Processing of high-clayed fine-gold-bearing sands

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Abstract. Under consideration are the main causes for the fine and very fine gold loss in processing the alluvial high-clayed sands at conventional equipment. Scrubber-free washing plant, consisting of disintegration, classification, steeply-inclined and centrifugal–vibration concentrators is presented. The experimental research results on the most-recent washing plant justified the economic feasibility of this application.

1. Introduction
The rebellious mineral ore deposits are distinguished for high content of clayed impurities interfering the recovery of valuable components. Along with this specific feature the content of fine gold fractions is typical of such deposits, and can be of commercial potential value in a number of cases. Therewith the lack of high-efficient facilities for washing and recovery of fine and very fine gold appreciably complicates the processing flowsheet.

At present scrubber-type apparatus are widely used for disintegration of clayed sands. Scrubbers can be used in combination with different mineral processing auxiliaries with regard to the granulometric composition of gold. There are few schemes of scrubber washing facilities feasible to beneficiate fine and very fine gold. The most popular device is the washing barreled sluice-type (WBS) facility designed to wash and to concentrate alluvial low-watered sands. However, the full-scale industrial application of this-type washing facilities encounters certain problems.

When washing high-clayed sands containing more than 20% of sludgy-and-clayey sands, the drum rotates and induces formation of dense, oval pellets which are capable to entrap non-disintegrated material containing valuable components and to discharge it into pellet dump wastes [1]. In this case the precious metal loss reaches more than 20% [2, 3]. Moreover, insufficient dispersability of production sands leads to the situation when the clayey conglomerates stick and choke up operation of facilities. Thus, if fine clayey pellets reach the sluices, they move in the flow over separating surface, entrap the precipitated gold grains on screen, disturb the separation bed and pass out to ephelides dump, and negatively influence the recovery. Therewith, the scrubber is not designed to remove slime-like fractions so the cells of patterns are stuffed with sludge along with resultant poorer quality of sluice performance.

The operation experience with application of different conventional concentrators on alluvial sands with high content of fine and very fine gold showed that the loss of this-size gold can reach 54% [4].

2. A scrubber-free washing facility test
In IGDS SB RAS the researchers developed and proposed a new type of a scrubber-free washing facility designed to treat gold-bearing sands with high content of sludge-clayey fractions. The novel full-scale original plant designed at IGDS SB RAS consists of a disintegration and classification facility, steeply-inclined concentrator, and centrifugal-vibration concentrator.

The scheme of a pilot novel full-scale plant (technological module) of design parameters for technological streams is shown in Figure 1.

![Diagram of washing plant scheme.](image)

The head facility in the full-scale washing plant is the apparatus for disintegration and classification which operation principle rests on the integrated progressive effect on the washing feed in the air and water-air media. The apparatus provides disintegration and hydraulic classification and removal of slime fractions.

The principal concentrator in the new-developed scrubber-free plant is a steeply-inclined concentrator where the separation of minerals proceeds in upwelling water stream at the steeply inclined surface, this operation provides reorientation of flattened particles in the pulp stream with increase in hydraulic coarseness of these particles. The increased hydraulic coarseness of these particles permits to recover rebellious flattened- and flaky-shaped particles of gold.

The novel centrifugal-vibration concentrator is designed to process the slime product of the disintegration-and-classification apparatus. Its specific feature is that vibration oscillations of the working member are directed along axis of its rotation thus creating the most favorable conditions for entrapping of fine and very fine gold grains.

The full-scale washing plant flowsheet is as follows.

Initial sand of -100 mm in size is fed for washing to the disintegration-and-classification apparatus where it is separated into four size fractions: -100+20 mm, -20+5 mm, -5+0.1 mm, -0.1 mm. Fractions of -100+20 mm and -20+5 mm are dump products and discharged to tailings. The production fraction of -5+0.1mm is fed to the primary steeply-inclined concentrator with the yield of a concentrate and dump tailings. Slime fraction of -0.1 mm being a product of the disintegration-and-classification apparatus is fed to the centrifugal-vibration concentrator.

The laboratory stands and models manufactured in the course of the experimental research made it possible to determine rational design parameters of the novel machinery and to estimate the
principal operational feasibility of the facilities proposed. The laboratory models were used as the base to manufacture the pilot larger-scale facilities to test them and to work out proposals on their design modification.

The assembling of the scrubber-free washing plant was performed at the testing site of IGDS SB RAS (Figure 2).

Figure 2. General view of the washing plant.

The research experiments aimed at obtaining the rational qualitative technological parameters were conducted under the methodical procedure on sand specimens originated from a berried placer deposit in B. Kuranakh river, the Aldan region, Republic of Sakha (Yakutia). The placer material is highly clayey with fine and very fine gold content. The experimental results justified the feasibility to obtain the concentrate at 70% gold recovery at production rate of 2 m³/h. This provides the grounds to state that it is possible to apply the scrubber washing plant to process a highly clayey material.

The main technical and technological advantages of the novel-type washing plant as compared to conventional equipment are efficient disintegration of clayey materials with elimination of secondary species (pellets) formation, high performance and recovery ratio per a unit of apparatus volume as well as none of moving parts in washing and basic processing modules.

3. Conclusions
Comparative evaluation of technical-and-economic parameters of the pilot plant and the conveyer barrel-sluice facility proved the economic feasibility to apply the new-proposed washing plant. The plant is specified with simplicity in design and maintenance as well as reliable functioning and repair capability along with low capital and operating costs. Further experimental research and pilot design works are planned to develop large-scale pilot plants in view to improve the performance of the washing plant under consideration as a whole.

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