

Evaluation of commingled tailings and waste rock as an integrated approach to mine waste management: outcomes of a pre-pilot trial

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Minera Antamina operates a large polymetallic (Cu-Zn-Bi-Mo) open pit operation located approximately 300 km north of Lima, Peru, within the central Andes at an elevation of 4300 m. Operations have been underway since 2001 with a throughput of approximately 53 Mtpa. The current mine life is expected to extend to at least 2070 with the potential for 100 years of operations.

Tailings are generated from the flotation process at a rate of approximately 50 Mtpa and are deposited as a 40 wt% slurry into a conventional valley infill facility with containment provided by a lined zoned rockfill embankment that is currently 265 m in height containing approximately 1 Bt of tailings. The ultimate capacity within the facility is approximately 1.8 Bt which will be reached in 2036, after 35 years of continuous operation.

Antamina, as part of its strategic planning process, is undertaking studies to determine future tailings management opportunities that will be required after 2036. The studies have considered both conventional and non-conventional approaches, ranging from continuing the current tailings management approach to developing a filtered tailings stack. A significant challenge for moving from the conventional slurry transport approach to a non-conventional 'dry' tailings system is posed by the significant daily tailings production rate (144,000 tpd) and the very high reliability required for the transport-placement system.

Contemporaneous with the tailings studies, Antamina has also been conducting studies on the transport of mine rock from the pit to the rock storage areas. Future requirements are projected to significantly increase the need for a conventional truck haul fleet, even when considering the ultra-class trucks. An evaluation has been undertaken to examine crushing and conveying of mine rock to the storage areas, and this evaluation has provided a significant enabler for the codisposal of mine rock and tailings into the rock storage areas.

An initial proof of concept laboratory study was undertaken to evaluate the potential for codisposal of mine rock and dewatered tailings. The study was successful in demonstrating the Antamina mine rock material can contain up to 20-25% tailings with commingling while maintaining the geotechnical properties of the mine rock material. The laboratory tests evaluated three different approaches to generating dewatered tailings: paste thickening, cycloning off the coarse sand fraction of the tailings, and filtration of the complete tailings. All three approaches demonstrated that, with the correct blend ratio of mine rock to tailings, suitable geotechnical properties can be achieved.

In 2022, Antamina advanced a pre-pilot plant trial project aimed at confirming the results of the laboratory testing at a large scale (100+ tpd) as well as providing material for larger scale testing programs and materials handling testing. This work program incorporated and will evaluate i) the dewatering of process tailings obtained from the tailings storage facility deposition system under field conditions, ii) the mechanical handling aspects under a test conveyor circuit, and iii) the establishment of long-term, large-scale geochemical test columns as well as bulk samples for a geotechnical testing program. The latter two components are currently in progress while the initial components have been completed.

The preliminary results of the pre-pilot plant dewatering determined

- paste thickening was unsuccessful in providing a viable material for codisposal by commingling, as a suitable water content was not achievable;
- cycloning was able to convert 65% of the total tailings into a free-draining material with a suitable water content for commingling; and
- filtering was able to provide a material with a suitable water content for commingling.

The latter two approaches were advanced for further evaluation, including the conceptual design of the dewatering systems, with cycloning being the preferred approach due to the simplicity of the system, ability to efficiently handle the throughput, existing experience within Peru and alignment with the mine rock conveying system capacity. It will mean a separate tailings management facility will be required to manage the fine fraction. Filtration was able to provide a suitable material; however, the moisture content was higher and more susceptible to liquefaction on the conveyor system. It would also require a significant capital investment while incurring high operating costs.

Antamina is currently undertaking the engineering design work for advancing the cycloned codisposal option for a pilot plant operation to be undertaken in 2024. The commitment for this work recognizes the opportunity provided by codisposal with commingling for the minimization of the overall mine waste footprint while achieving social expectations for safe tailings management.