**122-ENGR**

# TITLE: MECHANOCHEMICAL DESTRUCTION OF PFAS AND OTHER PERSISTENT HALOGENATED ORGANIC POLLUTANTS: A CRITICAL REVIEW

Per- and polyfluoroalkyl substances (PFAS) exhibit exceptional chemical and thermal stability, rendering them highly resistant to conventional degradation pathways and posing persistent environmental and toxicological challenges. Mechanochemical destruction (MCD) via high-energy ball milling has emerged as a promising alternative to conventional soil remediation methods due to its minimal energy input, high mineralization efficiency, and operation under ambient conditions. This review consolidates advancements in MCD for PFAS degradation and its broader application in the remediation of other persistent organic pollutants (POPs). Emphasis is placed on the critical role of co-milling agents, such as zero-valent iron (ZVI), calcium oxide (CaO), potassium hydroxide (KOH) and new additives like $BaTiO_3$ and persulfates, in enhancing degradation kinetics. These agents facilitate bond cleavage, improve defluorination yields and minimize the formation of toxic intermediates by modulating electron transfer processes and reactive species generation within contaminated porous matrices. This analysis further examines mechanistic pathways, physiochemical interactions and evaluates the scalability of MCD for application beyond the laboratory settings. Critical gaps in current knowledge include incomplete product characterization, inconsistencies in experimental methodologies, and the absence of a standardized operational framework. The lack of a unified protocol across studies presents a significant barrier to large-scale implementation, necessitating further research into process optimization, real-world applicability, and potential secondary environmental impacts.

**Keywords**: Mechanochemistry, PFAS, POP, ball milling, mineralization, defluorination