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Application of Catalytic Wet Air Oxidation for breaking mining sludge emulsions generated in mine tailings and fracking drilling

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In the Alberta oil industry large amounts of tailings that are produced and contained in lake size ponds controlled by a zero-discharge policy. The ponds are consolidated in different layers; the bottom layer it is identified as mature fine tailings (MFT), which is comprised by 30-38% solids, 3-4% of bitumen and water. Particle analysis of MFT reveals that it is a mixture of particles of different sizes (clay, silt and sand) that are trapped around bitumen, sticking them together to create an emulsion and does not separate on its own. Polymers and flocculation processes have been used to accelerate the dewatering of the MFT to consolidate the particles into a solid material. These processes consolidate the MFT enough to be used in roads and in reclaimed ponds. After the water is separated from the consolidated MFT the material still contain more than 3% of the bitumen that might leach off releasing organic compounds to the environment. Despite of all the research efforts, there is still there is not an optimal way to treat the MFT and produce an innocuous material.The objective of this study is to investigate the use of the catalytic wet air oxidation (CWAO) as an alternative and effective method to separate this kind of waste sludges, maximizing the recovery of the water, minimizing the process time and producing a consolidated and environmentally safe material.

The CWAO process involves treating the waste sludges in a pressurized reactor at temperatures between 120-150°C. Air is used to provide oxygen as the oxidation reagent for the reaction. In this process the residual oil (bitumen or tight oil) was removed from the particles, releasing the trapped water provoking a fast sedimentation of the solid particles. The radicals generated in the oxidation process will further oxidize organic compounds in the recovered water. Hydrogen peroxide was used to boost the radical formation and to accelerate the oxidation mechanism. The waste sludge used in these experiments was MFT from an oil sands tailing pond in the Fort McMurray area. In all the experimental conditions the MFT emulsion was effectively separated in its main constituents (bitumen, water and solid particles). The released water showed a high transmissivity and low concentration of dissolved solids. The CWAO provoked a fast disintegration of the emulsion releasing most of the water in the first 5 minutes of reaction. When peroxide was used the recovered water and the particle consolidation was increased by 50%. Water analysis showed that carbonates were reduced by 80% and the dissolved organic carbon (DOC) increased from 20 to 100 p.m. In the first 15 min and after 90 min the DOC starts to diminish. A substantial amount of froth (bitumen) was collected in every batch with an average of 8% of the dry weight of MFT. The CWAO proved to be a feasible treatment to break oil-based waste emulsions, such as MFT, recover water with low levels of DOC, dissolved solids and salt, while producing a consolidated and environmentally safe material.