PERCENTAGE RECOVERY IN ORE DRESSING

By Edgar P. Anderson, Cobalt.

In the recovery of metals from the rocks in which they occur, it is generally necessary to concentrate them in the form of metallic minerals before the metal is extracted by smelting operations. In thus concentrating the mineral a loss always occurs, so that the actual mineral recovered for smelting is a portion only of the original content. The ratio of the metal in the recovered portion to the metal contained in the original ore when multiplied by one hundred is called the Percentage Recovery.

In practice this factor cannot as a rule be determined directly, as the concentrate may be wet or oily and is usually inconvenient to weigh. The metal in the ore delivered for concentration may be more easily determined, since its dry or actual weight can be found, by sampling for moisture and deducting the weight of water. Generally weights of the various products can be accurately determined at a testing works, where comparatively small parcels of ore are treated as a guide to practical work. For testing works the only percentage recovery which should be taken as correct is the following:

Percentage recovery

$$= \frac{100 \times \text{wt. of concentrate} \times \text{assay value of concentrate}}{\text{weight of ore} \times \text{assay value of ore.}}$$

It is the recovery obtained that is wanted, not the loss sustained. The latter may serve as a check, since the tailing loss plus the metal recovered should not be greater (nor much less) than the metal in the original sample.

To obtain the percentage lost in the tailing the following calculation must be carried out.

Percentage loss in tailing

$$= 100 \times \frac{\text{metal in tailing (=assay} \times \text{weight)}}{\text{metal in ore (=assay} \times \text{weight)}}$$

and metal in ore should be equal to metal in concentrate+metal in tailing.

In practice there are two methods available (both dependent on sampling) supposing that the total weights of products cannot conveniently be obtained.

1. The ore is sampled and its average metal content obtained as a percentage. The concentrate is also carefully sampled and the assay value determined. The samples taken should be large and are taken as a certain fraction of the whole over a considerable period, say one shift. These samples are dried, so that water is driven off and also oil, if used, but nothing else. If any solid, added during treatment, is found in the concentrate, such as carbon, magnetite, iron, etc., the weight of added material must be deducted from the concentrate. The percentage recovery can then be estimated as for a test sample.

This method is very good but gives unnecessary work for comparative day to day runs.

2. The ore feed is carefully sampled periodically and the assay value in metal returned as a percentage. The concentrate obtained is also sampled over the same period and the percentage assay value determined.

The following formula gives the percentage recovery quite close enough for practical work, the errors being due to sampling and assaying only.

$$E = 100 \frac{c\,(a-b)}{a\,(c-b)}, \text{ where}$$

E=extraction rate per cent.
a =assay of ore per cent.
b =assay of tailing per cent.
c=assay of concentrate per cent.

This formula is made up from the assay values and the concentration rate.

The formula may be proved thus:

$\frac{c}{a}$ =concentration rate or the ratio

$$\frac{\text{assay value of concentrate}}{\text{assay value of ore sample.}}$$

(a—b)=assay of ore—loss in treatment=proportion of metal taken out of the ore.

(c—b)=assay of concentrate—loss in treatment=proportion of metal concentrated.

Formula says:

$$\text{Extraction} = \frac{\text{proportion of metal in concentrate} \times \text{proportion of metal taken out}}{\text{proportion of metal in ore} \times \text{proportion of metal concentrated.}}$$

That is, if there were no loss in the tailing metal extracted=metal in ore, and metal in concentrate=metal concentrated, dividing out in the above equation the total metal extracted=1, which is correct.

To obtain the percentage loss in the tailing the following formula may be used, the symbols having the same significance as above:

$$\text{Loss in concentration per cent.} = 100 \times \frac{b - \frac{b}{R}}{a}$$

$$= 100 \times \frac{b - \frac{ab}{c}}{a}$$

where $R = \text{concentration rate} = \frac{c}{a}$

This result may be added to the extraction and should give 100, serving as a check on the extraction determined from the concentrate value. For convenience the loss may be determined very quickly because of the smallness of the figures involved and subtracted from 100 to give the approximate extraction, say when in a works and wishing to know "if the treatment is going satisfactorily this morning."

That is

That the addition of the extraction and the loss give the metal contained, is shown by the following:

Using the same symbols, and R=concentration rate.

then $R\,c + (1-R)\,b = a$ (1)

$$\text{for } R = \frac{a-b}{c-b}$$

$$\text{and } 1-R = \frac{c-a}{c-b}$$