Analysis of Benefits Between Sales Revenue and Transportation Cost of a Gold Mineral Processing Plant in Shandong

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Abstract: With the mining of gold mines, the gold level is gradually reduced, and the transportation cost of gold concentrate is gradually increased. This study analyzes the relationship between the analysis of different concentrate grades and transportation costs, so as to find the best economic benefits of the concentrator. A function is established in this paper. It is used to find the best economic benefit in different enrichment ratios. Raising the rate of recovery is not necessarily able to increase the total economic benefit of the concentrator. It was discovered by practice that the total economic benefit increased by 1109130 yuan when the recovery decreased by 0.22%.

1. Introduction

With the depletion of ore resources, in the gold beneficiation process, the ore grade is gradually reduced, the production cost and human resource cost are gradually increased, and the profit of the concentrator is gradually reduced, so it is necessary to constantly look for profit growth points in the beneficiation production [1-3]. In this paper, the differential method is used to analyze the relationship between concentrate grade and transportation cost, and to find the best economic benefits of concentrators under different concentrate grades. I hope it can help the production of the same type of concentrator [4-6].

In the beneficiation production, if the tailings grade is unchanged, the concentrate grade will be increased, the recovery rate will be correspondingly reduced, the concentrate yield will be reduced, and the transportation cost will be reduced; On the contrary, the concentrate grade decreases, the recovery rate increases correspondingly, and the transportation cost increases. In this paper, the relationship between the transportation cost and the sales revenue under different concentrate grades is found to find the best economic benefits for the concentrator [7-8].

2. Analysis of Relationship between Mineral Processing Recovery and Enrichment Ratio

Calculation formula for theoretical recovery rate of concentrator [9-10]:

\[
\varepsilon = \frac{\beta(\alpha - \theta)}{\alpha(\beta - \theta)} \quad \text{(1)}
\]

In the formula:
\(
\varepsilon\) Recovery \((\times 100\%)
\beta\) Concentrate grade \((\times 10^6)
\alpha\) Raw ore grade \((\times 10^4)
\theta\) Tailings grade \((\times 10^4)

In the process of differential deduction of the theoretical calculation formula of recovery rate, the recovery rate changes with the change of concentrate grade when the raw ore grade and tailings grade are considered as constants.

\[
\varepsilon' = -\frac{1}{\alpha} \frac{\theta(\alpha - \theta)}{(\beta - \theta)^2} \quad \text{(2)}
\]

From equation 2, it can be concluded that the reciprocal of the recovery rate is less than zero. It shows that under the condition that the grade of raw ore and tailings are set to be constant, the recovery rate of gold concentrate decreases with the increase of concentrate grade [11-15]. Although the grade of gold concentrate increases, the reduction of its yield leads to the reduction of the recovery rate. From the perspective of tailings, the tailings grade remains unchanged, the yield increases, and the amount of metal in the tailings increases, so the recovery rate decreases [16-18].

Under the assumption that the grade of raw ore and tailings remains unchanged, and without considering the transportation cost, the concentrate grade will increase, the concentrate yield will decrease, the tailings yield will increase, the metal content in tailings will increase, and the metal content in concentrate will decrease, and the sales price will inevitably decrease [19-23].

If the transportation cost is considered, there is a problem that the concentrate grade increases, the production rate decreases, and the sales price decreases, but the transportation cost also decreases. The content of
this paper is whether there is a point or an interval between
the two, which can maximize the profit of the concentrator
in the actual production process.

3. Establishment of functional relationship between grade of
secondary concentrate and transportation cost

In the actual production of gold mine, with the increase of
concentrate yield, the amount of concentrate to be
transported increases, and the transportation cost
increases\cite{24-26}.

In fact, in addition to the impact of metal volume on
the sales price, different concentrate grades correspond to
different gold return rates, which also affect the yield of
gold concentrate, thereby affecting the transportation cost
of gold concentrate.

In the production and sales of gold concentrate in a
gold concentrator in Shandong province, the economic
benefit can be determined as the difference between the
concentrate sales price and the transportation cost. Among
them, the factors affecting the sales price of gold
concentrate include gold concentrate grade, gold
concentrate sales volume and different return rates under
different gold concentrate grades; The factors affecting
transportation cost are only the quality of gold concentrate
and transportation cost\cite{27-29}.

Table 1. Return rate of metals in gold concentrates of different
grades

<table>
<thead>
<tr>
<th>NO.</th>
<th>Gold concentrate grade/$\times 10^6$</th>
<th>Rate of return/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5-9</td>
<td>82.0</td>
</tr>
<tr>
<td>2</td>
<td>10-14</td>
<td>85.0</td>
</tr>
<tr>
<td>3</td>
<td>15-19</td>
<td>88.0</td>
</tr>
<tr>
<td>4</td>
<td>20-24</td>
<td>90.0</td>
</tr>
<tr>
<td>5</td>
<td>25-29</td>
<td>94.0</td>
</tr>
<tr>
<td>6</td>
<td>30-34</td>
<td>95.0</td>
</tr>
<tr>
<td>7</td>
<td>35-39</td>
<td>95.5</td>
</tr>
<tr>
<td>8</td>
<td>40-44</td>
<td>96.0</td>
</tr>
<tr>
<td>9</td>
<td>45-49</td>
<td>96.5</td>
</tr>
<tr>
<td>10</td>
<td>50-54</td>
<td>97.2</td>
</tr>
<tr>
<td>11</td>
<td>55-59</td>
<td>97.5</td>
</tr>
<tr>
<td>12</td>
<td>60-69</td>
<td>97.7</td>
</tr>
<tr>
<td>13</td>
<td>$&gt;70$</td>
<td>97.9</td>
</tr>
</tbody>
</table>

Notes: The data above are not applicable to other
mines because of different gold concentrate return rate.
The data in Table 1 of this paper is for reference only.

Sales income=$\text{processing volume} \times \text{raw ore grade} \times
\text{recovery rate} \times \text{international gold price} \times \text{return rate}$

\[ M_1 = Q \frac{\beta}{\beta - 0} K, K \]

Transportation cost = gold concentrate quantity \times
transportation cost

\[ M_2 = Q \frac{\alpha - \theta}{\beta - 0} K \]

The economic benefits are expressed as follows.

\[ M = Q \frac{\beta}{\beta - 0} K, K - Q \frac{\alpha - \theta}{\beta - 0} K. \]  

In the formula:
M Economic benefits,
M1 Sales revenue,
M2 Transportation costs,
Q Processing capacity,
K1 International gold prices;
K2 Refining rate of gold return;
K3 Transportation cost per ton of concentrate.

In equation 5, economic benefit \( M \) varies with
concentrate grade \( \beta \). Differential toppling of economic
benefit \( M \) can be obtained.

\[ \frac{M'}{Q} = \frac{\alpha - \theta}{(\beta - 0)}^\alpha (K, K, \theta) \]

It can be seen in Formula 6, \( \alpha > 0 \),

\[ \frac{\alpha - \theta}{(\beta - 0)^\alpha} > 0 \]

So,

\[ (\beta - 0)^\alpha > 0 \]

Under normal production conditions, K1 adopts the
Shanghai Gold exchange price of 267.77 Yuan per gram.
The highest return rate of smelting unit to concentrator K2
is 97.9\%, the cost of transportation for the concentrator is
51 yuan per ton.

\[ K_1 - K_1, K_1, \theta = 51 - 267.77 \times 97.9\% \times 0.12 > 0 \]

So, \( M' > 0 \).

From the above derivation, it can be concluded that
proper improvement of concentrate grade is beneficial to
the increase of total economic benefit in the production of
concentrator. The loss of metals due to higher concentrate
grade is less than the cost of transportation.

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4. Production practice verification

The processing capacity of a gold concentrator in Central
Plain is 5,000 TPD. Although the gold grade of the mine
fluctuates in the actual production process, the average
grade of the raw ore is 1.98×10^{-6} and the concentrate grade
fluctuates in the range of 30-100×10^{-6}, the average grade
of tailings is 0.12×10^{-6}.

Under the condition of 30×10^{-6} concentrate grade, the
recovery is 94.32\%, the economic benefit is 2483489 Yuan,
the recovery is 93.11\% under the condition of 100×10^{-6},
the economic benefit is 2488504 yuan. Therefore,
although the recovery rate decreased by 1.21\%, but the
economic benefit increased by 4115 yuan.

However, the rate of return of metal in gold
concentrate of different grade can be seen that when the
grade of gold concentrate is greater than 70×10^{-6}, the rate
of return of gold is no longer increased to 97.9\%. In
practical production, the high concentration ratio
sometimes leads to the increase of tailing grade, so the
optimum gold concentrate grade is 70×10^{-6} in practical
production. At this time, the enrichment ratio was 35.35.
times, the recovery was 94.10%, decreased 0.22%, and the economic benefit increased 3361 yuan per day.

The comparison of economic benefits of different gold concentrate grades is shown in Figure 1.

![Fig. 1 Economic benefits under different concentrate grade](image)

As can be seen from Figure 1, with the improvement of concentrate grade, the economic benefits gradually increased. And in the gold concentrate grade in the process of increasing, the economic benefit of the growth rate has a decreasing trend.

According to the annual working days of the concentrator 330 days, an increase in economic benefits 3361 yuan every day, an annual increase in economic benefits 1109130 yuan.

5.Conclusions

(1) Through the analysis of this paper, it can be concluded that the cost of reducing the transportation cost is lower than the cost of reducing the recovery rate, and the economic benefit is increased.

(2) Formula 5 is applicable to the calculation of most gold concentrators, and it is hoped that it can also be used for reference to other ore processing enterprises.

(3) From the above calculation, the economic benefit can be increased by 1.11 million yuan per year by adjusting the enrichment ratio in production.

References


