

COST ANALYSIS OF DEWATERING SYSTEM OF COPPER CONCENTRATE

B. Tora

University of Mining and Metallurgy im Stanislaw Staszica, Krakow, Poland

W. Woyciechowski

University of Mining and Metallurgy im Stanislaw Staszica, Krakow, Poland

ABSTRACT: The continuous depreciation of deposits is the reason of increase of complexity of utilization of raw materials, especially the recycle and waste materials. The paper presents the results of investigations of the set of conditions contributing to the decrease of costs of raw materials yield and the optimization of their distribution in the entire tasks of processing.

The paper presents the principles of complex utilization of raw materials in two basic approaches
- the raw material one, i.e. the utilization of all useful components of the mineral,
- the regional one, i.e. the utilization of all the raw materials, primary and recycle ones, occurring in a given region

1. INTRODUCTION

i. The Raw Material Approach

The economic evaluation will constitute an estimating criterion of the complexity of utilization of raw materials. An example of copper ore enrichment in the Lubin Region will be the base of discussing of the raw material approach. Copper ore, apart from the main useful components, i.e. copper, silver and gold, contains several accompanying elements (cadmium, arsenic, lead and others). The author will present an analysis of possibilities and profitability of recovery of accompanying elements from copper ore. The profitability analysis will include, besides the internal factors (technical and technological), the external conditionings (such as the cost of environment use, social costs)

ii The Regional Approach

At present the generally accepted procedure of minimizing the amount of wastes by means of utilization is replaced by the policy of preventing the formation of wastes and their recycling. Therefore the development of low-waste and wasteless technologies became not only a very important tendency of both saving the deposits and environment protection but also the increase of production efficiency. Because of that, the process of mining of minerals must be carried out simultaneously with the utilization of the accompanying components for manufacturing of various materials. In this case the wastes are not only

dumped but also forwarded directly to the processing plants. The low-waste technologies contribute to the complete and complex utilization of secondary sources, the reduction of harmful impurities directed to atmosphere and throws of contaminated waste water as well as the decrease of the area of arable land used for waste dumping. In fact, in the present conditions, the waste production ratio must become a factor which determines the choice of the technology of processing and production of materials.

In the paper the analysis of the costs of dewatering of copper flotation concentrate is presented.

Dewatering system used in Polish plants consists of thickening, vacuum filtration and drying. After the modernisation pressure filtration is applied instead of vacuum filtration. The proposal of minimisation of costs through modernisation of dewatering system is shown.

Petrographical and mineralogical characteristic of Polish ores is the cause of the necessity of reduction of the grain size below 0,075 mm. The costs of crushing and milling are very high. Significant position in costs has the dewatering system. Dewatering is, after, comminution, the most costly operation in mineral processing. One makes an assumption that the cost of dewatering are 20% of total processing costs.

The economic complex consists of mine, beneficiation plant and metallurgical plant. Processing Plant is organisational part of the mine.

Processing Plant has the most influence on final results of copper concentrate producing. It decides about the final losses of copper and useful components in wastes from flotation process (wastes are deposited in waste pond). Quantity of wastes is very high - about 90% of total amount of ore. From the other side processing decide about the quality of the feed for the metallurgical process.

To reach the optimum grain size for the liberation of copper minerals it is necessary to reduce grain size below 75 μm . Copper ore is prepared in several stages of flotation. Obtained final concentrate has the density 1150 g/tW (moisture 80% of water).

Concentrate is sold to the metallurgical plant and is transported by rail. Requirements of buyer are determined by minimal copper content and maximum water content (moisture) less than 7%.

2 DEWATERING SYSTEM OF THE COPPER CONCENTRATE

In consideration of minimisation of energy consumption dewatering is leaded in several stages. Successive stages are characterised by more and more high energy demand.

The first variant (A) of dewatering system was introduced during the projecting and erecting of the plant. In this paper it is treated as a base (as a reference system).

Second variant (B) is the proposal of authors. We propose changing two stages drying system by one stage.

Variant A

This system was made in the beginning of the plant building. Dewatering system in variant A is shown in Figure 1.

Dewatering takes place in three stages in Processing Plant and one stage in Metallurgical Plant.

- 1 gravitation and thickening in Don thickener. Diameter of thickener is 40 m, total height 15 m, capacity 3700 m^3 . In order to increase efficiency of thickening tin lined plates are used. Density of underflow is 1700 kg/m^3 .
- 2 vacuum filtration in disk filter type 1 (IM). Diameter is 150 m. Synthetic filter cloth is used. Rotary of central barrel is controlled and could be

changed between 0,1 to 1,5 rpm. Obtained filter cake consist of 22-25% of water.

- 3 thermal drying in drum dryer. Dryer size are length 21m, diameter 3 m, rotation of drum 3,5 rpm. Temperature in the burning chamber 650°C, temperature of exhausted gases 150°C. Concentrate obtained from dryer has 7% moisture.
- 4 second stage of drying, drying to the final moisture of 1%. This stage is lead in metallurgical plant. Concentrate after first stage is transported by rail.

Increasing prices of energy caused the need of modernisation of dewatering technology. The aim of modernisation is to decrease gas consumption in thermal drying.

One of possibilities is to decrease the filter cake moisture through implementation of filter press instead of vacuum filter.

In press filtration higher pressures are used than in vacuum filtration. Change of type of filter did not require the changes in stage of thickener and drying. Press filter type Larox Oy PF 132 AI 60 were used. After using filter press cake consist of 14% of water.

Reorganisation of dewatering system will not need the new investment. Existing dryers in Processing Plant have enough capacity to dry concentrate to the moisture 1%.

This system was made in the beginning of the plant building. Dewatering system in variant A is shown in Figure 1 (W is the moisture of product [%]).

Increasing prices of energy caused the need of modernisation of dewatering technology. The aim of modernisation is to decrease gas consumption in thermal drying.

One of possibilities is to decrease the filter cake moisture through implementation of filter press instead of vacuum filter.

In press filtration higher pressures are used than in vacuum filtration. Change of type of filter did not require the changes in stage of thickener and drying. Press filter type Larox Oy PF 132 AI 60 were used. After using filter press cake consist of 14% of water.

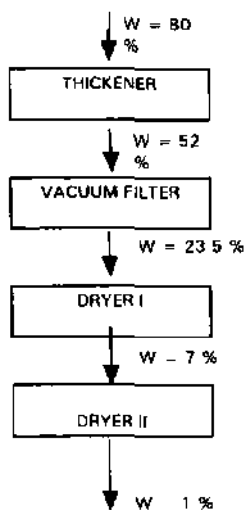


Figure 1 Dewatering system - variant A

Variant B

It is proposed by authors (Figure 2) In this variant, dewatering will be led in three stages

- 1 Thickening
- 2 Pressure filtration, and
- 3 Drying in one stage in Processing Plant

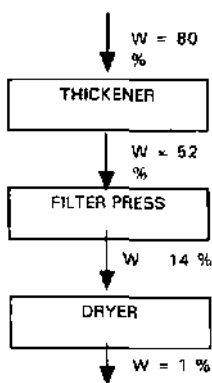


Figure 2 Dewatering system - variant B

Energy savings will be the results of
 -elimination of twice heating SS% of mass of filter cake, and
 -decreasing of transportation costs (minimisation of water content in transported concentrate from 7 to 1%)

Reorganisation of dewatering system will not need the new investment Existing dryers in Processing Plant have enough capacity to dry concentrate to the moisture 1%

3 EVALUATION OF ENERGY CONSUMPTION

The base for cost evaluation was industrial experiment The basis for evaluation the relations between gas consumption and the working parameters of dryer was the 'factor' experiment made during 160 working shifts

The more important relation for control and optimisation of the dewatering system is the relation between gas consumption and efficiency of process and moisture of products

For the cost analysis the assumption that thickening costs are constant and the same for each stage was accepted

Cost distribution for each stage of dewatering is the following

- thickening 7%
- filtration 12%, and
- drying (one stage) 81%

Energy consumption for press filtration in Larox PF is 3,5 kWh/ 1 t filter cake

For evaluation of the energy consumption in rotary dryer experimental data were used

Dependence between gas consumption and efficiency of the process was elaborated by the theoretical way the base was balance of mass and energy

Based on experimental data the coefficients in theoretical equation was elaborated
 Step-wise method of analysis was used
 Number of experimental data was 160
 (calculated form of equation (1) is

$$\ln V_{\text{gas}} = 0.04316 \ln Q_1 + 19.112 \ln \left[\frac{W_1}{100} \frac{W_k}{W_r} \right] + 9.01988$$

where
 V_{gas} - gas consumption
 Q_1 - quantity of dried ctmiuwaU
 W_N moisture of feed
 W_K moisture of concentrate