**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**

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Thesis Title: Synthesis and Performance Evaluation of a Novel Natural Surfactant–Polymer Assembly for Enhanced Oil Recovery

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**SHORT ABSTRACT**

A significant amount of oil (i.e., 60–70%) remains trapped in the reservoirs after the conventional primary and secondary methods of oil recovery. Enhanced oil recovery (EOR) is, therefore, necessary to recover the major fraction of unrecovered trapped oil from the reservoir to meet the present-day energy demands. The chemical method of EOR involves the injection of alkali, surfactant, polymer, and a combination of alkali–surfactant–polymer solution in the reservoir with the objective of achieving a reduction in interfacial tension and matching the mobility between oil and water for more recovery of oil. The success of this method depends on the effective synergy between the chemical additives.

This work is focused on the development of an alternative cost-effective and sustainable natural surfactant derived from the weed *Eichhornia crassipes*, and study its beneficial effects on EOR. The surfactant has been characterized by the FTIR, GC–MS, $^{1}$H NMR, FESEM, and FETEM analyses. The surface and interfacial tension have been measured. The influence of the synthesized surfactant on the rheological properties of xanthan gum (a polysaccharide) has been studied and compared with that of a commercially-used surfactant. The experimental data acquired from the rheological analysis of the surfactant–polymer solutions under varying shear rate were fitted by several non-Newtonian fluid models. An effective reduction in the interfacial properties, improvement in the rheological properties, and stability against heat and salinity suggest its potential application in EOR.

Loss of surfactant by adsorption on porous media is one of the most critical concerns of the surfactant flooding method of EOR. Hence, the present study is also dedicated to analyze the adsorption of the synthesized surfactant on sandstone and sand surfaces under reservoir-like conditions. The mechanism, equilibrium, and kinetics of adsorption of the synthesized natural surfactant on sandstone and sand surfaces have been investigated through batch experiments at different concentrations (i.e., 1000–5000 mg dm$^{-3}$), temperatures (i.e., 298–333 K), and a fixed salinity. The interfacial phenomena are associated with the adsorption of the surfactant at the oil–rock and oil–water interfaces. Therefore, it is essential to understand the mechanism of adsorption of surfactant at the oil–water interface for better implementation of surfactant flooding. The adsorption of the synthesized surfactant on the oil–water interface was investigated using small-angle X-ray scattering, interfacial rheology, zeta potential, and phase behavior analyses. A noteworthy improvement in the stability of the oil-in-water emulsion was observed in the presence of the surfactant. Moreover, the feasibility of the use of the synthesized surfactant for EOR was studied based on the wettability alteration and IFT measurements under reservoir-like conditions (i.e., high temperature and

pressure). Further, core flooding experiments were carried out by injecting the surfactant–polymer slugs of different concentration into the sandstone core sample under reservoir-like conditions. An effective reduction of ~37–41% in the IFT and ~43% in wettability was observed with increasing surfactant concentration. Based on the core flooding experiments, 13.3–22.4% additional oil recovery was achieved. Based on the aforesaid studies, the performance of the synthesized surfactant is promising for EOR applications.