Mining Sustainability by Water Treatment, Tailings Repurposing and Slag Recycling

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OVERVIEW

Montana Tech has been engaged in treating water, repurposing tailing, and recycling slags for several decades in order to help sustain the mining industry. Recent efforts include treating contaminated waters including acid-rock drainage, repurposing tailings to manufacture synthetic lunar soil and make sand for concrete production, and using slag to not only recycle valuable metal content as a pig iron but also to produce a secondary slag for the glass industry. These efforts are reviewed in detail. It is important to note that results are applicable universally; however, some are site-specific but can be modified for use elsewhere. In all cases, an environmental issue is resolved but by-products are marketed to help offset remediation costs. Consequently, waste products become economic by-products allowing the mining industry to reduce its environmental footprint and improve the bottom line.

WATER TREATMENT

Butte, Montana, USA is home to the Berkeley Pitlake which is part of the largest superfund site in the country. When the acid-rock drainage (ARD) water in the former open pit mine reaches the critical water level, which is expected to occur in 2022, water must be treated for discharge using the two-stage lime precipitation process, the best demonstrated available technology (BDAT). The Horseshoe Bendwater Treatment Plant has been constructed and operating on a large scale in anticipation of going full production in 2022. Sludge generated from this process is discharged into the pitlake and reclaimed water is used in the neighboring mining operations of Montana Resources with their Continental Pit and Clyde Weed Concentrator. Prior to the treatment plant, an extensive sampling program of the pitlake was undertaken to see if natural processes were occurring that could be taken advantage of on an elevated scale to remediate the pitlake by a technology other than lime precipitation. Examples that are reviewed include photolytic activity in the surface waters above approximately 10 meters and side wall/bottom rock interaction with deep water as much as 1000 meters below the surface.

TAILINGS REPURPOSING

Tailings from two proprietary mining operations in Montana were examined. NASA expressed interest in one because the mineral content matched 3 of the 4 major minerals on the moon: plagioclase, orthopyroxene and clinopyroxene. To effectively separate them, the tailings were characterized and tested using a variety of processing unit operations including electrostatic separation, magnetic separation and flotation. Concentrates were combined with an olivine concentrate made by recycling casting sands from a Montanan foundry. Results met NASA requirements for making synthetic lunar soil. In the second example, a proprietary company wanted help reducing their tailings footprint by developing a recycling process. As before, the tailings were characterized and tested using the same unit operations. In this case, the unrecovered valuable commodity was concentrated and waste materials were found to make an appropriate sand for concrete making. These examples of tailings repurposing are discussed in detail.

SLAG RECYCLING

In the 1980's and 1990's, several smelting operations in Montana were closed. The legacy slags from these operations were characterized and shown to have remediation capabilities of ARD. Slags include fayalite slag from the Anaconda Company Copper Smelter Operations, olivine slag from ASARCO East Helena Lead Blast Furnace, and pseudowollastonite slag from Rhone Poulenc Phosphorus Plant. ARD remediation approached that of lime precipitation and are explained using statistical designed experiments with % solids, particle size and slag type as major variables. Current studies with Anaconda slag involve using carbothermal reduction to produce pig iron and secondary slag/glass products. In this case, statistically designed experiments showed that temperature, flux composition and time need optimization because it was not possible to maximize both glass strength and metal recovery to the pig iron.

CONCLUSIONS

Societal demands and resulting government regulations for a clean environment have forced the mining industry into thinking differently. Sustainability practices have arisen and include metallurgical processing aspects. In the selected cases, by-products are marketed that offset remediation costs that allow the mining industry to reduce its environmental footprint and improve the bottom line.

BIOGRAPHY

Dr. Young is Department Head and Lewis S. Prater Distinguished Professor of Metallurgical & Materials Engineering at Montana Tech. He is a graduate of three premiere mineral/coal processing and extractive metallurgy institutions having obtained his BS in Mineral Processing Engineering from Montana Tech in 1984, his MS in Mining and Minerals Engineering from Virginia Tech in 1987, and his PhD in Metallurgical Engineering from The University of Utah in 1994. He started teaching at Montana Tech in 1993 and became Department Head in 1998. Most of his research has been company-driven to help sustain the mining industry through minimization and treatment of wastes including but not limited to water, tailings and slags.