Underground Mining of Metalliferous Deposits
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Lecture 07
Determination of Cut Off Grade – I

Minerals
Mineral is a solid chemical compound with a fairly well-defined chemical composition and a specific crystal structure, that occurs naturally in pure form.

Ore
Ore is natural rock that contains one or more valuable minerals, typically containing metals, or economic material that can be mined, treated and sold at a profit.

Mineral Resource
Mineral resources are the rockmass containing one or more minerals potentially valuable, and for which reasonable prospects exist for eventual economic extraction.

Mineral/Ore Reserve/Deposit
Mineral/Ore reserves/Deposits are the mineral resource that are valuable and legally, economically, and technically feasible to extract.

CUT OFF GRADE

Cut-off grade = The grade at which the mineral resource can no longer be processed at profit.

Davey (1979) applied a net value concept to determine the cut-off-grade.

Apart from the above definition, cut-off grade may also be governed by -Technical acceptance of the processing unit, Legislative restrictions etc.

Davey (1979) applied a net value concept to determine the cut-off-grade for a copper ore.

The ROM copper ore is milled thereby producing a copper concentrate. This mill concentrate is shipped to a smelter and the resulting blister copper is eventually refined.

So the process is –

Mining (gives ROM) Mill (gives concentrate) Smelting (gives Blister copper) refining (gives copper)

In this example the following will be assumed:

Mill recovery rate = 80% of copper

Mill concentrate grade = 20% cu

Smelting loss= 10 lbs of cu per st of concentrate

Refining loss= 5 lbs of cu per st of blister copper

Note- 1 Ton = 1 short ton = 2000 lbs

The steps of the net value computation are outlined below for an ore containing 0.55% Copper. All of the costs and revenues will be calculated with respect to one ton of ore (2000 lbs).

Step 1. Compute the amount of saleable copper (lbs/st of ore).

[1] Contained copper (CC) in the ROM is

$$CC = 2{,}000\ lbs/st \times \frac{0.55}{100} = 11.0\ lb$$

[2] Copper recovered by the mill (RM) is

$$RM = 11.0 \times \frac{80}{100} = 8.8\ lb \quad RM = 11.0 \times \frac{80}{100} = 8.8\ lb$$

[3] Concentration ratio (r). The ratio of concentration is defined as

$$r = \frac{lbs\ Cu/st\ of\ concentrate}{lbs\ Cu\ recoverd/st\ of\ ore} \quad r = \frac{lbs\ Cu/st\ of\ concentrate}{lbs\ Cu\ recoverd/st\ of\ ore}$$

Since the mill product runs 20% copper there are 400 lb of copper contained in one ton of concentrate. One ton of ore contains 8.8 lb of recoverable copper. Hence

$$r = \frac{400}{8.8} = 45.45$$

This means that 45.45 tons of ore running 0.55% cu are required to produce 1 ton of concentrate with running 20% cu.

OR in other words, From 2000 lbs ROM, Concentrator receives 44 lbs contains 8.8 lbs copper

Thus, to produce 2000 lbs of concentrator, ROM required is 90909 lbs = 45.45 ton i.e st

[4] Copper recovered by the smelter (RS). The mill concentrate is sent to a smelter. Since the smelting loss is 10 lb of copper/st of concentrate, the smelting loss (SL) per ton of ore is

$$SL = \frac{10\ lb/st\ \text{of concentrate}}{45.45\ tons\ of\ ore/st\ of\ concentrate} = 0.22\ lb$$

$$SL = \frac{10\ lb/st\ \text{of concentrate}}{45.45\ tons\ of\ ore/st\ of\ concentrate} = 0.22\ lb$$ /ton of ROM

Thus the recovered copper after smelting is

$$RS = 8.8 - 0.22 = 8.58\ lb$$

OR in other words,

There are 44 lbs concentrator which has 8.8 lbs cu. So the loss is 10 lbs copper. So the loss of copper with respect to ROM (2000 lbs) is (10/45.45) = 0.22 lbs

Thus now after smelting of one ton ROM the copper content is = 8.8 – 0.22 = 8.58 lbs

So from one ton ROM, Blister copper got is 8.58 lbs of copper.

[5] Copper recovered by the refinery (RR).

2000 lbs (1 ton) ROM has 8.58 lbs copper as input to refinery (blister copper). So if blister copper has 2000 lbs copper, pure copper comes out 1995 lbs. So the ROM required to give 2000 lbs cupper as input to refinery is = 233.1 ton. So 233.1 ton of ROM will give 1 ton cu in blister copper.

So the overall recovery as pure copper per ton of ROM is

1995lbs/233.1 = 8.56 lbs.

And the refining loss is = 5 lbs/ 233.1 = 0.02 lbs per ton of ROM.