# Some Variables Affecting Countercurrent Decantation

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Since its development about forty years ago by J. V. N. Dorr (Cyanidation and Concentration of Gold and Silver Ores, McGraw Hill Book Co., 1936, 1-5), and others, continuous countercurrent decantation has not only become one of the standard methods for extracting gold and silver from their ores, but has also found wide application in other metallurgical and chemical industries.

In 1917 L. B. Eames published an excellent paper (Countercurrent Decantation, Trans AIME, 1917, 57, 143-158), in which he determined the effects of grade of ore, ratio of solution precipitated to ore treated, variations in the density of the thickener spigot discharge and variations in the value of the barren solution upon the gold assay of the solutions discharged from the thickeners in the system. Eames showed that, other things being equal, the dissolved gold lost in the tailing varies directly as the value of the ore and as the value of the barren solution. The tailing loss decreases rapidly as the ratio of solution precipitated to ore treated is increased to about three or four to one. Beyond this point the improvement is negligible.

It is the object of this paper to present results of calculations for cyanidation in which four additional variables are considered, namely: the point of addition of barren solution to the circuit, the number of secondary thickeners, the percent of the soluble gold dissolved in the grinding circuit, and the omission of the primary thickener. Some of the variables considered by Eames and some of those to be discussed are subject to control while others are not.

The method for solving problems of this nature is well discussed elsewhere (J. V. N. Dorr: loc. cit. 133-139. A. Butts: Metallurgical Problems, 2 ed., McGraw Hill Book Co. 1943. 284-287) and hence won't be repeated here. There will be considered a common type of flowsheet, Fig. 1, consisting of one primary and four secondary thickeners having a spigot product with 50 percent solids. It is assumed that 75 percent of the values are dissolved in the milling circuit and 25 percent in the agitators and that the liquid-to-solids ratio of the feed to the primary thickener is five to one. Dissolution in the secondary thickeners will be neglected. Furthermore, as is customary, it will be as-

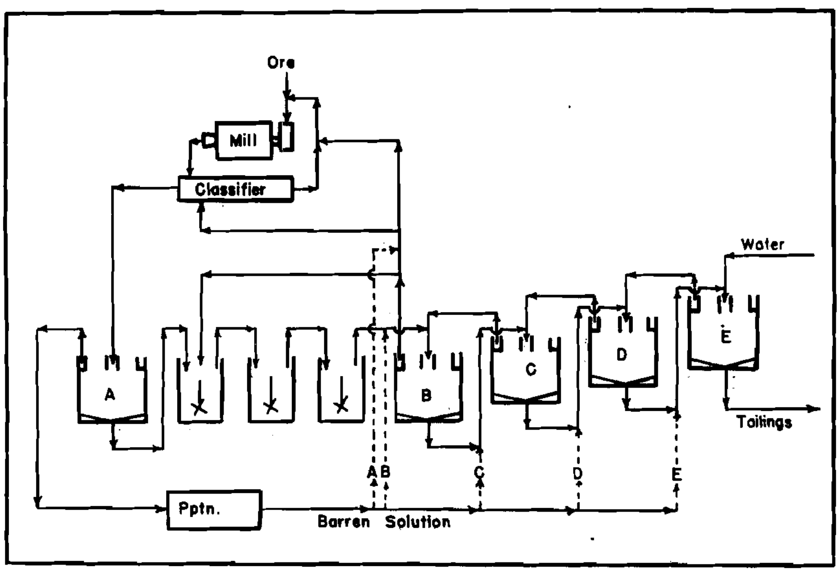


Fig. 1. Typical countercurrent decantation flowsheet showing possible points of barren solution addition.

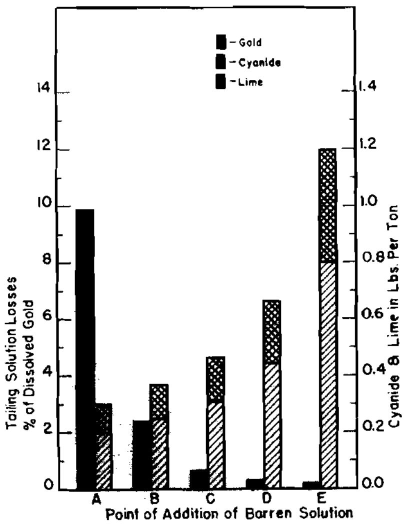


Fig. 2. Cyanide and lime losses increase and gold decreases the farther toward the end of system barren solution is added.

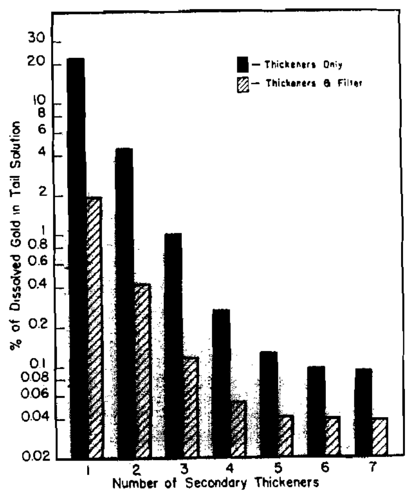


Fig. 3. If only thickeners are used, saving in gold is appreciable if the number of secondary units is increased to five or six.

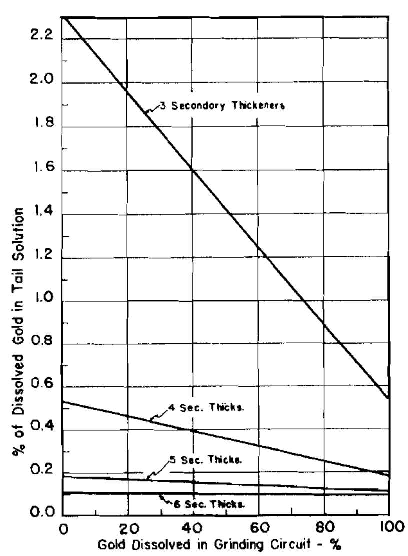


Fig. 4. Gold loss is a straight line function of the percent dissolved in the mill and the more thickeners, the less the effect of variation in point of gold dissolution.

sumed that the cyanide and lime strengths of the solution leaving the primary thickener will remain constant. For calculation we shall use 1 lb of cyanide, a protective alkalinity of a ½ lb of lime per ton of solution, and a barren solution containing gold to the extent of 2 cents per ton.

Upon making the foregoing assumptions and computing the assays of the tail solutions in gold, cyanide, and lime with the addition of the barren solution to thickeners A, B, C, D, and E, respectively (see Fig. 1), the tailing solution losses shown in Fig. 2 were obtained. These clearly show that the dissolved cyanide and lime losses increase and the dissolved gold loss decreases the farther toward the end of the system the barren solution is placed. Also, it can be seen that the loss in cyanide and lime is almost halved by placing the barren solution into thickener "D" rather than "E," while the gold loss is not markedly increased. By introducing the barren solution into "C" rather than "D," as great a saving in lime and cyanide is not made and the gold loss almost triples. This is perhaps the main reason that in actual plants one most often sees the barren solution being added in the next to the last unit in the series. Other things being equal, the most economical place to add the barren solution to the system will be determined by the unit value of gold, lime, and cyanide.

The conditions used here are the same as for the preceding section. The effect of using a filter has also been determined, assuming a cake with 33 1/3 percent moisture and a displacement efficiency of 60 percent. The barren solution has been added to next to the last unit in each case. The results are summarized in Fig. 3, employing a semilogarithmic scale for convenience. The lime and cyanide losses remain almost constant in this instant and therefore have been omitted from the tabulation.

It is apparent that if only thickeners are used the savings in dissolved gold are appreciable by increasing the number of secondary units to five or six. Additional thickeners do not bring corresponding improvements. As is well known, the use of a filter decreases the dissolved losses still further; but again, little improvement is achieved by using more than four or five thickeners and a filter. From the economic viewpoint the proper number will be dictated by the cost of thickeners and filters when balanced against the potential losses.

Calculations of the dissolved gold loss were made, using previously stated assumptions and varying the gold dissolution in the milling circuit. The number of secondary thickeners used varied from two to seven. The results are shown in Fig. 4. As is evident from Fig. 4, the dissolved gold loss is a straight line function of the percent dissolved in the mill. (In order not to confuse the diagram the graphs for the two and seven thickener cases have been omitted.) It is also obvious that the greater the number of secondary thickeners used, the lesser will be the effect of variation in point of gold dissolution upon the dissolved loss.

Fig. 5 is the result of plotting the logarithm of the slope of the straight lines obtained in Fig. 4 versus the number of secondary thickeners used. By combining Fig. 4 and 5 and letting

X = percent of gold dissolved in the mill

Y = percent of dissolved gold lost in tail solution

Z = the number of secondary thickeners

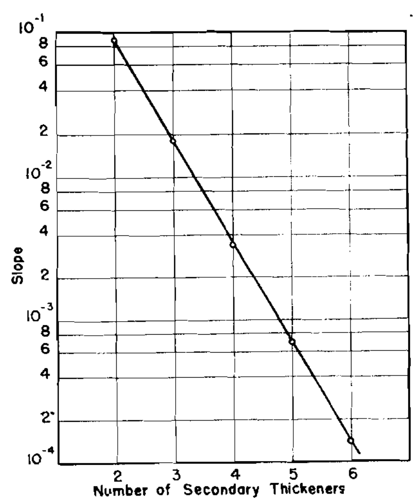


Fig. 5. The slope of the lines of Fig. 4 versus the number of secondary thickeners.

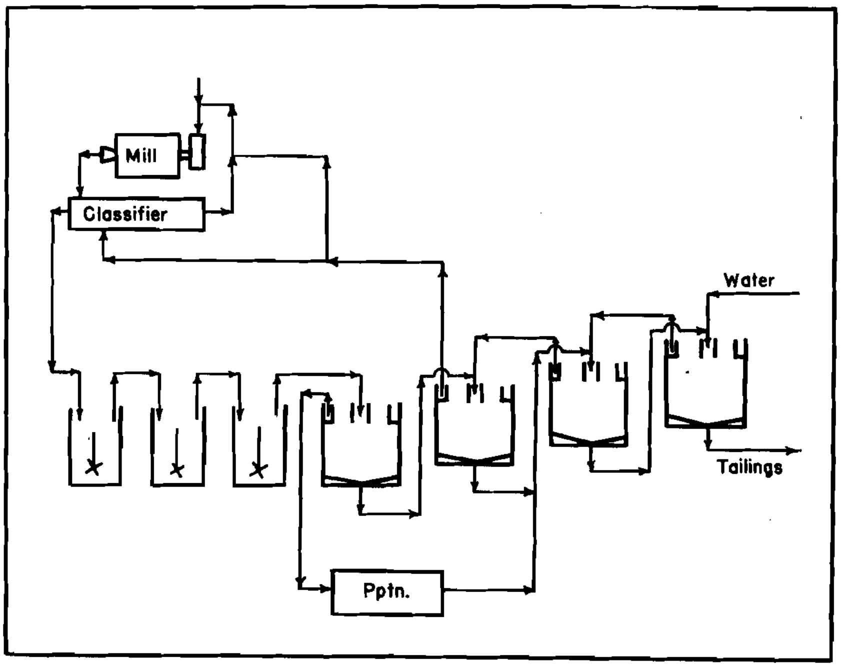


Fig. 6. Calculations indicate that lower dissolved gold losses are obtained if no primary thickening is done as shown in this flowsheet.

we obtained the following relationship:

$$X + 10^{(0.7Z-0.549)}\,Y = 125 + 0.089 \times 10^{(0.7Z-0.549)}$$

This equation applies, of course, only to the cases where the conditions are those assumed in the paper. Other conditions will give a similar identity, but with different constants.

Perhaps most of the time in the application of countercurrent decantation systems a primary thickener is essential in order to obtain a pulp of suitable consistency for agitation. Calculations indicate, however, that lower dissolved gold losses are obtained if no primary thickening is done, with a setup as shown in Fig. 6. It is clear that with this arrangement it will make no difference how the dissolution is distributed between the grinding circuit and the agitators. The losses are given in Fig. 7 in comparison with those occurring when the primary thickener is used assuming 10 percent of the gold dissolved in the grinding circuit. The saving is great if up to about five thickeners are used. With six or more thickeners in the system it makes relatively little difference whether or not one of the thickeners is used as a primary. Also, the larger the percentage of gold dissolved in the mill, the smaller will be the improvement by omission of the primary thickener.

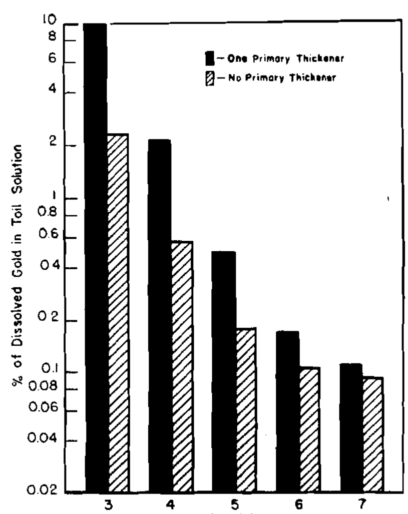


Fig. 7. Comparison of dissolved gold losses with and without primary thickening; up to about 5 thickeners, the saving is great.

The results of calculations have been presented showing that in a countercurrent decantation system the following generalizations can be made:

(1) Dissolved gold tailing loss decreases and the dissolved lime and cyanide losses increase the farther toward the end of the system the barren solution is placed.

(2) Dissolved gold loss decreases rapidly as the number of thickeners is increased to five or six. Beyond this number, the loss decreases very little.

(3) Dissolved gold loss varies inversely as the percent dissolved in the mill.

(4) If less than five thickeners are used, the dissolved gold loss will be less by not using one of them as a primary, if it is possible to do so.

## Weeds, Wood, and 2-4-D

"Come forth into the light of things,
Let Nature be your teacher."
—Wordsworth

Mine operators who are having trouble with fungus-infested timbers are urged, by one of their Vermont confrères, to spend a little time on their front lawns thinking it over.

Willis P. Mould of Williamstown notes in a recent letter that he had been warring against weeds with a preparation called 2-4-D, and, entering his cellar, bespied fungus growth upon his coal bin. "I gave it a shot of that 2-4-D," he says, "and within a week it disappeared"—never to return again. Mr. Mould is cautious, lest magical powers be ascribed to 2-4-D, but he believes it's worth a fair trial. If unsuccessful on the timber, it's always useful on the front lawn.

## More Gas from Each Barrel

"Fill 'er up with silica-magnesia catalyst" may never become part of the motorist's vocabulary, but that new material will see to it that car owners get more gasoline from each barrel of oil taken from the earth. Ten years of experimentation in the use of catalysts in fluid catalytic cracking units were reported on recently by A. L. Conn, W. F. Meehan, and R. V. Shankland of the Standard Oil Co. of Indiana at the AIChE's regional meeting in Los Angeles. They've discovered that synthetic silica-magnesia causes cracking to take place at lower temperatures, producing more gasoline, less coke. Tests made in a large cracking plant showed higher gasoline yields with lower octane number, but the addition of tetraethyl lead overcame the latter difficulty, their report said.