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Hydraulic hoisting technology for platinum mines

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Anglo Platinum has initiated a project to investigate hydraulic hoisting technology for platinum mines.

Hydraulic hoisting systems are categorized as pumping, fluidizing feeder or displacement feeder systems. Positive displacement piston diaphragm pumps are most suitable for pumping systems but they require that the ore be milled prior to pumping. Fluidizing feeders are unsuitable for platinum ore applications due to the large percentage of fines in the ore. The three-chamber pipe displacement feeder has been most widely used for hydraulic hoisting and is the most suitable technology for platinum mines.

Eight hydraulic hoisting applications covering pumping and displacement feeder technologies are reviewed.

The key factors to be assessed in selecting a hydraulic hoisting system for a platinum mine are discussed. A typical platinum mine configuration will comprise an ore preparation plant (to produce -15 mm material through screening or crushing), motive water pump on surface, high pressure water pipeline from surface to underground, ore slurrification plant, three-chamber displacement feeder, and a high pressure slurry pipeline to surface. The water and slurry pipelines are housed in a purpose drilled borehole.

A hydraulic hoisting system selection chart is presented. A 150 mm diameter system with a 25 MPa pressure rating is required to hoist 60 000 t/m from a depth of 1 200 m. Generic capital and operating costs are presented.

A major potential advantage of hydraulic hoisting is that the fines, which contain a high percentage of PGMs, are captured underground and transported directly to the concentrator.

Hydraulic hoisting technology is ideally suited to providing supplementary hoisting capacity to existing shafts that have reached the skip hoisting capacity limit. The main advantage for new shafts is the potential to significantly simplify underground rock handling and transportation.

All hydraulic hoisting system components are proven. The only risk area is the wear rates of the valves and piping. Current estimates are based on gold ore. The business cases investigated show that the financial viability of the installations are not sensitive to wear rate.

Hydraulic hoisting is technically feasible and financially attractive for platinum mines.

Keywords: Hydraulic hoisting, slurry

Introduction

Hydraulic ore hoisting technology has the potential to revolutionize horizontal and vertical rock transportation in platinum mines. In the short-term, the production of existing shafts can be increased by installing a hydraulic hoisting system to provide supplementary hoisting capacity. The longer-term benefits are potentially greater with major changes to new mine layouts and infrastructure.

This paper presents some findings of a project initiated by Anglo Platinum to investigate the application of hydraulic hoisting technology in platinum mines.

Hydraulic hoisting technology review

Hydraulic hoisting systems are categorized in terms of whether the ore slurry is in direct contact with the pumping equipment (termed pumping systems) or is isolated from the pumping equipment by some form of feeder or pressure exchange system (termed feeder systems). Most feeder systems require a low pressure pump to supply the feeder.

Pumping systems

Pumping systems employed for hydraulic hoisting applications incorporate a pump (or multiple pumps in series) suitable for slurry duty and capable of generating the required head to lift the slurry to surface. A typical pumping system configuration is shown in Figure 1. In this case, the ore slurry is fed from the slurry preparation plant to the pumping system that delivers the slurry to surface.

A number of slurry pump types can be considered for hydraulic hoisting applications:

Centrifugal slurry pumps

The rotating impeller of the centrifugal pump imparts kinetic energy to the fluid, which converts to pressure head in the pump casing. The abrasive nature of most slurries means that for practical purposes, the impeller tip speed is limited to 20 m/s to 30 m/s, depending on the solids, particle size, hardness, sharpness and slurry concentration. This translates to a maximum pump head of 25 to 50

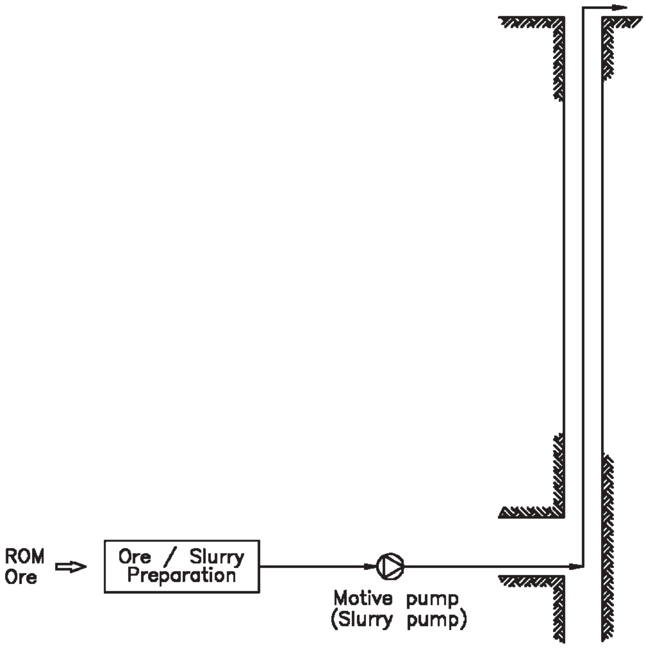

Figure 1. Typical pumping system configuration

metres. Several pumps in series increase the overall head developed, subject to a pump casing pressure limitation of typically 4.5 MPa.

The advantages of centrifugal pumps are low unit cost and high volumetric capacity. The main disadvantage of centrifugal pumps is the limitation on vertical lift resulting from the relatively low slurry pump casing pressure rating. For a typical platinum hoisting application, the 4.5 MPa pressure limit translates to a maximum vertical lift of about 230 m. A number of pump stations in series are required to achieve reasonable lift heights.

Centrifugal pump trains suffer from low availability requiring the duplication of all pumps to provide stand-by capacity. For a typical platinum application with a 1 000 m lift, five pump stations are required with 60 installed pumps. Centrifugal pumps are impractical for high lift applications.

Positive displacement pumps

Three types of positive displacement pump are available for slurry applications:

- Plunger pump
- Piston pump
- Piston diaphragm pump.

The piston diaphragm pump is most suitable for hydraulic hoisting applications as a flexible diaphragm separates the slurry from the driving piston. The only wearing parts in contact with slurry are the membrane and valves. These pumps operate with duplex double-acting pistons or triplex single-acting pistons and produce discharge pressures of up to 25 MPa. This translates to a lift capability of more than 1 200 m for platinum hoisting applications.

Nitrogen-filled pulsation dampeners smooth the pressure pulsations produced by the pumps.

The main drawback associated with piston diaphragm pumps is the particle size limitation. The maximum allowable particle size is 4 mm and the slurry must also have sufficient fine particles, as shown in Figure 2 (information provided by pump manufacture Geho). To comply with this size distribution limitation, three-stage crushing or milling is required.

Mars pump

As shown in Figure 3, the Mars pump developed by Mitsubishi is also a positive displacement pump. The reciprocating movement of the piston is transmitted via an oil buffer onto the slurry in the oil chamber. On the outward stroke of the piston, the oil level in the oil chamber moves up and the slurry flows via the suction valve into the oil chamber. The oil and slurry in this chamber are immiscible. On the inward stroke of the piston, the oil level in the chamber moves down and the slurry is pumped out through the delivery valve. By using a double-action two-cylinder pump, together with pulsation dampeners on the suction and delivery pipes, near continuous flow is achieved. The main advantage of this system is that the slurry never comes into contact with the piston or cylinder and there is therefore little wear of these components.

The Mars pump technology has been be superseded by piston diaphragm pumps but is included in this review for historical interest (Vaal Reefs installation described later in this paper).

Feeder systems

Feeder systems isolate the slurry from the motive pump. The slurry is ‘pumped’ indirectly from a chamber using high pressure motive water. The primary advantage of feeder systems is that the motive (high pressure) pump handles clean water only, significantly reducing pump operating costs.

Feeder systems operate in two configurations:

- U-tube arrangement, as shown in Figure 4. The static water head from surface is available and the motive pump energy input is only required to overcome friction losses and the density difference between the downcoming water pipeline and the rising slurry pipeline. The U-tube configuration is suitable where water is required underground to make up slurry for ore hoisting or it is desirable to simplify the underground installation. As the volumetric flow rate in the downcoming and rising pipes are equal, water equal to the volume of solids hoisted must be pumped out of the mine (generally using the mine dewatering system).

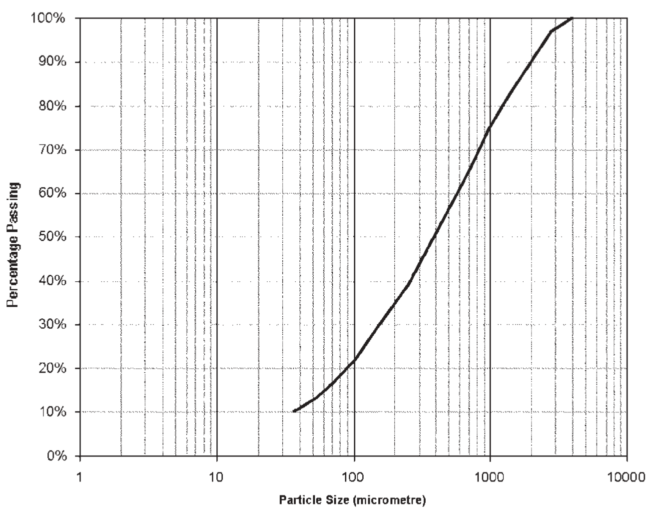

Figure 2. Upper particle size grading limit for piston diaphragm pumps

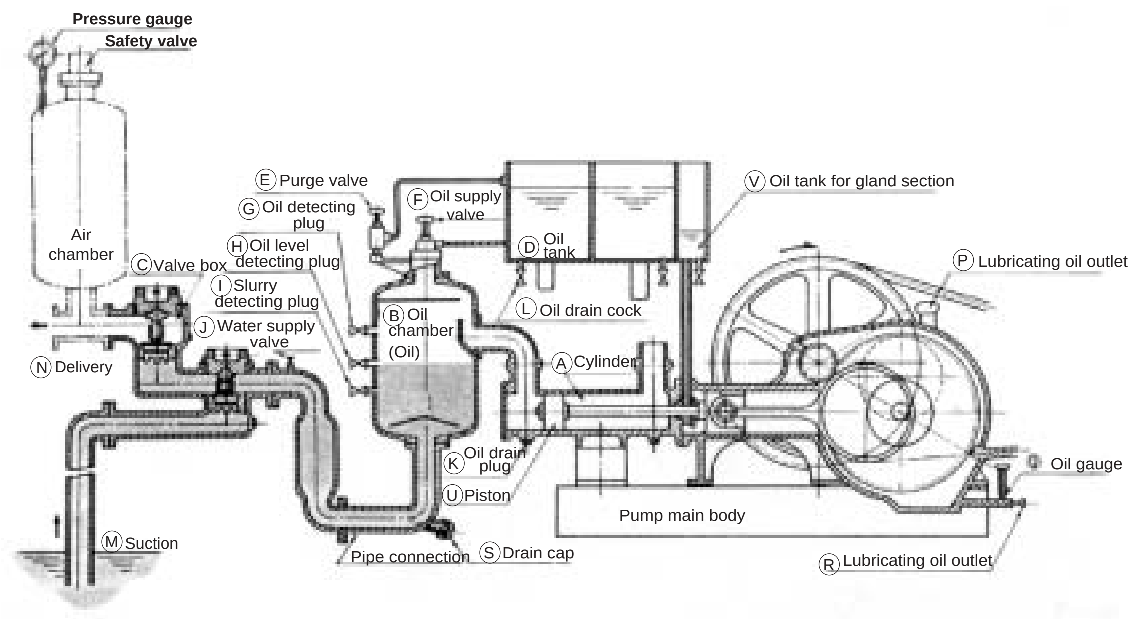

Figure 3. Mars pump

- Where there is an excess of water in the mine, it can be efficient to use clarified mine water for ore hoisting and install the motive pump underground, as shown in Figure 5. In this case, the motive pump must overcome the full static head and friction losses.

Feeder systems are classified as fluidizing or displacement feeders, as discussed below.

Fluidizing feeders

A number of fluidizing feeder concepts have been developed for hydraulic hoisting:

- Lock hopper feeder (Condolios *et al.*, 1963)
- Hydro-lift feeder (Laubscher and Sauermann, 1972)
- Tore feeder developed by Merpro Process Technologies Ltd.

The fluidizing feeder concept is discussed with reference to the Hydro-lift shown in Figure 6. The pressure vessel is isolated from the pipeline during filling. The water-filled vessel is charged with ore displacing water, which overflows from the vessel. The ore feed and overflow valves are closed and the vessel is pressurized. Motive water introduced via the jet nozzle entrains ore through the annular gap between the nozzle and the sleeve valve and carries slurry up through the discharge pipe. For continuous ore transport, either multiple vessels (cycling between filling and discharging) or a lock hopper ore feed arrangement (to allow for filling under pressurized conditions) is required.

Fluidizing feeders have two key drawbacks that render them unsuitable for platinum ore hydraulic hoisting:

- Fine, slow settling particles flow out of the vessel with the displaced water during the ore filling cycle. Thus further handling is required to recover and transport fine particles
- During the ore-filling cycle, large heavy particles settle to the bottom of the vessel first, followed by finer light particles. When the vessel is discharged, the large particles enter the pipeline first, followed by fine particles. Due to slip, the fine particles travel faster than the large particles and blockages may occur due to a concentration build-up as the fine particles overtake the large particles.

Displacement feeders

Various complex displacement feeders have been developed for hydraulic hoisting (e.g, Jupiter pump developed by Haggie Rand and Hitachi slurry hydro-hoist). These systems were designed to handle fine particle slurries and the technology has been superseded by piston diaphragm pumps.

The three-chamber pipe displacement feeder system has been most widely used for hydraulic hoisting and remains the simplest and most appropriate technology for slurries with wide particle size distributions. As illustrated in Figure 7, the use of three chambers (long horizontal lengths of pipelines) allow for continuous slurry discharge. While the content of the first chamber discharges into the high pressure delivery pipeline, the second chamber fills with slurry and the third is in the waiting position. All valves are actuated in a strictly controlled timing sequence to ensure a smooth flow through the system.

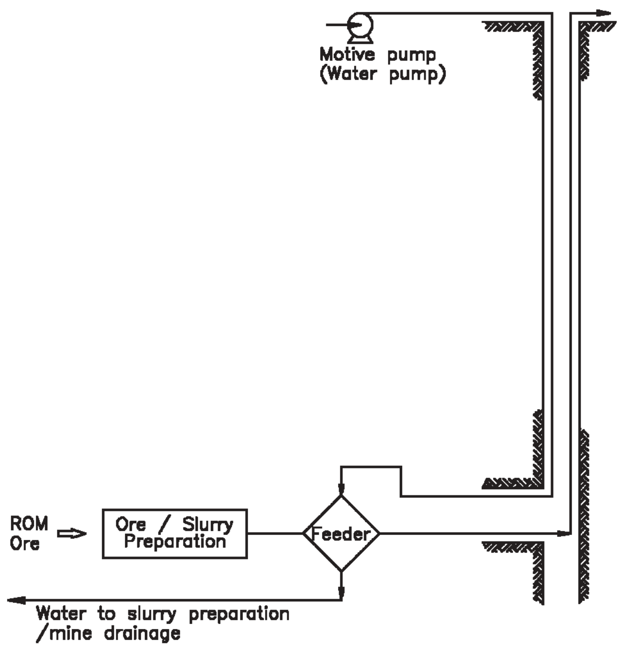

Figure 4. U-tube type feeder system

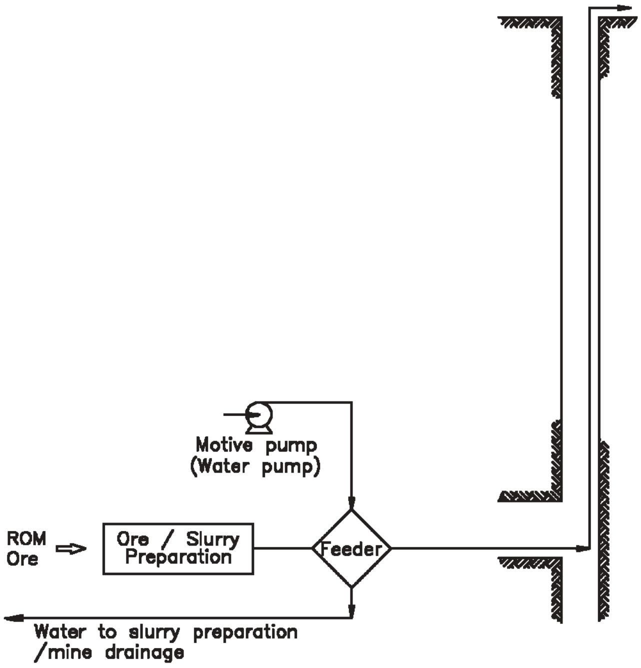

Figure 5. Feeder system with motive water pump underground

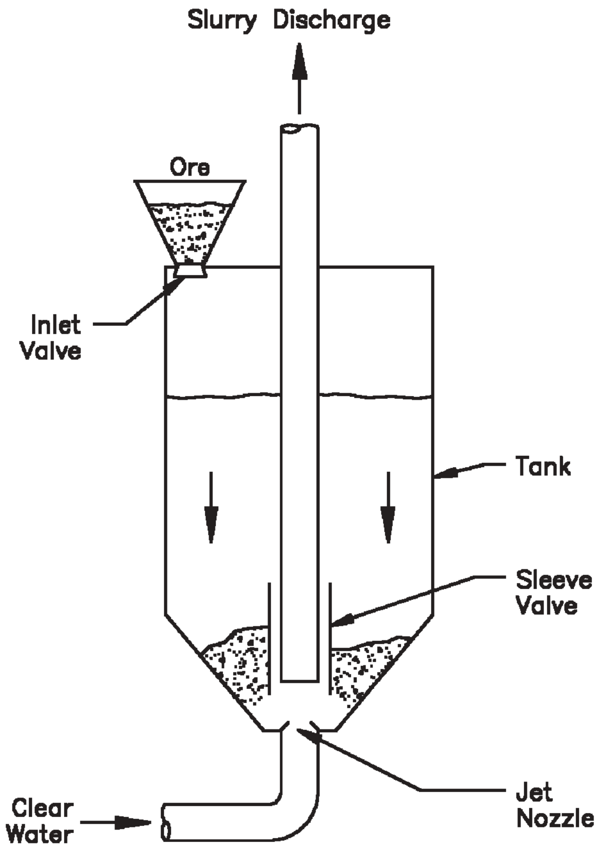

Figure 6. Hydro-lift feeder

Novel technologies

The current novel proposals for hydraulic hoisting relate to modifying the properties of the carrier fluid.

- Viskeau, UK, propose a system where an organic polymer is used to change the carrier fluid rheology to aid particle transport. It is claimed that it is possible for the system to be shut down without the need for flushing as the ore particles can be maintained in suspension in the quiescent state. While further work is required to validate these claims, the major concern for platinum ore applications is the effect of the polymer on PGM flotation recovery
- It has been suggested that using a U-tube feeder system combined with a high density conveying medium (ferrosilicon or magnetite slurry) will permit hoisting without the need for a motive pump. The density of the dense medium in the down leg will be greater than that of the ore and dense medium mixture in the vertical delivery column, thereby driving the flow through the U-tube. Significant work is required before this concept can be considered for platinum ore hoisting.

Hydraulic hoisting installations

The key parameters of hydraulic ore hoisting systems reviewed in this section are summarized in Table I. Most successful hydraulic hoisting systems have been implemented in the coal-mining industry based on the three pipe chamber concept.

There has been significant interest in developing hydraulic hoisting systems for gold mines, namely Doornkop and Mina Grande. These systems were close to being implemented, but unfortunately in both cases the implementation was terminated due to a drop in the gold price.

Recently a positive displacement pump hoisting system has been installed in the McArthur River Uranium Mine. This novel application includes underground milling and it is likely to be the forerunner of a number of successful applications based on piston diaphragm pumps.

Mitsui-Sunagawa Colliery, Japan

Hitachi implemented the Mitsui-Sunagawa Colliery -30 mm coal hoisting system in 1965. The system, which operated reliably for over 20 years, was based on the three-pipe chamber feeder concept with the motive water pump installed underground.

Vaal Reefs No. 1 Shaft, South Africa

The -2 mm gold ore hoisting system was installed at Vaal Reefs No. 1 Shaft in 1970 utilizing the Mitsubishi Mars

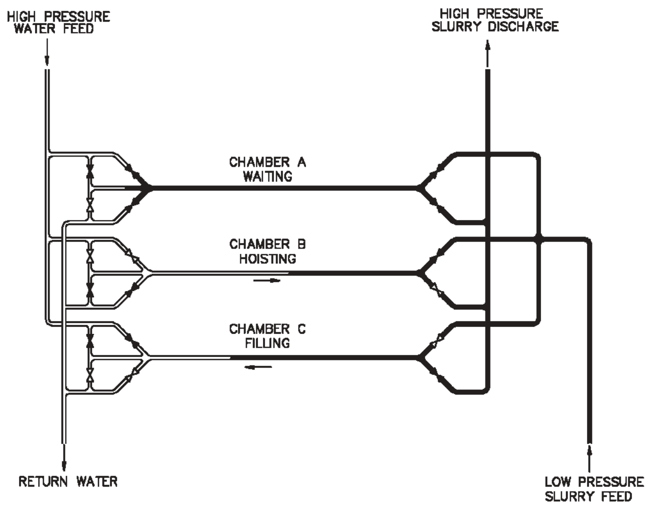

Figure 7. Three-chamber pipe displacement feeder

Table I
Selected hydraulic hoisting installations

Mine	Mitsui-Sunagawa Colliery, Japan	Vaal Reefs No. 1 Shaft, South Africa	Hansa Mine, Germany	Loveridge Coal Mine, USA	Sabero Coal Mine, Spain	Doornkop Mine, South Africa	Mina Grande, Brazil	McArtur River, Canada
Pumping system	Hitachi 3CPF, motive pump u/g	Mitsubishi Mars pump (seven stages)	Horizontal Centrifugal pumps Vertical Siemag CPF with U-tube arrangement	Centrifugal pumps (seven in series)	Centrifugal pumps (horizontal) Siemag CPF (vertical) with motive pump u/g	Siemag CPF (vertical) with U-tube arrangement	2 x Siemag CPF (vertical) with U-tube arrangement	Horizontal Centrifugal pumps Vertical 2 x Wirth piston diaphragm pumps (operating and standby)
Material	Coal	Gold ore	Coal and waste rock	Coal	Coal	Gold ore	Gold ore	Uranium ore
Max. particle size	30 mm	2 mm	60 mm	100 mm	30 mm	30 mm	8 mm	0.5 mm
Capacity	100 t/h	55 t/h	250 t/h	840 t/h	50 t/h	250 t/h	75 t/h	54 t/h
Pipe size	150 mm	150 mm	250 mm	300 mm	125 mm	200 mm	125 mm	100 mm
Vertical hoist (m)	520 m	2 200 m	850 mm	270 m	570 m	1 160 m	2 222 m	650 m
Horizontal distance (u/g)	200 m	–	2 800 m	3 350 m (max)	1 350 m	–	3 665 m	variable
System pressure	8.5 MPa	8 MPa	12 MPa	3 MPa	7 MPa	25 MPa	25 MPa	12.5 MPa
Status	Operated 1965–1987	Operated 1970–?	Operated 1977–1980	Operated 1980–1987	Operated 1988–?	Not installed	Not installed	Operating 1999–

Abbreviations: 3CPF Three chamber pipe feeder
u/g underground

pump (Burge, 1972). The system was designed with four pump stages in series for the 2 200 m lift but was upgraded to seven stages to reduce system pressures. A small transfer tank provided a pressure break at each stage. The pumping flow rate was increased at each successive stage, with make-up water added at the transfer tanks to balance the system.

The installation was not successful due to problems with the pumping system and a throughput of 6 800 tons per month was achieved (compared to the design value of 22 000 tons per month). The failures were mainly related to the pump gear boxes, high pump stroke rate and pipe bursts associated with cavitation.

Hansa Mine, Germany

The Hansa Mine hydraulic ore transport system was commissioned in November 1977. 250 t/h of -60 mm coarse run-of-mine coal was transported horizontally over a distance of 2 800 m using centrifugal pumps and vertically 850 m using a Siemag three-chamber pipe feeder system. The pipe feeder operated without any major problems and proved to be efficient and reliable (Jordan and Dittmann, 1980).

Loveridge Coal Mine, USA

The Loveridge mine hydraulic ore handling system was designed to transport coal from low capacity continuous miners and a much higher capacity longwall mining machine (Alexander, 1983). The coal was crushed to a top size of 100 mm, mixed with water and pumped to an underground wet storage area. The coal was re-slurried using a travelling dredge and pumped 270 m to surface using seven centrifugal pumps in series.

The average daily throughput exceeded 200% of the target design values with a system availability of 93%.

Sabero Coal Mine, Spain

A Siemag three-chamber pipe feeder system was installed in 1988. Conventionally mined coal from the working faces was washed over screens for removal of plus 30 mm material which was conventionally hoisted. The -30 mm slurry was pumped 1 350 m horizontally to the three-chamber pipe feeder, which hoisted the coal slurry to surface. Sabero subsequently installed a second three-chamber system to enable the entire mine output to be hydraulically hoisted.

Doornkop Mine, South Africa (proposed)

Although the Doornkop hydraulic hoisting system was not installed due to a change in economic conditions, the system design parameters are of technical interest. It was designed to increase the shaft hoisting capacity by 100 000 tons per month by hydraulically hoisting 250 t/h of -30 mm screened ore via a 200 mm pipeline from a depth of 1 200 m using a three-chamber pipe feeder system operating at a pressure of 25 MPa.

Napier (1989) describes the extensive work conducted to verify the proposed design:

- Pipe loop tests were conducted at the University of Hanover to prove the operational reliability of the main chamber valves, determine the ore settling characteristics of the ore in the chambers and evaluate the slurry flow behaviour to allow for optimal design of the system. There was concern that some heavier particles may be left behind during the acceleration and transport phase of the operating chamber, eventually

resulting in an accumulation of particles that could block the chamber. A transparent pipe installed in the test loop showed that all the ore was cleared on every stroke
- Wear tests were carried out by the University of Cape Town. Based on this work, it was decided to use either high alumina or polyurethane to line the horizontal sections of the pipe runs. The vertical piping was to be unlined
- A stress analysis, supported by test work, was conducted to validate the fatigue life of the installation.

Mina Grande, Brazil (proposed)

During the early 1990s a detailed investigation was conducted to implement a hydraulic hoisting system for the Mina Grande Gold Mine to overcome ineffeciences associated with hoisting the ore via six sub-vertical shafts (Reis and Denes, 1994). The system was not implemented due to a decision to close the mine but, as with the proposed Doornkop installation, the system is of technical interest.

It was proposed to transport 75 t/h of –8 mm gold over 3 665 m horizontally and 2 222 m vertically using two 125 mm three-chamber systems operating in series. A primary crusher was to be located on each mining level with a secondary and tertiary crusher feeding minus 8 mm ore to the hoisting system. Transport from the mining levels would be by conveyor to the secondary crusher installation. The study concluded the total project (including mining method upgrade) would cost US$52 million and take five years to implement. This was considerably cheaper than the US$94 million cost of the cheapest conventional shaft alternative with an eight-year implementation time.

Extensive test work was conducted to:

- Determine pipeline wear rates and identify suitable piping materials
- Establish the pipeline friction losses, minimum operating velocities and maximum operating concentration.

McArthur River, Canada

Underground lateral ore pumping and hydraulic hoisting systems form an integral part of the remote mining method devised for the high-grade McArthur River uranium deposit. A raise bore machine reams out 2.4 m diameter holes between drifts established in barren rock above and below the orebody. The rock chips generated by the raise bore fall into a transportable screening plant located below the hole and sealed up against the back of the drift to eliminate spillage. The minus 20 mm fraction is slurried and pumped to a central SAG mill installation. The plus 20 mm fraction is collected in a holding container for transport to the SAG mill by a remotely controlled scoop tram. The SAG mill is operated in closed circuit with a 500 µm classifying screen. The milled ore is thickened to 50% by mass in underground thickeners and then stored in an air agitated tank prior to being pumped to surface using a piston diaphragm pump. The system transports 54 t/h of ore from a depth of 650 m via a 100 mm pipeline installed in a dedicated borehole.

Platinum mine hydraulic hoisting system

Key factors

The key factors considered in the selection of a hydraulic hoisting system for platinum mines are:

Pump/feeder system

Fluidizing feeders are not considered feasible due to the large percentage of fine particles in the run of mine platinum ore.

Positive displacement pumps were thought to be an attractive option for hydraulic hoisting due to the high mechanical reliability and efficiency of the pumps. However, due to the need for underground milling or three stage crushing, the capital costs are prohibitive.

The three-chamber pipe feeder system is selected for platinum mines based on the following:

- Simplicity of operation and low technology requirement. The most complex component of the system is the chamber isolation valves
- The concept is well proven and has a good installation history. Admittedly these have been on coal applications with relatively low wear rates, but provision can be made for the wear rates expected for platinum ore
- The capital and operating costs are relatively low compared with other systems.

U-tube configuration

The U-tube configuration is selected for the following benefits:

- Energy efficiency through utilizing static head
- Provision of the bulk of the system power requirements on surface (motive pump)
- The ability to swop over the water and slurry pipelines to maximize the system life.

Process water

Metallurgical plant process water is provided on surface for the motive pump. This avoids concerns about potential flotation circuit recovery problems due to the use of contaminated mine water.

Surge capacity

All surge capacity is provided in dry silos underground. No wet slurry storage is provided to avoid oxidation of the ore.

Typical system configuration

As shown in Figure 8, a typical platinum mine hydraulic hoisting installation will comprise the following primary components:

- Ore preparation plant to produce material with a top size of typically 15 mm:
  - For supplemental hoisting applications, a screening plant may generate sufficient tonnage. In this case the +15 mm material is conventionally skip hoisted.
  - If all the ROM ore is to be hydraulically hoisted, a two-stage crushing circuit is required.
- Slurrification plant to produce -15 mm slurry at a consistent concentration
- Motive water pump on surface
- Three-chamber pipe feeder system
- Borehole to house the high pressure motive water and slurry delivery pipelines
- Metallurgical plant interface. Typically the -15 mm slurry is pumped directly into the mill circuit.

Capacity

Figure 9 shows a typical hydraulic hoisting system sizing selection chart developed for UG2 ore. To hoist 60 000 tons

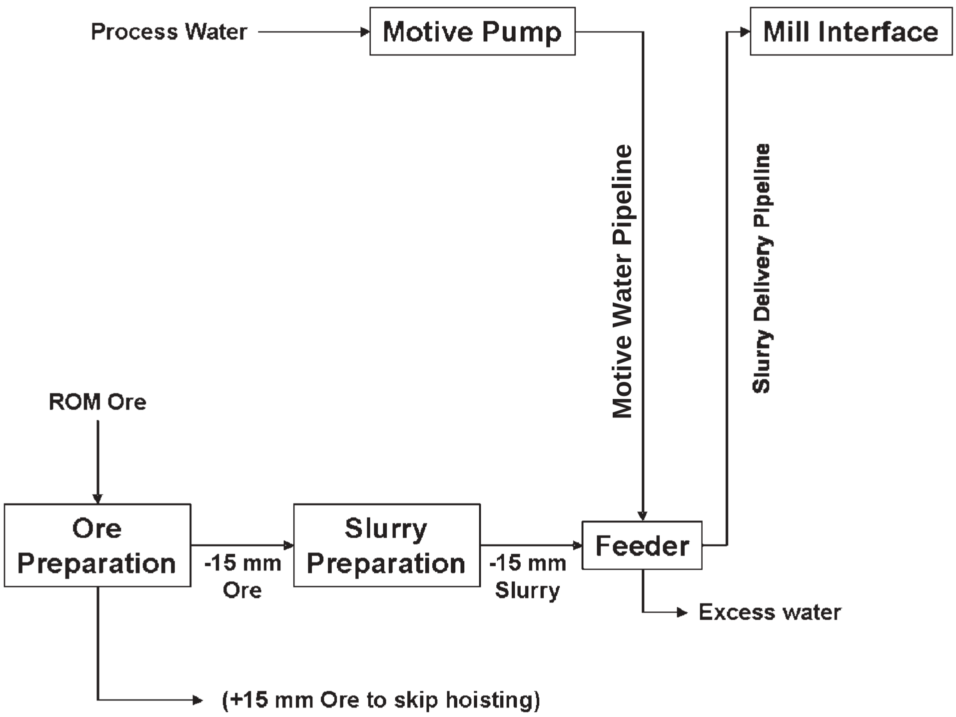

Figure 8. Typical hydraulic hoisting system flow sheet

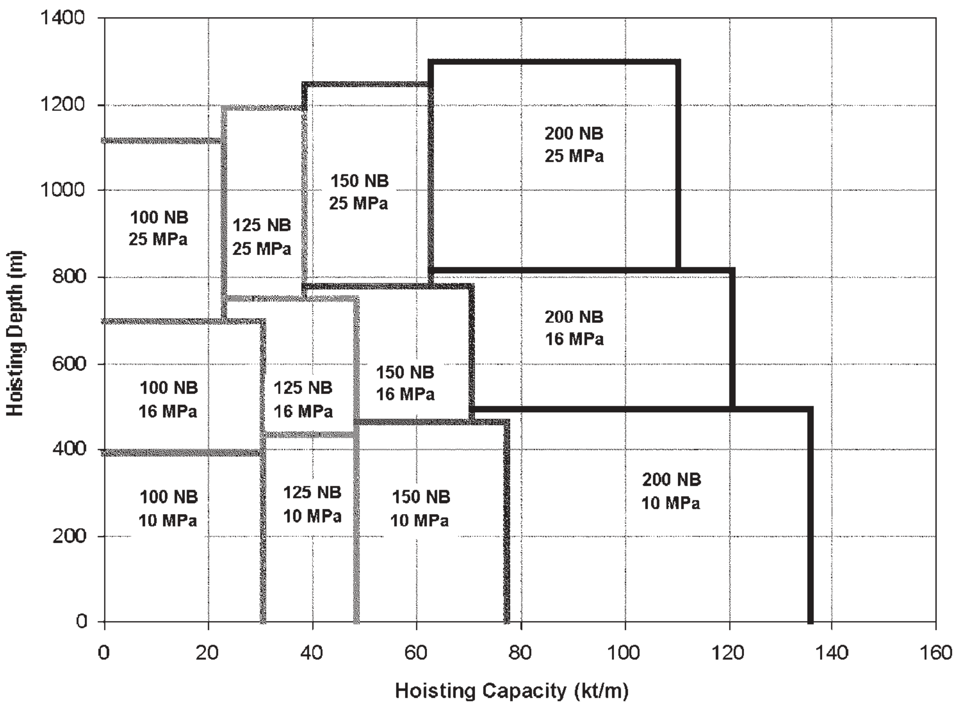

Figure 9. Hydraulic hoisting system selection chart (UG2 Ore)

of ore per month from a depth of 1 200 m requires a 150 mm system with a 25 MPa pressure rating.

Although the chart is drawn for pipe sizes from 100 mm to 200 mm, larger pipe sizes are technically feasible. For example, a 300 mm system will have a capacity of 260 000 tons per month.

Generic costs

A detailed study has been undertaken to establish generic costs for hydraulic hoisting installations (range of capacities and hoisting depths). Figure 10 shows the variation of capital cost (screening and crushing plants) with capacity for a 1 000 m deep hoist. The costs include equipment, excavations, civils, boreholes, underground ventilation, electrical supply, the metallurgical plant interface and an allowance for 500 m of horizontal piping (on surface or underground).

The operating costs per ton of ore hoisted are illustrated in Figure 11. Electrical, maintenance and personnel costs are included.

Platinum mine installations: opportunities, considerations and risks

Platinum fines

Figure 12 shows the characteristic size distribution of ROM UG2 ore with about half the ore naturally breaking to a particle size of less than 1 mm after blasting. What is of particular interest is the high percentage of PGMs in the fines – nearly 40% of the PGMs are in the -10 μm fraction. Although still to be quantified, it is believed that fines loss during skip hoisting and surface transportation (loading, tramming and conveying) could be significant.

A hydraulic hoisting system would capture the fines underground and transport them to the surface concentrator without any loss.

Supplemental hoisting

Hydraulic hoisting systems installed to supplement a mine's existing hoisting capacity are likely to be financially attractive for the following reasons:

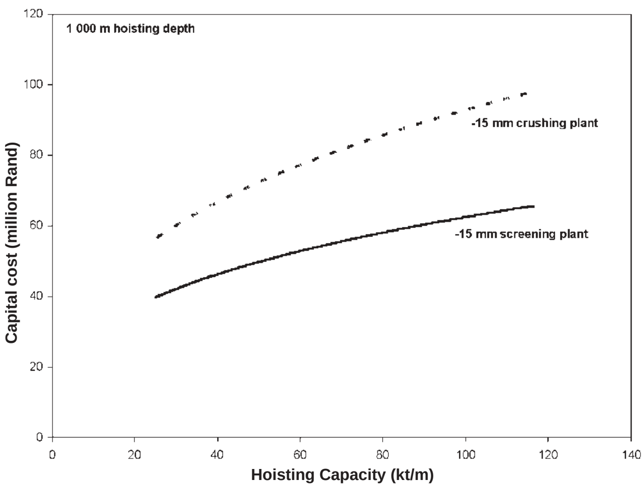

Figure 10: Hydraulic hoisting system capital costs

- It may be possible to produce sufficient sized material for hydraulic conveying by screening the ROM ore. For example, nearly 60% of the ore shown in Figure 12 is finer than 15 mm. This saves the cost and complexity of installing an underground crushing plant. An additional advantage is that fines-related problems associated with skip hoisting are reduced
- If the additional tonnage is a relatively small percentage of the ore being hoisted, there may be negligible additional capital costs associated with mining and the metallurgical plant.

New mines

The following points should be considered for potential new mine applications:

- The energy consumption of vertical shaft skip hoisting and hydraulic hoisting is similar. Although further work is required, it is likely that hydraulic hoisting will be more energy efficient than decline ramp hoisting systems
- A shaft is generally required for ventilation so it may not be possible to significantly reduce the mine implementation time (there will be some savings in equipping the shaft)
- As rock can be hydraulically hoisted from the mining area centroid, underground rock handling and transportation systems can be significantly simplified. It will be relatively inexpensive to provide a number of hoisting systems within a mine.

Site-specific factors need to be assessed to determine the suitability of hydraulic hoisting technology for each case.

Hoisting depth

For platinum mines, the hoisting depth is ideally limited to about 1 200 m. Deeper installations are possible but will require the use of very high pressure components or a series installation. Neither option is considered desirable until there are a number of systems operating at shallower hoisting depths.

Metallurgical considerations

There are a number of metallurgical issues to be considered:

- The quality of water used may have a bearing on the

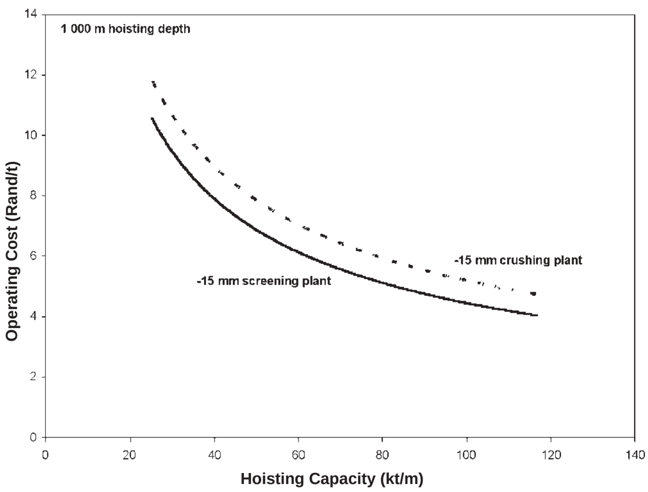

Figure 11. Hydraulic hoisting system operating costs

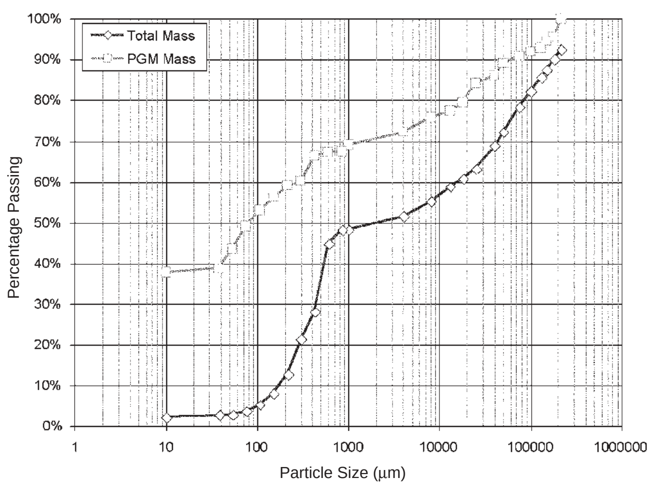

Figure 12. Typical ROM UG2 Size and PGM distributions

efficiency of the flotation process. If the mine water quality is not considered suitable, metallurgical plant process water will be used for hoisting.
- During transportation, the ore slurry is subjected to a sudden high pressure as the chamber is pressurized followed by a gradual pressure reduction as the slurry flows to surface. There is some concern that this pressurization cycle may effect PGM recovery. Test work is still to be conducted to investigate this issue.
- There are indications that the PGM recovery from natural fines (less than 500 μm) is enhanced through flotation prior to milling. The discharge from a hydraulic hoisting system can be split into a fine stream (to natural fines flotation) and a coarse stream (for milling) through screening or cycloning on surface.
- There are various issues regarding the metallurgical plant interface (primarily related to the mill feed control system) that need further investigation.

Technical risk

All proposed hydraulic system components are proven: crushing circuit, three-chamber pipe feeder option, high-pressure piping, boreholes and vertical solids, transportation. The only unknown factor is the wear rates of the valves and piping. Wear rates have been estimated using test data for gold ore (Cooke, 1996). It is planned to determine platinum ore wear rates through pilot plant investigations; however, the business cases investigated show that the financial viability of the installations are not sensitive to wear rate (i.e. piping and valve replacement frequency).

Conclusions

Hydraulic hoisting is technically feasible and financially attractive for platinum mines. It offers a viable method for increasing production from existing shafts at relatively low capital cost and within a short implementation time (one year). Hydraulic hoisting systems provide significant flexibility, allowing underground rock-handling systems to be simplified.

It is recognized that a hydraulic hoisting system must be proven in a platinum mine application before the technology will gain industry-wide acceptance. This first installation will be a technology demonstrator and ideally the application should have one or more of the following attributes:

- Supplemental hoisting system where sufficient ore can be screened from the ROM feed. This will simplify the underground installation as crushing will not be required
- A dedicated waste rock hoisting system will avoid any metallurgical complications
- Relatively low tonnage (under 40 000 tons per month)
- Hoisting depth of less than 1 200 m.

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