VALORIZATION OF GROUND TIRE RUBBER BY BIO-DEVULCANIZATION AND INVESTIGATION OF ITS USE IN INDUSTRIAL APPLICATIONS

The rapid industrialization and especially the growth in the automotive industry significantly increased rubber consumption. Simultaneously produced rubber wastes are one of the most critical challenges in waste management of the 21st century. Because of their network structure, the natural degradation of rubber wastes lasts too long. Besides, the reuse/recovery of waste rubber without pre-treatment is impossible. Tires have economic value even after they have been wasted. Many new methods have been developed for the recycling of waste tires. Among these developed methods, bio-devulcanization (i.e. bio-desulfurization) takes attention with its low energy requirement, selectively breaking sulfidic (mono-, di-, poly) crosslinks without damaging the main rubber chain, and being an environmentally friendly application. This process, which is carried out without damaging the main chain, takes place on the surface of the rubber by oxidation or reduction of sulfidic crosslinks. Although the mixed cultures were seen as more efficient than pure cultures, most of the studies in the literature were conducted by using pure cultures. Recently, the bio-devulcanization of ground tire rubber (GTR) by autotrophic denitrifiers, enriched from leather industry biological nutrient removal (BNR) sludge, was investigated for the first time and 3.9% sulfur removal was achieved.

This thesis study aims to optimize the operational conditions for bio-devulcanization of GTR by autotrophic denitrifiers to increase its recycling potential. GTR bio-devulcanization will be investigated under optimum conditions in scaled-up reactors. Although synthetic wastewater will be used as the electron acceptor in the optimization stage, nitrate-containing industrial wastewater will also be studied to investigate 'Simultaneous Devulcanization and Denitrification'. To our knowledge, investigation of the recycling potential of waste rubber was the main aim of the bio-devulcanization studies carried out so far, and the 'Simultaneous Devulcanization and Denitrification' approach will be the first application of both valorization of waste rubber and wastewater. Moreover, the use of bio-devulcanized ground tire rubber in different industrial applications, such as sustainable rubberized bitumen production, replacement of virgin rubber to produce automotive floor mats, will be investigated.

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