The Development of Mineral Process Separating Interstage Screens (MPS) From the NKM Interstage Screen

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INTRODUCTION

The use of activated carbon to recover gold via Carbon-in-Pulp (CIP) Carbon-in-Leach (CIL) and Carbon-in-Columns (CIC - principally in heap leaching operations) catalysed a world wide gold boom over the last twenty years. The rapid growth of carbon technology for gold recovery has provided a driving force for the development of new equipment, one of the focus areas being the development of efficient interstage screening systems. The early developments in interstage screening involved either external vibration screens that allowed the pulp to flow through to the next contactor while the carbon was returned to the same tanks or air swept screens such as the EPAC (equalised-pressure air cleaned) in its various forms.

The operating problems such as high operating and maintenance costs and frequent screen cloth failing led to the development of mechanically swept screens. The first was the Kambalda Screen, a horizontally swept screen. The introduction of the Kambalda screen led to the replacement of EPAC type screens to Kambalda screens on many gold plants in South Africa[1], however, operating problems such as:

- operation inflexibility - the pulp level must be lowered below the screen to maintain the screen thus frequent contactor bypassing occurs,
- high power requirements due to horizontal wiper blades. This is especially a significant problem on large adsorption circuits such as the Daggafontein gold plant (treating 1000 000t/m through to two carbon-in-leach circuits),

lead to the development of the NKM vertically swept interstage screen, which became the preferred interstage screen[2].

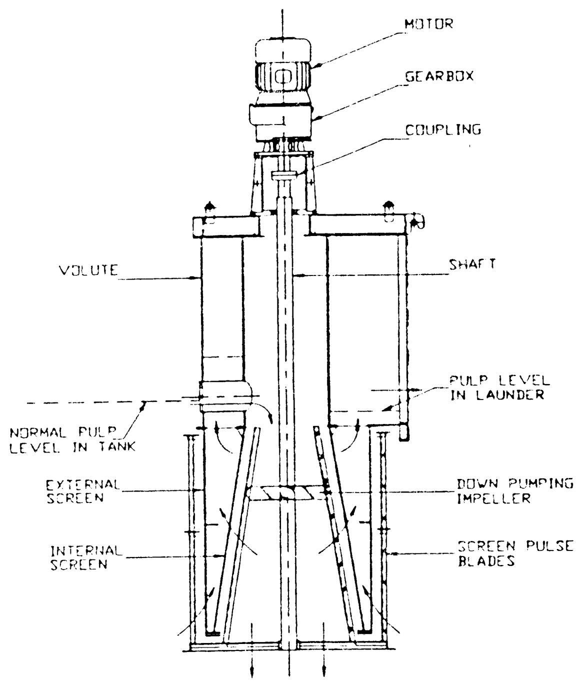

FIGURE 1.
TYPICAL NKM SCREEN ARRANGEMENT

THE NKM INTERSTAGE SCREEN

The NKM interstage screen was developed in 1986 for the Daggafontein Carbon-in-Leach gold plant[3] from an idea originating from a similar screen seen in Australia, hence the name North Kalgoorlie Mines (NKM).

The screen as shown in Figure 1 is in the form of a basket with rotating pulse blades around each screen surface. Pulp passes through both sides of the screen basket with carbon being retained to a small degree on the screen surfaces but dislodged due to the pulsating effect of the pulse blades thus enabling relatively unrestricted pulp flow through the screen.

A downthrust impeller is attached to the unit's central drive shaft which circulated pulp through the unit. The screen was designed to have a specific throughput of between 70 and 100 m^3 per hour per m^2 screen area. The range depends on the quality of the feed material, the lower value being caused by near size grit and wood chips.

A comparison of pulp throughputs through the various screens is shown in the table below.

TABLE 1.
COMPARISON OF THROUGHPUTS THROUGH INTERSTAGE SCREENS

Screens	Specific pulp flow rate $m^3/m^2/hour$
External Vibratory Screen	54
EPAC Screens	20 to 40
Kambalda	40
NKM	70
NKM (without inside cone)	70

Based on references 1 and 2 and current practices in South Africa.

The high throughputs through the NKM screen and its ease of maintenance has resulted in the NKM screen being accepted as "state of the art" for interstage screens in Carbon-in-Pulp (CIP) and Carbon-in-Leach (CIL) plants world wide. However, the NKM type screen does have some short comings:

a) The internal conical wedge is difficult to keep clean, thus usually becomes irreversably "pegged" or blanked off. This results in a 30% loss of open area, thus the cylindrical screen takes all the flow resulting in a reduction in screen life due to increased wear rate.

b) The NKM screen is adversely affected by low flow rates or loss of flow because the dampening effect of the wedge wire screen on the pulse blades is so high that there is no agitation in the annular area created by the screen and cone. Since the NKM screen requires the full flow of pulp to maintain solids in suspension, phase separation occurs when there is low or no flow. The separated solids cannot be resuspended once normal pulp flow is restarted thus the NKM screen ends up operating in a clogged or semi-clogged condition. This forces the pulp flow to be directed through the upper section of the cylindrical screen resulting in an increase in wear rate.

The Mineral Process Separating Screen (MPS) and Mineral Process Separating (Pumping) MPS (P) Screens have been recently developed and designed to overcome the problems discussed above while retaining all the benefits of the NKM interstage screen.

MINERAL PROCESS SEPARATING SCREEN DESIGN

The Mineral Process Separating Screen is available as the normal MPS screen for cascading CIP and CIL in circuits and the MPS (P) screen. The difference between them is that the MPS (P) has an up-pumping mechanism that lifts the pulp inside the interstage screen and deposits it in a launder above the pulp level in the adsorption contactor. A diagram of the MPS screen is given in Figure 2 and for the MPS(P) screen in Figure 3.

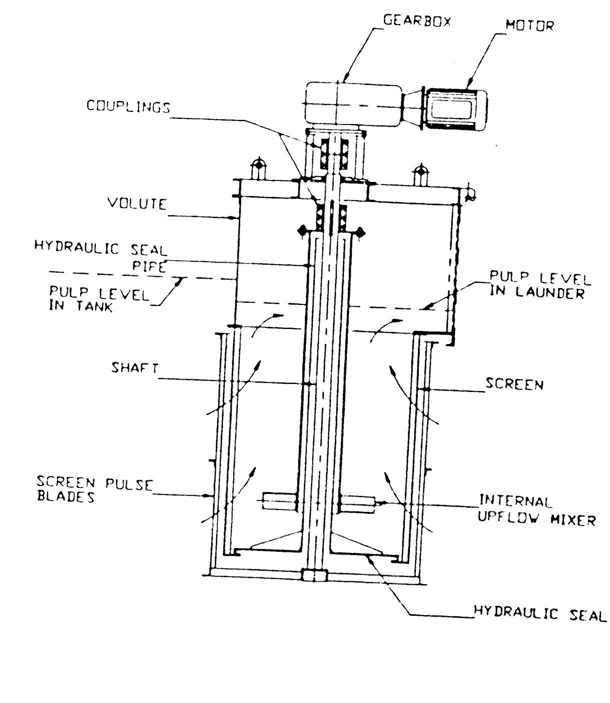

FIGURE 2.
SECTION THROUGH MPS SCREEN

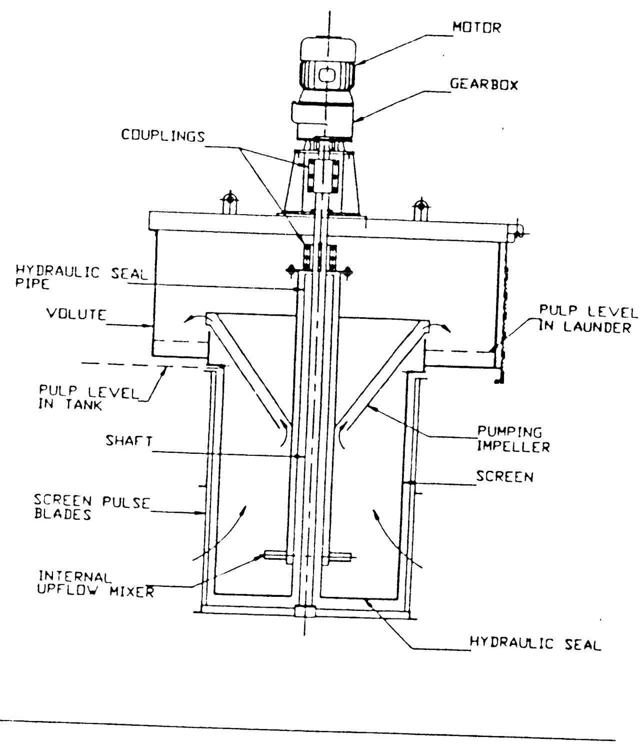

FIGURE 3.
SECTION THROUGH MPS PUMPING SCREEN

The MPS Screen

The MPS Screen incorporates a cylindrical wedge wire basket attached to the under side of a volute. Rotating around the periphery of the basket is a cage with pulse blades to keep the screen clear of carbon and other near size material. The drive shaft of the cage is surrounded by a stationary pipe which extends up beyond the slurry operating level. This pipe is referred to as the hydraulic leg which ensures that no pulp can by-pass the screen, forming a very effective seal without any rubbing parts. The hydraulic leg is attached to the screen at the bottom via a hydraulic seal base. Around the stationary hydraulic leg is a hollow shaft which is attached to the main drive shaft above the hydraulic leg. This hollow shaft rotates with the main drive shaft and has a mixer turbine attached which provides agitation inside the screen basket. The unit is driven by a gearbox and electric motor. The unique rotating cage sets up a pulse and sweeping action around the screen which keeps carbon off the screen. The screen is manufactured in stainless steel wedge wire or mesh or a combination thereof. The MPS screen is attached to the internal launder of the adsorption tank with a hook-on arrangement such that the complete mecha-.ism can be removed without undoing any bolts and without the need to drain the tank, like the NKM arrangement.

The features of the MPS screen are:

- The internal volume of the screen is a cylinder. Pulp flow through the screen mesh is evenly distributed over the whole screen area which ensures that the entire screen area is effectively utilised.
- The internal mixer ensures that the pulp contained within the screen basket is maintained in a fully suspended state even when there is no pulp flow through the intertank screen. If there are plant stoppages due to for example a power failure, which causes pulp to settle out inside the interstage screen, the MPS screen is able to resuspend the settled pulp using the internal mixer when restarted. Thus the MPS screen does not require physical cleaning after a plant shutdown. The MPS screen can also be operated at reduced flows without settling of pulp occurring inside the screen cylinder.
- The cylindrical screen mesh has easy access when the MPS screen is routinely maintained.

The MPS(P) Screen

The MPS(P) screen is similar to the MPS screen and has all the features of the MPS screen except for one important feature; the MPS(P) screen has an up-pumping impeller as part of its internal mechanism. The pumping impeller is a mixflo type specially designed to handle high flow rates to low heads at a low tip speed. The up-pumping impeller lifts the pulp from inside the screen cage and deposits it higher than the level of the pulp in the adsorption contactor in which the screen is operating. Thus, the MPS(P) screen is able to generate pulp height sufficient to overcome the pressure loss through the screen mesh, therefore overcoming the need to have a series of staggered adsorption contactors. The benefits of this screen are:

- The design of the MPS(P) screen allows all adsorption contactors to be placed at the same elevation. This would result in a considerable savings in capital costs in construction of the new adsorption circuit as costly civils to induce elevation are no longer required. The working platform on top of the adsorption circuit would also be level easing maintenance.
- Since the adsorption contactors are level, the carousel mode of operation can be utilised: that is the pulp feed and tailings discharge positions are rotated in such a manner that a counter current movement of carbon is achieved without the need to physically move the carbon from one contactor to another.

General Features Of The MPS And MPS(P) Screens

- **Flow Rate** - The tolerated flow rate per unit of the MPS and MPS(P) screens is between 70 and 100m^3 pulp per square metre of screen area per hour.
- **Power** - The power requirements of the MPS screen is very much lower than either air swept screens or other mechanically swept screens. Typically, at a flow rate of 500 cubic metres per hour, the MPS screen requires 5,5kW compared with 21kW for the Kambalda type screen and 27kW for an air swept screen.
- **Surge** - The MPS screen can handle fluctuating liquid levels up to 250mm differential head.
- **Cleaning** - The "launder hook-on" arrangement of the MPS screen allows the screen to be replaced with a clean screen within 10 to 15 minutes. It is not nevessary to drop the level of the tank and thus "off line" time is minimal, thus plant availability is maximized.
- **Handling Pulp with High Viscosities** - The internal up pumping impeller of the MPS(P) screen facilitates the transfer of highly viscous pulp through the interstage screen. This allows pulp that would normally be difficult to treat in a CIP plant in an unmodified form, to be treated without the need of expensive modifiers. This was demonstrated on testwork carried out on West African ore known for high viscosity and variability[4]. In the series of tests carried out pulp at a relative density of 1.27 (35% solids) both modified (calcium oxide/caustic) (viscosity = 22 m Pas) and unmodified (viscosity = 71 m Pas) was continuously passed through an MPS(P) screen at flow rates varying from 70m^3 pulp flow per square metre screen area per hour (m^3/m^2/hr) to 110m^3/m^2/hr with no detrimental effects. This shows that the MPS(P) interstage screen is suitable to handle pulp with high viscosities in preference to the normal MPS and NKM screens.

THE BENEFITS OF THE CAROUSEL MODE OF OPERATION

This is discussed in the sister publication covering Pump-cells, however, discussion applies to a carousel application utilising the MPS (P) screens equally well.

CONVERSION OF THE NKM TO MPS SCREEN

The difference between the NKM screen and the MPS screen is essentially related to the internal mechanism thus it is feasable to convert any NKM screen to the MPS at a minimal cost. This is currently being investigated at the Daggafontein Gold Plant in a joint project with KEMIX. It is not possible to convert NKM screens to MPS(P) screens due to differences in volute structure and launder requirements. The MPS(P) screen is seated higher on the adsorption contactor than the NKM screen.

CONCLUSIONS

The MPS and MPS(P) screens are an improvement on the NKM screen because they offer greater operational flexibility.

- The MPS screens can handle pulp throughputs ranging from zero flow to maximum designed flow without pulp settling inside the screens.
- The MPS screens are self cleaning with respect to start-up after a major plant shutdown.
- The MPS screen cylinders do not have an internal cone like the NKM screen. The screen mesh is easy to maintain when the MPS screen is on the ground.
- The MPS(P) screen offers the opportunity to either allowing the cascade adsorption circuit to have level contactors or to have a carousel adsorption circuit.
- The MPS(P) screen easily handles pulp with high viscosity.

REFERENCES

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2. Bailey, P. R. - "Adsorption Plant Design" page 19 in "Recent Developments in In-Pulp Technology" SAIMM Johannesburg 1991.
3. Whyte, R. M., Mollis, D. J. and Davidson, R. J. - Conf. on Sep. Processes in Hydrometallurgy. G, A, Davies Ed. Soc. of Chem. Ind. 1987 pp 298 to 321.
4. Cartner, W. N. - Report Covering Testwork for AAC, July 1994, KEMIX Confidential Report.

NOTE: PATENTS

COUNTRY	NUMBER
Argentina	321,462
Australia	90008/91
Brazil	9105024
Canada	2,058,532-3
Chile	1289-91
Colombia	352 762
Dom. Republic	78856
India	947/MAS/91
Mexico	9102694
Namibia	91/0130
Peru	195049
Philippines	44230
South Africa	91/1342
Spain	9102860
U.K.	9127135,3
U.S.A	5 238 117
U.S.S.R.	5010677.03
Zambia	48 / 91
Zimbabwe	16 / 91