Abstract

Pollution control is one of the most critical issue in front of developed and developing countries who are facing an immense crisis in this field. Hydrogen sulfide (H₂S) is a highly toxic and an undesirable gaseous component of natural gas and other waste gaseous streams. Abatement of H₂S by Catalytic conversion to elemental sulfur can be achieved by various chemical and biological methods. Liquid redox sulfur recovery processes absorb H₂S from gaseous streams and convert it to elemental sulfur. The gas desulfurization can also be carried out using liquid redox chemistry, where iron complexes are alternately reduced according to the following reactions.

\[
\begin{align*}
H_2S_{(g)} + 2Fe^{3+}L^{n-}_{(t)} & \rightarrow S^n_{(l)} + 2H^+ + 2Fe^{2+}L^{n-}_{(t)} \\
2Fe^{3+}L^{n-}_{(t)} + \frac{1}{2}O_2_{(g)} + H_2O_{(l)} & \rightarrow 2Fe^{2+}L^{n-}_{(l)} + OH^{-}
\end{align*}
\]

Since the active ferric chelate is converted to inactive ferrous chelate, the later component has to be regenerated by oxidation according to

\[
2Fe^{3+}L^{n-}_{(t)} + \frac{1}{2}O_2_{(g)} + H_2O_{(l)} \rightarrow 2Fe^{2+}L^{n-}_{(l)} + OH^{-}
\]

where ‘L’ denotes an organic ligands, which is usually a polyaminocarboxylic acids.

Chelating agents (EDTA, HEDTA, DTPA, NTA, CDTA, etc.) reported for iron chelation have very low rate of biodegradation (e.g. EDTA BOD₅- 0.1%, DTPA BOD₅- 0.7%) thus causing pollution in itself. Alternative chelating agents for gas sweetening should possess high rate of biodegradability along with equal or better complex forming properties compared to commercial chelating agents. It has been reported that carboxylic acids posses good chelating properties and have faster rate of biodegradation (e.g. citric acid BOD₅- 61% and malic acid BOD₅- 65%) as compared with commercial chelating agents.

This work, for the first time reports a detailed study involving screening of biodegradable Fe³⁺-chelates for the catalytic conversion of H₂S gas to elemental sulfur. Among various chelates that were screened, the Fe³⁺-MA chelate exhibits
maximum sulfur recovery and purity. Thus, the detail structural characterization of Fe$^{3+}$-MA chelate was studied. By using this novel biodegradable chelate the synthesis and characterization of sulfur nanoparticles was carried out in w/o microemulsion system and in different aqueous surfactant systems. The performance of mechanically agitated batch reactor (MABR) using Fe$^{3+}$-MA chelate as a catalyst was also studied extensively. The work done towards achieving this goal has been elaborated into following chapters of the thesis.