SYNTHESIS OF CHEMICALLY INDUCED SEPARATION SEQUENCES USING FUZZY HEURISTIC BASED SYSTEM

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Abstract-- **Chemical induced separation is used in a number of instances to accomplish difficult separations; however, there is a lack of information in the literature. In the present work, a fuzzy heuristic system for separation sequence synthesis using chemical induced separation is constructed. The construction of the present rule based system is based on the previous work of Huang and Fan (1990) in which knowledge-based system has been applied to physically induced separation sequence synthesis. Although the methodology proposed here, involves the use of declarative and procedural knowledge the emphasis is done on selection and sequence of chemical induced separation. A simple example is included to illustrate the procedure.**

Keywords -- **Fuzzy Heuristic, Separation, Process Synthesis, chemical induced separation.**

I. INTRODUCTION

Chemically induced separation is a common technique used for difficult separation. However, the synthesis of such systems has not received enough attention, and only few articles are available in the literature. Berthouex and Rudd (1977) developed a conceptual design, through an inductive reasoning, for the processing of red mud using chemically induced separation. Othmer and Nowak (1972) showed that the chemical affinities of halogens can be used in order to carry out difficult separations. Cisternas (1999) proposed a hierarchical morphology analysis to develop conceptual design for chemically induced separation.

On the other hand, there are many works on physically induced separation synthesis using knowledge-based systems and mathematical programming approaches. Examples of these works are: Hendry and Hughes (1972), Floudas and Paules (1988), Stephanopoulos and Westerberg (1976), Huang and Fan (1988), Qian and Lien (1994), and Wang *et al.* (1998).

Consider the following two examples as illustration of chemically induced separation:

1) The extraction of copper from a concentrated copper sulfide minerals by pyrometallurgical techniques. The extraction consists of roasting, matte smelting, and converting to blister copper. Roasting, an optional step, consists of partially oxidizing the sulphides and of partially eliminating sulphur from them as SO_2. The iron oxides and sulphates are subsequently eliminated during smelting as slag. Matte smelting consists of melting concentrates or partially roasted concentrates to produce two immiscible liquid phases consisting of oxides (slag) and sulphide (Cu_2S-FeS matte). The presence of FeS in the matte tends to sulphidize all the copper present in the charge. This reaction also allows the partial oxidation of iron, which is eliminated in the slag. The third stage, converting of copper matte, consists of blowing air through the mass of molten copper matte with the purpose of removing iron, sulphur and other impurities. The converting process takes places in two steps: a) slag forming stage in which FeS is oxidized, and b) the copper-making stage in which the copper sulphide is oxidized.

2) Another example is the separation system in the production of lithium carbonate from natural brines. In this process, sodium carbonate is used to precipitate magnesium carbonate, calcium carbonate, and lithium carbonate in several steps to separate Mg^{+2}, Ca^{+2}, and Li^{+} from an aqueous solution.

Chemically induced separation is usually considered when: (1) the components of a mixture have similar properties, so that a physical separation is unfeasible or difficult, and (2) the valuable components are present in small amounts.

In this work, a fuzzy heuristic based system for the synthesis of chemically induced separation sequences is presented. The aim is not to develop a complete rule based system, but to prove that this kind of synthesis problem can be solved using knowledge based systems.

II. PROBLEM SPECIFICATION

This problem can be defined as follows "Given a mixture of known composition, synthesize a sequence of chemical reactions and physical treatment that allows the separation of their species at minimum venture cost." The synthesis for separation involves three major steps: selection of a chemical transformation that allow the