Research and Application of Nelson Concentrator in Beneficiation Test of Quartz Vein Type Gold Ore

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Abstract. A gold deposit in Shandong belongs to Quartz vein type gold-bearng deposit, the main gold minerals are natural gold and silver-gold minerals, there are a few metallic minerals such as pyrite, the main gangue minerals are quartz, feldspar, sericite and so on, the average size of gold minerals is 62.37 microns, the particle size of the cloth is coarse. As a kind of gravity separation equipment, Nelson concentrator is more and more favored by mines because of its high enrichment ratio, high recovery rate and extremely friendly to environment, the experimental research of Nelson concentrator was carried out, and the gold concentrate with gold grade of 385.06 G / T and recovery of 62.21% was obtained.

1. Introduction
The gangue minerals in quartz vein type gold deposits are mainly quartz, usually about 60% [1-2], and their gold reserves account for more than half of China’s total gold reserves [3-4], which is an important gold in China One of the mineral resources. The gold minerals in this type of deposits are usually dominated by natural gold and silver-gold ore. The inlay size of gold minerals is relatively coarse, and the metal sulfide content is relatively small. The common metal sulfide is pyrite, and a small amount of chalcopyrite, etc.[5]. This paper systematically studied the mechanism and working principle of the Nielsen concentrator and its application effect in a quartz vein gold mine resource in Shandong, which provided an important reference for the efficient development of similar gold mine resources [6-7].

2. Ore composition

2.1. Chemical composition

Table 1 is the chemical composition analysis results of a gold mine in Shandong. It can be seen from Table 1 that the gold content in the ore is 6.19 gt⁻¹, which has high recycling value.

| Ingredient | Au(gt⁻¹) | Ag(gt⁻¹) | Fe | K | Al |
|------------|---------|---------|----|---|----|
| Content (Wt%) | 6.19 | 6.01 | 2.55 | 1.40 | 6.68 |
| Ingredient | Na | Ca | Mg | Si | S |
| Content (Wt%) | 3.19 | 2.39 | 1.02 | 32.15 | 0.67 |
2.2. Distribution of gold elements

Table 2 is the distribution results of gold in the ore.

| Phase          | Natural gold in gold | Silver and Gold Mine in gold | Total  |
|----------------|----------------------|-----------------------------|--------|
| Content (gr^-1)| 3.87                 | 1.19                        | 5.06   |
| Distribution (%)| 76.40               | 23.60                       | 100.00 |

It can be seen from Table 2 that gold is mainly distributed in natural gold minerals, and a small amount is distributed in silver and gold mines.

2.3. Mineral composition

Through light film identification under microscope and automatic analysis of BPMA automatic detection, the main gold minerals in this ore are natural gold and silver-gold ore; there is also a small amount of pyrite, chalcopyrite, galena, sphalerite and other metal minerals; veins Stone minerals are mainly composed of quartz, sericite, feldspar, calcite, pyrophyllite, ordinary pyroxene, fluorite, iron dolomite and other minerals. Table 3 is the relative content of ore minerals.

| Metal mineral | Content (%) | Gangue mineral | Content (%) |
|---------------|-------------|----------------|-------------|
| Pyrite        | 1.21        | Quartz         | 33.30       |
| Chalcopyrite  | 0.04        | Iron chlorite  | 4.83        |
| Others        | 0.42        | Feldspar       | 38.33       |
|               |             | Sericite       | 11.52       |
|               |             | Calcite        | 1.43        |
|               |             | Fluorite       | 1.26        |
|               |             | Pyroxene       | 3.56        |
|               |             | Others         | 4.10        |

2.4. Gold mineral particle size distribution

The particle size analysis of gold-bearing minerals in the ore is measured with a BPMA detection and analysis system at a fineness of 60% of the ore sample particle size -200 mesh content. The results of the gold mineral inlaid particle size analysis are shown in Table 4.

| Granularity (μm) | Content (%) | Positive accumulation (%) |
|------------------|-------------|----------------------------|
| -150+74          | 30.15       | 30.15                      |
| -74+37           | 38.77       | 68.92                      |
| -37+10           | 29.92       | 98.84                      |
| -10+5            | 0.56        | 99.40                      |
| -5               | 0.60        | 100.00                     |
| Average          |             | 62.37                      |

It can be seen from Table 4 that most of the gold mineral inlays in the ore are coarse in size, with a -150+37 micron particle size content accounting for 68.92%, and the average particle size of gold minerals is 62.37 microns, mainly in coarse-medium inlays.
3. Nielsen re-election test

3.1. The sorting structure and working principle of Nielsen concentrator

The sorting mechanism of the Nielsen concentrator is a double-walled cone with recoil water holes on the inner wall. A closed space is formed between the inner and outer cones to become a water cavity. The inner side of the inner cone has grooves and is equipped with water holes. This cone is called an enriched cone.

When the Nielsen concentrator is working, the material enters the bottom of the enrichment cone through the feed port, moves toward the inner test of the enrichment cone under the action of centrifugal force, and gradually fills the groove. The backwash water is fed into the enrichment from the lower part through the rotating shaft. In the collecting cone, the bed is fluidized; mineral particles are selected under the action of centrifugal force, backwashing hydraulic force and gravity, and the target mineral with a larger specific gravity is left in the enriching cone to become a concentrate, with a smaller specific gravity the gangue minerals are brought out of the enrichment cone by the flushing water and enter the tailings outlet, becoming tailings; with the continuous addition of materials, the minerals in the enrichment cone are repeatedly washed and enriched, making the internal minerals the grade is getting higher and higher, so as to realize the sorting of materials.

3.2. Experimental procedure

Combined with the characteristics of the ore, a 20 kg sample was taken to carry out a re-election test study using the MD3 Nielsen concentrator. The test conditions were gravity 60G, fluidized water volume 3.0-3.5 L/min, and ore feed volume 600-1000 g/min. The process flow chart is shown in Figure 1, and the test results are shown in Table 5.
Figure 1. Flow chart of gravity separation test of Nelson concentrator

| Table 5. Results of reselection test |
|-------------------------------------|
| Feeding granularity | Product     | Yield (%) | Grade (g/t) | Recovery rate (%) |
|----------------------|-------------|-----------|-------------|-------------------|
| <2mm                 | Concentrate 1| 0.45      | 156.30      | 11.36             |
| 100%                 | Tailings 1  | 99.55     | 5.51        | 88.64             |
| <0.074mm             | Concentrate 2| 0.15      | 987.23      | 23.92             |
| 45%                  | Tailings 2  | 99.85     | 4.01        | 64.71             |
| <0.074mm             | Concentrate 3| 0.14      | 870.67      | 19.69             |
| 65%                  | Tailings 3  | 99.86     | 2.79        | 45.02             |
| <0.074mm             | Concentrate 4| 0.16      | 279.65      | 7.23              |
| 85%                  | Tailings 4  | 99.84     | 2.34        | 37.79             |
| Feed mine            |            | 100.00    | 6.19        | 100.00            |
| Comprehensive concentrate | 0.90 | 385.06     | 62.21       |
It can be seen from Table 5 that as the grinding fineness of the ore sample increases, the gold grade in the concentrate first rises and then decreases. When the ore feeding size is -200 mesh and accounts for 45-65%, the gold grade of the concentrate can be above 870 gt\(^{-1}\), it shows that at this fineness, the gold minerals in the ore mainly exist in the form of monomers or in the form of continuum-rich bodies. When the ore feeding particle size is controlled at -200 mesh and accounts for 85%, a comprehensive concentrate product can be obtained. The process index is 0.90%, the gold grade is 385.06%, and the gold recovery rate is 62.21%.

The concentrate obtained by the above test was subjected to elutriation treatment. Obvious granular gold can be observed in the elutriation concentrate. The results of the above test verify that such ore is suitable for selection by the Nielsen re-selection process. Figure 2 is for the situation of panning products.

Figure 2. Pictures of concentrate elutriation products

4. Conclusion
(1) The gold content in the ore is 6.19 gt\(^{-1}\). The main gold minerals in the ore are natural gold and silver-gold ore. The average particle size of the gold minerals is 62.37 microns. Ore, chalcopyrite, galena, sphalerite and other metal minerals; gangue minerals are mainly composed of quartz, sericite, feldspar, calcite, pyrophyllite, ordinary pyroxene, fluorite, iron dolomite and other minerals.

(2) It can be known from the Nielsen concentrator re-selection test that the quartz vein type gold-bearing ore is suitable for the re-selection process, and a comprehensive concentrate gold grade of 385.06 gt\(^{-1}\), a yield of 0.90%, and a gold recovery rate of 62.21% can be obtained. Process indicators.

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