

New Tailings Water Management System Supports Expansion, Helps Safeguard Environment

By David Oliphant

A recent tailings water management overhaul provides increased capacity for high volume tailings water and significantly reduces treatment time. The new system also ensures the operation maintains low impact to the environment.

The Goldcorp Red Lake Mine in Balmertown, Ontario, is Canada's largest gold mine and one of the world's richest and lowest cost gold producing operations. Mining is carried out using underground cut and fill techniques, allowing maximum ore extraction and minimal dilution. The operation continues to grow, recently adding Shaft #3, a 6,134-foot deep shaft complex, and expanding its mill capacity to 1,200 tonnes per day.

Prior to this expansion, tailings were either directed underground for use as backfill or discharged to the operation's tailings water management facility for further refining through natural attenuation and ferric treatment prior to discharge to nearby Balmer Lake. The mine and mill expansion rendered these treatment methods inefficient for handling the increased volume of tailings pond effluent.

Goldcorp initiated procedures for identifying potential new treatment systems that could handle the projected increased loadings. But handling the sheer volume of additional tailings water was not the only objective. While most treatment processes are designed to remove a broad range of contaminants, precipitated arsenic is the primary contaminant of concern for Red Lake Mine. In addition to elevated arsenic treatment, elevated ammonia levels in the tailings ponds during the winter and early spring are present. In the late spring and summer, as the water temperature increases, bacteria in the tailings ponds becomes more active and the ammonia levels drop below the mine's 10 mg/l discharge limit.

With the higher treatment volumes resulting from the mine's increased production, Goldcorp required a high rate water treatment system capable of treating the high volume of tailings effluent water for arsenic during May through October, when ammonia levels are naturally below 10 mg/l.

Following a comprehensive technology review, Goldcorp requested a pilot study to determine the efficiency of a high rate sand-ballasted flocculation and clarification process. The process, ACTIFLO®, has proven especially suitable for removing contaminants such as arsenic, heavy metals and suspended solids from many sources of contaminated water.

The test ran for two weeks, during which time raw water was pumped from the tailings pond into the pilot unit. Following treatment, the clarified water was pumped into a different pond and the residual sludge returned to the original tailings pond.

High arsenic removal achieved

The results from the pilot test showed arsenic removal at 94 percent, with clarified water containing only .09 mg/L arsenic, well below the 0.3 mg/L target. Although iron concentration increased slightly (due to iron based coagulant used for this application) it remained below the target value of 1 mg/L. In addition, turbidity was reduced by 67 percent, from 3 NTU to 1 NTU. The process was able to produce good clarified water quality that easily met the pilot testing program requirements at a rise rate as high as 60 m/h.

Based on the pilot study results (for specific numbers contact the author), the tailings water management facility

was completely overhauled to add two ACTIFLO ACP-750 package plants for high-rate sand-ballasted flocculation and clarification, followed by an ACTIDYN® Lamella Thickener to provide high load sludge thickening. The ACTIFLO and ACTIDYN systems are both developed and patented by Veolia Water Solutions & Technologies (VWS). VWS Canada provided the treatment plant to the Red Lake Mine. With these renovations in place, total flow capacity has been increased to 30,000 m³/d, while continuing to meet and exceed all provincial and federal effluent standards in the discharge water.

Sand-ballasted flocculation, clarification

The sand-ballasted flocculation and clarification process is a compact process that operates with microsand as a seed for floc formation. The microsand provides surface area that enhances flocculation and also acts as a ballast or weight to aid a rapid settlement, resulting in a very high rate settling process with a very small footprint.

With this process (see Figure 1), raw water is first mixed with a coagulant in a high-shear environment where it is retained for two minutes. In the next tank, the water is injected with a polymer along with microsand and mixed aggressively for roughly another two minutes. The water then enters a "maturation zone," where gentle shear is applied for an additional six minutes.



The Red Lake Mine's arsenic treatment plant includes two ACTIFLO® ACP-750 units with a total flow capacity of 30,000 m³/d. Retention time of the sand-ballasted flocculation and settling technology is considerably lower than conventional treatment.

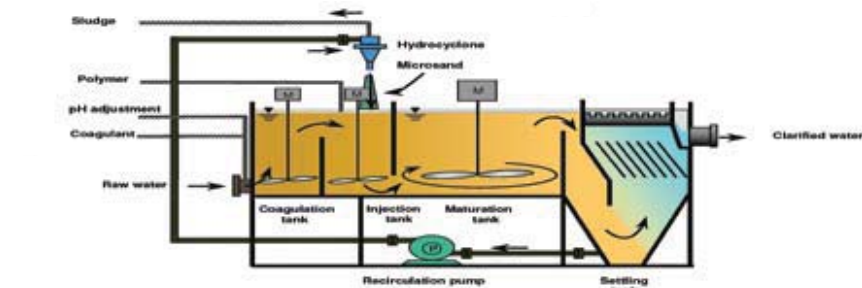
The microsand-ballasted flocs increase in size, trapping smaller flocs before the water enters the sedimentation tank, where the large flocs immediately begin to settle. The clarified water at this stage then counterflows upward through settling tubes to collection troughs where it can be diverted to various applications. The microsand and other solids in the ballasted flocs that settle in the bottom of the tank are then pumped to a hydrocyclone centrifuge. The microsand is cleaned and re-injected for reuse and the waste solids are removed.

This process allows for high overflow rates and short retention times. It can also handle extreme conditions with high upflow velocities (40-150 m/hr) with quick response time (less than 10 minutes).

The ACTIFLO process serves not only as an effective high-rate clarifier but also as a highly versatile chemical reaction vessel. Depending on pH conditions, colloidal and dissolved metals in the influent can be precipitated using classic and familiar chemical methods for efficient sand-ballasted removal in the settling step. Because retention times in the system are very rapid (minutes instead of hours), the technology is extremely compact, providing increased capacity without the large surface area requirements of traditional flocculation/sedimentation systems.

High load sludge thickening

The ACTIDYN Lamella Thickener, added to condition the sludge coming off the two ACTIFLO units, is a high-rate gravity settler combined with a circular picket-fence sludge thickener/scrapper in one tank. It provides high load sludge thickening through chemical flocculation followed by lamella clarification and picket fence thickening. Picket fence thickening includes a series of vertical rods supported on a structure that spans the tank. As it rotates about the center of the tank, a series of vertical voids are produced which permit the passage of separated water and micro-bubbles released from the flocs to rise to the surface. By combining this mechanical procedure with chemical flocculation and lamella settling, the process provides the advantages of producing good supernate



The ACTIFLO® system is an extremely compact, high-rate water clarification/treatment process that provides increased capacity without the large surface area requirements of traditional flocculation/sedimentation systems. Several important features combine to make the system very conducive to mining applications: high quality effluent, process stability, and reduced chemical consumption.

quality and high thickened sludge concentration in a small footprint.

Results

Construction of the tailings water treatment plant was completed in April 2007, and performance testing was completed the following May. The end of 2008 marked the first full year of operation of the new systems at the Red Lake Mine.

“The ACTIFLO system is performing very well, as anticipated,” says David Gelderland, Environmental Manager for Goldcorp Red Lake Gold Mines. “We are meeting compliance standards with ease and the plant has excess capacity to deal with storm events.”

The high rate systems allow the Red Lake Mine to meet its entire annual tailings water arsenic removal goals during May through September, when ammonia levels are below the 10 mg/L threshold.

“The ability of this process to minimize treatment time allows us to retain water over the winter and utilize natural degradation during the spring and summer. Then, as ammonia concentrations are acceptable, we batch treat our tailing effluent through the treatment season. We move tailing effluent through our four-stage tailings management area. When the ammonia levels reach the appropriate threshold, we turn the ACTIFLO plant on, drain the water from the final impoundment over short duration and then shut the plant down, move more water downstream, waiting for further ammonia degradation.”

The sand-ballasted flocculation and clarification process at Red Lake mine is completely automated, minimizing staff workload. “We can oversee the entire process from our office complex. We

perform maintenance as required and top off the reagent tanks, but the system is very automated,” Gelderland says.

With the addition of the ACTIDYN sludge thickener, solids have increased approximately 2.5 percent. According to Gelderland, the mine is exceeding its expectations on sludge densities achieved.

“This translates to significantly increased storage life for our sludge pond. We had been looking at a five-year storage life. Now we’re probably looking at 10-20 years of storage life.”

High standards met

The new treatment processes have been welcome additions to the Red Lake Mine, providing the performance the operation needed in its tailings water treatment to allow for expansion of the mine and mill without adverse impact to the environment.

“Currently our arsenic limit is .25 mg/L, but the treatment objective for arsenic treatment objective is .05 mg/L,” Gelderland says. “That’s a substantial reduction, and our Red Lake plant easily meets that criteria.”

Goldcorp maintains high standards of environmental responsibility in its mining operations. One of the major items of environmental concern in any mining operation is the disposal and/or refinement of mine tailings. Goldcorp has incorporated high rate treatment processes at its Red Lake mine that serve the operation at a level consistent with its high commitment to the local community and the environment. **M**

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