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Evaluation of calcium chloride for synergistic demulsification of super heavy oil wastewater

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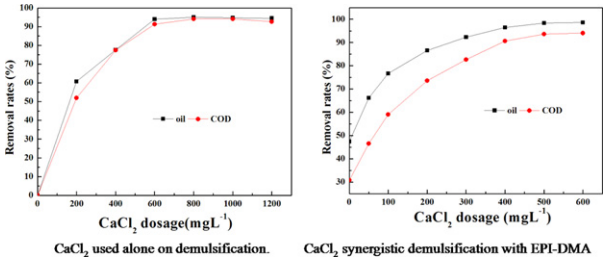
HIGHLIGHTS

- $CaCl_2$ has a good performance in synergistic demulsification of super heavy oil wastewater.
- A new demulsifier REB is combined with P-DcE,$CaCl_2$ and CPAM.
- REB can remove more mineral oil, COD and organic compounds than two traditional demulsifiers.
- The REB effluent has low BOD/COD and delivers good performance in anaerobic digestion.
- REB is an efficient, safe and economical demulsifier of super heavy oil wastewater.

GRAPHICAL ABSTRACT



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ABSTRACT

Calcium chloride ($CaCl_2$) is used together with cationic poly (dimethylamine-co-epichlorohydrin) (P-DcE) and cationic polyacrylamine (CPAM) to demulsify super heavy oil wastewater. A new reverse emulsion breaker (REB) with the optimal ratio of P-DcE to $CaCl_2$ to CPAM of 20:600:1.2 (m/m) can remove 98.04% mineral oil and 94.48% COD. Compared to P-DcE used alone and P-DcE supplemented with concentrated sulfuric acid to enhance demulsification, the advantages of the REB are high removal rates for mineral oil and COD, low cost, and environmental friendliness. GC–MS indicates that the REB can remove more organic compounds such as mineral oils than other agents and most of the residues are oilfield chemicals such as corrosion inhibitors, scale inhibitors, biocides, and demulsifiers. The REB, which exhibits good efficiency in anaerobic digestion and synergistic demulsification of SHOW arising from $CaCl_2$, is efficient, safe, and economical.

1. Introduction

Super heavy oil wastewater (SHOW) in the Liaohe oilfield in China is a complex one that comprises not only water produced from the oil extraction, but also steam-assisted gravity drainage wastewater (SAGD) [1], scum and filtered wastewater, as well as ion-exchanged wastewater. It is a complicated system containing high amounts of oil, SS (total suspended solid), reductive substances (such as sulfide, Fe and Mn) and saline materials [2]. It is enriched with dissolved recalcitrant organic compounds such as polymers, surfactants [3] or oilfield chemicals (OCs) [4], and the super heavy oil has a density of 0.95–1.20 g/cm^3 (20 °C) and viscosity larger than 10,000 mPaS (50 °C) [5]. The mineral oils in SHOW contain a number of asphaltenes, resins, and naphthenates, which are polar and surface-active species, and are natural emulsifiers [6]. Naphthenates, particularly sodium naphthenates,

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