

EFFECT OF VARIOUS VARIABLES ON GRAVITY GOLD RECOVERY IN GRINDING CIRCUITS – RESULTS FROM MATHEMATICAL MODELING

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Introduction

Gold recovery using gravity concentration has advanced significantly over the past twenty years, largely because of the advent of high capacity centrifugal gravity concentrators such as the Knelson Concentrator. Knelson Concentrators are almost always placed within the grinding circuit, either treating cyclone underflow or, less often, the mill discharge to take advantage of gold's unusual behaviour in grinding circuits. The fact that gold often accumulates in grinding circuits due to its grinding kinetics and classification behaviour in cyclones is well documented (Laplante et al. 1994). Gold grinds six to twenty times slower and its cut size in cyclones is approximately three times smaller than other minerals associated with gold ores.

Gold losses from flotation and cyanidation circuits can occur for numerous reasons. Coarse gold can work its way to tails in flotation circuits or have insufficient residence time to be leached in cyanidation circuits. Additionally, due its malleability, gold smears onto grinding media and mill liners and is lost during removal of these parts for mill maintenance and grinding media changeovers. Removing gold, while it is still coarse, is one the primary justifications for placing a gravity concentrator within the grinding circuit.

An iterative model was developed to further understand the factors affecting gravity gold recovery within a grinding circuit. Input variables for the model are; the gravity-recoverable-gold (GRG) content of the ore, the fraction of the cyclone underflow (circulating load) treated using a gravity recovery unit, the stage recovery of the gravity concentrator, the probability of a GRG particle reporting to the cyclone underflow (survival to cyclone underflow) and the probability of a GRG particle surviving as gravity recoverable in the grinding mill. A schematic of a standard grinding circuit layout is shown below in Figure 1.

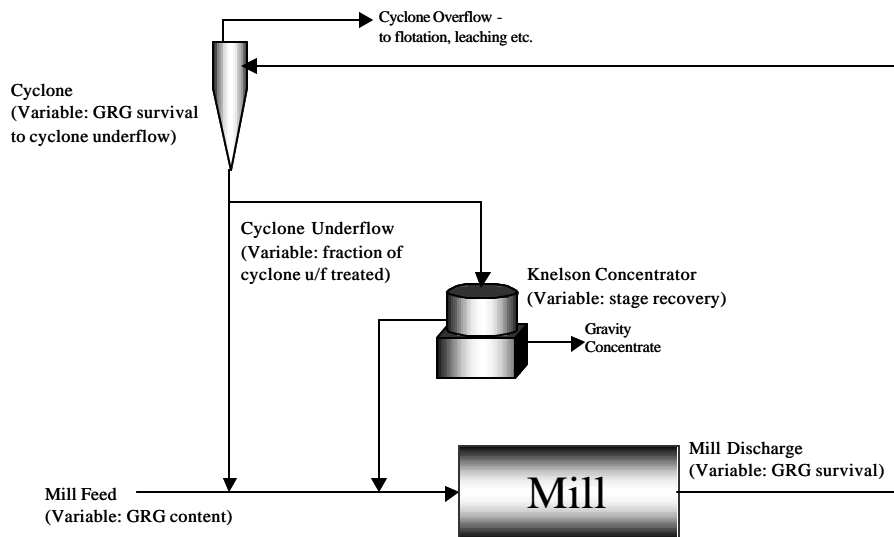


Figure 1. Typical gravity recovery circuit and model input variables.

The GRG value is determined by a three-stage sequential liberation and recovery test using a lab scale Knelson Concentrator. The test procedure is based on work done at McGill University (Woodcock et al. 1994) to develop a method to measure the gravity-recoverable-gold content of an ore sample. The values of the GRG survival in the mill and cyclone are based on ranges suggested by Dr. A.R. Laplante in various publications.

Discussion of Modeling Results

A series of recovery curves, at different GRG values, are plotted as a function of the circulating load treated in figure 2. The values or survival rate of GRG in the mill and cyclone underflow were set to relatively conservative

values of 95 and 98% respectively. The notable point here is that very high recoveries are achieved very quickly when increasing the amount of the circulating load treated. The theoretical recovery limit is the GRG value.

When the value of the gold survival is increased to 99% in both the mill and cyclone underflow, the relative increase in recovery is very significant as indicated by the arrows in figure 2. Only the curves for the 50 and 70% GRG values are plotted with the higher survival values. The most important result from the change in the survival rates is the increase in the slopes of the curves at very low circulating load values. The overall recovery approaches the theoretical limit of the GRG value very rapidly. These results support the common plant practice of treating only a fraction of the cyclone underflow to obtain a significant overall recoveries using gravity concentration.

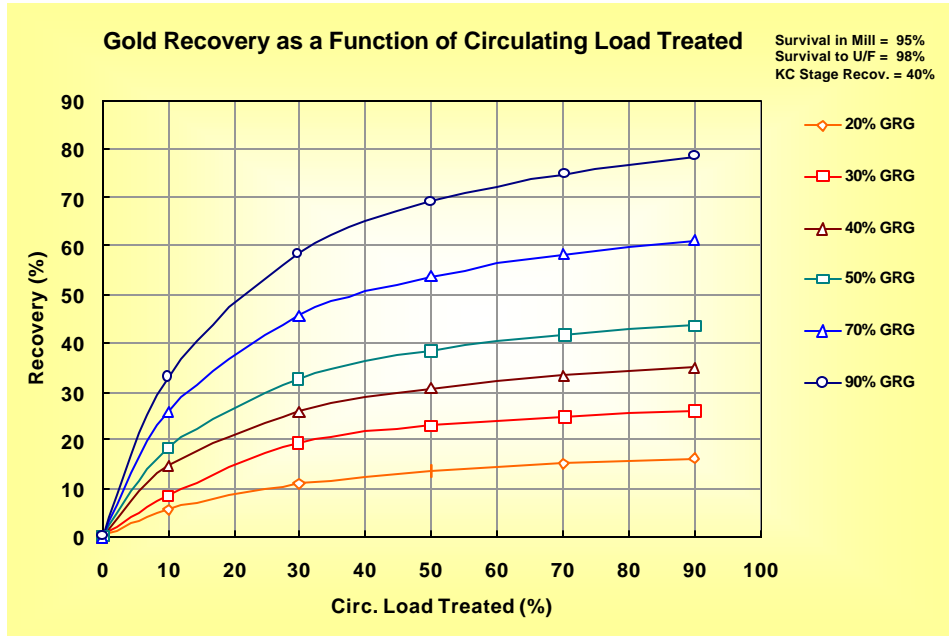


Figure 2. The gold recovery as a function of the circulating load treated at various GRG values.

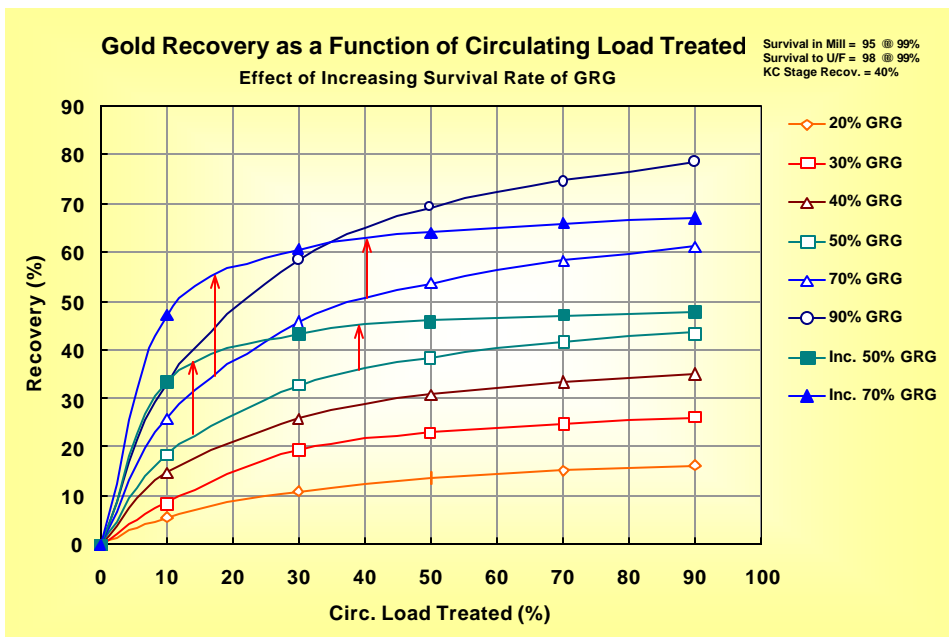


Figure 3. The impact of increasing the survival of GRG as gravity recoverable gold in the grinding mill and increasing the probability of GRG reporting to cyclone underflow (i.e. survival to U/F). The base survival values and new values are stated.

Conclusions

The impact of recovery of the gravity-recoverable-gold (GRG) is very highly dependent on: 1) the ability to prevent conversion of gold in to a non-gravity recoverable form in the grinding mill and 2) the ability to maximize the efficiency of the cyclone to redirect GRG to the underflow. As these losses of GRG are minimized, the amount of circulating load that needs to be treated to achieve equivalent gravity recoveries is reduced significantly.

References

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