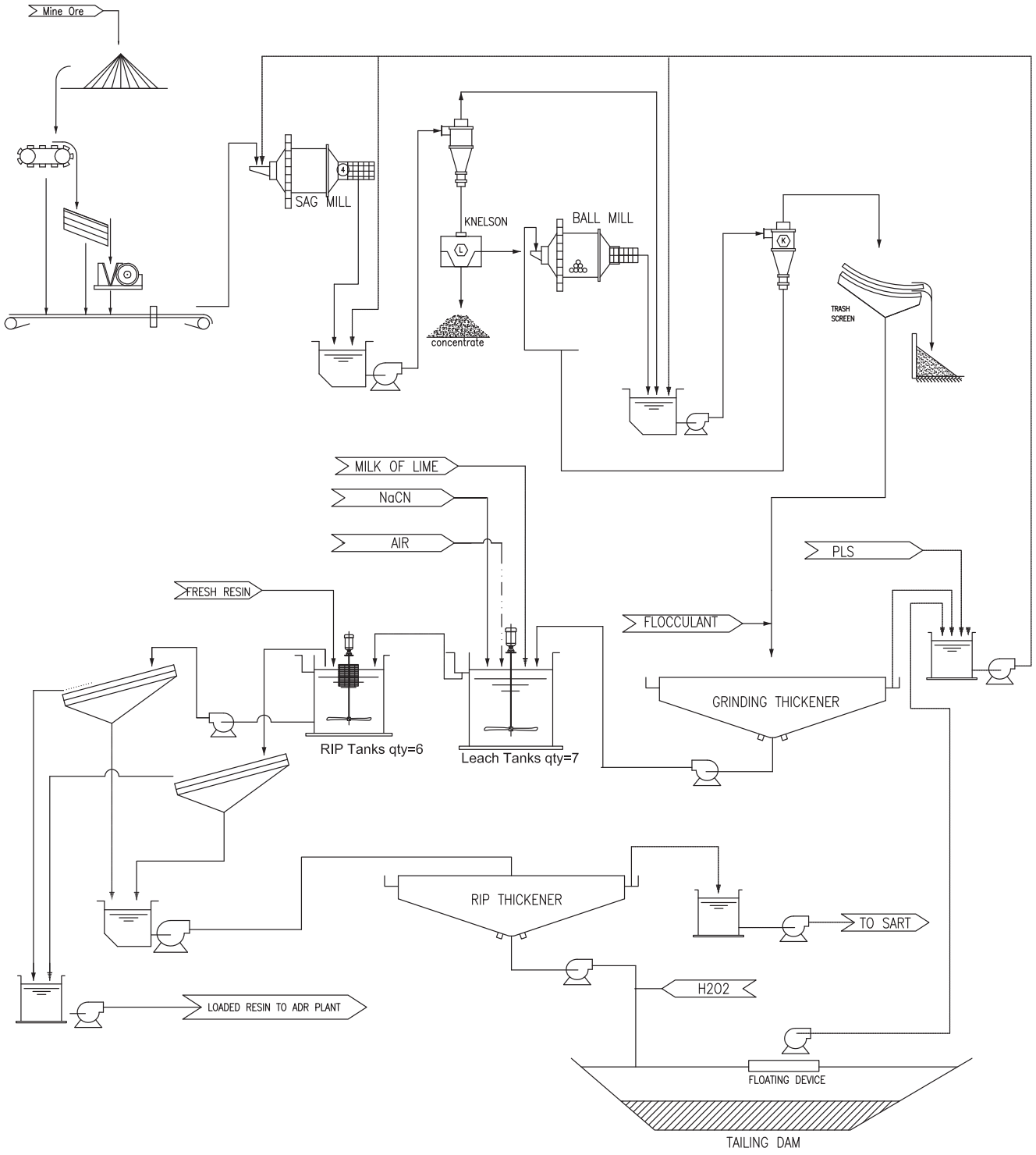

Fig. 1. Agitation Leach Plant flow sheet.

Fig. 1. The design is conventional, except for the resin-in-pulp section, which as far as is known, was unique at the time for this type of application.

2.2.1. Comminution circuit

Mined ore from the stockpile is fed into a silo by a front-end loader. The broken ore is moved from the silo by an apron feeder over a vibrating grizzly, with the oversize passing through a jaw crusher (1100 × 900 mm). Undersize and crushed ore at minus 15 cm size is conveyed to the SAG mill (5000 × 2800 mm, 750 KW), which reduces the ore to minus 1 mm. Return water from the tailings dam is added to the SAG and ball mills to maintain the correct pulp densities. The SAG mill discharge is cycloned, with a cut at 75 μm (P_{80}), with part of the underflow passing to a continuous Knelson concentrator (CVD64) to remove any particles of free gold. After the Knelson, the cyclone underflow goes through a ball mill (4000 × 6000 mm, 1.4 MW), with the cyclone overflow joining the ball mill discharge. The combined ball mill discharge is then cycloned again, also with a cut at 75 μm. The overflow from these cyclones is the main feed to the leach tanks, which is first thickened to 40 wt% solids in the leach thickener, before passing into