CONTENTS

LIST OF TABLES
I
LIST OF FIGURES
II
1. INTRODUCTION
1

2. LITERATURE SURVEY
5
2.1 Historical Perspectives
6
2.2 Emulsion liquid membrane separation process
7
2.3 Transport mechanisms into emulsion liquid membranes
10
2.4 Essential features of emulsion liquid membranes (ELMs)
14
  2.4.1 Membrane materials
  2.4.2 Surfactants
  2.4.3 Emulsion preparation
  2.4.4 Emulsion stability
  2.4.5 Emulsion dispersion techniques
    2.4.5.1 Emulsion globule size and its prediction
  2.4.6 Emulsion swelling
  2.4.7 Membrane Leakage
  2.4.8 Demulsification
2.5 Type I facilitated transport
39
  2.5.1 Extraction of phenol
  2.5.2 Extraction of phenol derivatives and other weak acids
  2.5.3 Extraction of weak bases
  2.5.4 Biomedical applications of emulsion liquid membranes
  2.5.5 Commercial applications of Type I Transport
2.6 Type II facilitated transport
49
  2.6.1 Acidic carriers
    2.6.1.1 Chelating carriers
    2.6.1.2 Organic acid carriers

36
4.4 Distribution coefficients and effective diffusivities

4.4.1 Distribution coefficients of phenols between kerosene and water

4.4.2 Prediction of effective diffusivities

4.5 Extraction of phenol

4.5.1 Effect of stirring speed

4.5.2 Effect of internal phase volume fraction ($\phi$)

4.5.3 Effect of surfactant concentration

4.5.4 Effect of internal phase reagent concentration

4.5.5 Effect of Treat ratio

4.5.6 Effect of initial phenol concentration

4.5.7 Extraction of phenol at constant molar ratio $M$

4.5.7.1 Effect of treat ratio at constant molar ratio

4.5.7.2 Effect of initial phenol concentration at constant molar ratio

4.5.8 Effect of temperature

4.5.9 Effect of membrane material

4.5.10 Effect of delayed addition of solute

4.6 Extraction of o-cresol

4.6.1 Effect of stirring speed

4.6.2 Effect of internal phase volume fraction ($\phi$)

4.6.3 Effect of surfactant concentration

4.6.4 Effect of internal phase reagent concentration

4.6.5 Effect of Treat ratio

4.6.6 Effect of initial o-cresol concentration

4.6.7 Effect of temperature

4.6.8 Effect of membrane material

4.6.9 Extraction using acrylate emulsifier

4.7 Extraction of p-cresol

4.7.1 Effect of internal phase volume fraction ($\phi$)

4.7.2 Effect of internal phase reagent concentration

4.7.3 Effect of Treat ratio

4.7.4 Effect of initial p-cresol concentration
4.8 Extraction of 2-chlorophenol
4.8.1 Effect of internal phase volume fraction (G)
4.8.2 Effect of internal phase reagent concentration
4.8.3 Effect of Tert ratio
4.8.4 Effect of initial 2-chlorophenol concentration

4.9 Features of emulsion swelling and breakage
4.9.1 Swelling of emulsions
4.9.2 Emulsion breakage/leakage
4.9.3 Some aspects of emulsion stability

4.10 An integral view of separation of phenols
4.10.1 Effect of $\phi$ on extraction of phenols at $M = 2$
4.10.2 Effect of Tert ratio on extraction of phenols at $M = 2$
4.10.3 Effect of $C_o$ on extraction of phenols at $M = 2$

5 RESULTS AND DISCUSSION:

EXTRACTION OF COPPER AND NICKEL

5.1 Introduction
5.2 Chemistry of metal extractions
5.3 Characterization of extracting emulsions
5.3.1 Internal dropsize distribution of water in oil emulsion
5.3.2 Rheological properties of extracting emulsions
5.4 Dispersion behavior of emulsions
5.5 Extraction of copper using ELMs
5.5.1 Effect of stirring speed
5.5.2 Effect of $C_o$
5.5.3 Effect of surfactant concentration
5.5.4 Effect of internal phase volume fraction $\phi$
5.5.5 Effect of carrier concentration
5.5.6 Effect of Tert ratio
5.5.7 Effect of pH of external phase on extraction
5.6 Extraction of copper and nickel from ammoniacal media using ELMs

5.6.1 Effect of extraction of nickel from ammoniacal media

5.6.2 Extraction of copper and nickel from ammoniacal media

5.7 Features of emulsion swelling and breakage

5.8 Summary

6 TRANSPORT OF SOLUTES INTO EMULSION LIQUID MEMBRANES:

MODELING AND SIMULATION

6.1 The advancing front model

6.1.1 Prediction of extraction profile using the advancing front model

6.2 The reversible reaction model

6.2.1 Prediction of extraction profiles using the reversible reaction model

6.3 Summary

7 SUMMARY AND CONCLUSIONS

7.1 Characterization of ELMs

7.2 Extraction of phenols

7.3 Extraction of copper and nickel

7.4 Scope for future work

NOMENCLATURE

REFERENCES

APPENDICES

Appendix A
Appendix B
Appendix C
Appendix D
Appendix E
Appendix F