CHAPTER-5

CONCLUSIONS
Conclusions

"It is not easy for the earth to replenish her at a pace that she may be relieved of all the pollution we impose upon her."

The abatement of highly toxic odorous hydrogen sulfide gas is a challenging task. The use of liquid redox sulfur recovery processes are most popular and widely used processes for gas sweetening. The iron (III) was chelated using polyamino-polycarboxylic acids e.g. EDTA, HEDTA, NTA, CDTA, etc. which catalytically converts H₂S into elemental sulfur precipitate. However, very low rate of biodegradation of these commercial chelating agents in the blow down raises the question about environmental pollution.

The main theme of our research work is to replace these commercial chelating agents with some biodegradable chelating agents like simple carboxylic acids which have good chelating property along with higher rates of biodegradation. Taking into consideration the above problem, the screening of some carboxylic acid as chelating agents for iron chelation was carried out. The iron chelates using gluconic acid, malic acid and citric acid as chelating agents were synthesized and used for H₂S to elemental sulfur conversion. Based on the study on the screening of synthesized iron chelates, FeCl₃-malic acid chelate system has been observed to give maximum recovery of sulfur (499 mg/g of iron chelate) along with high purity (> 99%) and reasonable extent of reaction time (15 min). Further study was carried out to decipher the detailed structural characterization of this Fe⁺³-MA chelate using IR, ESI-MS,
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TG/DTA techniques which corroborates emphasis the bimetallic iron chelate formation with six malic acid molecules.

The second part of the thesis is focused on the sulfur nanoparticle synthesis, characterization and their applications. Sulfur finds extensive applications in various industries. In our work we first time report the sulfur nanoparticles synthesis using biodegradable iron chelates from hazardous H₂S gas. The synthesis was carried out in reverse microemulsion and aqueous surfactant systems. The sulfur nanoparticles so synthesized are highly mono-dispersed, uniform in shape and size of 5-15nm range. Sulfur is known for its antimicrobial and antifungal activity. The statistical analysis of the experimental data on sulfur activity confirms the high antimicrobial and antifungal activity of sulfur nanoparticles compared with normal sulfur. The analysis also confirms this is due to the actual nano-size, shape and high surface area of nano-sulfur.

The performance of novel biodegradable Fe⁴⁺-MA chelate for catalytic conversion of H₂S to elemental sulfur was studied in mechanically agitated batch reactor. To achieve maximum catalytic conversion of H₂S, it is necessary to design an optimal process operating strategy for the MABR. The process variables and parameters which significantly influence H₂S conversion were determined using Plackett-Burman (PB) design method. Then modeling and optimization of the process operating variables and parameters were conducted using an artificial intelligence based hybrid strategy involving artificial neural networks (ANN) to develop model predicting H₂S conversion. Then this model’s inputs are optimized using the GA formalism with a view to maximize H₂S conversion. The interactive effects of the process variables and parameters were studied using Plackett-Burman (PB) – Response Surface Method using Central Composite Design RSM (CCD). The
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optimized sets of process conditions obtained using the hybrid ANN-GA and PB-RSM (CCD) strategy were successfully validated in fresh experiments. The GA-optimized process conditions leading to a high (≈ 97%) \( \text{H}_2\text{S} \) conversion was verified experimentally.

The objective of replacement of commercial chelating agents by novel biodegradable iron chelates for maximum catalytic conversion of \( \text{H}_2\text{S} \) to elemental sulfur at ambient temperature and atmospheric pressure was achieved. The reported biodegradable iron chelate system serves many objectives; as reduction of aqueous pollution (by using biodegradable iron chelate), treatment for gaseous waste (removal of \( \text{H}_2\text{S} \)) and recovery of commercially important product (sulfur recovery).