W. Herman de Groot

Sulphonation Technology in the Detergent Industry

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by

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DEDICATION

This book is dedicated to friends with whom I have worked or still work in the sulphonation field. They live throughout the world and work for a variety of companies. I name them in alphabetical order:

Jorge Aparicio
Mario Ballestra
Jim Begnel
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Romeo del Vecchio
Antonio Zalaquett

and others too numerous to mention, my heartfelt thanks.

Wim

PREFACE

This book is about Sulph(on)ation Technology in its technical entirety, aiming at superiority in final product quality, raw material utilisation, sustained plant reliability and safety, minimisation of liquid effluent and gaseous emissions; it is about the total quality of the operation. It will be of value to engineers and chemists who are, or will be, involved in the practical daily operation of sulphonation plants or R&D activities. The book can also be used as a tool for the teacher in preparing final year projects in a chemical engineering curriculum.

The book covers sulphonation of alkylbenzenes, primary alcohols, alcohol ethers, alpha-olefins and fatty acid methyl esters, with a strong emphasis on the sulphur-based SO_3/air sulphonation technology.
The first part deals with raw material specifications, hazards, storage, handling and physical properties. In the following section the process chemistry is discussed, indicating main chemical reactions, undesired parallel and consecutive reactions, exothermal heat effects and all other process chemistry data that are relevant for process selection and equipment design. The section about the actual process equipment from the various plant equipment suppliers (Ballestra, Chemithon, Mazzoni, Meccaniche Moderne and Lion Corp.) takes into account the chemical reaction engineering aspects derived from the sulphonation technology processing chemistry.

Product quality, product storage and handling, product safety and physical properties are the contents of the next section.
The effluent handling and exhaust gas treatment of the SO_3/air sulphonation technology are further discussed in detail.
Plant instrumentation and computer control in various degrees of sophistication are described in the next section. Plant housing, space requirements, lay-out and required plant documentation are briefly discussed.

A further chapter of the book describes the 20% oleum and sulphuric acid based sulphonation technology. This part is less extensive, since the SO_3/air process is becoming predominant in the manufacture of detergent actives, taking over from the older oleum and sulphuric acid technologies.

A final chapter outlines the virtues of the sulphonation technology as a "learning paradise" for chemical engineers. All kinds of problems and disciplines come together in one concise operation: highly exothermic reactions in combination with substantial viscosity increase of the reaction products, undesired parallel and consecutive reactions affecting final product quality, environmental problems, hazardous and corrosive chemicals demanding careful selection of plant equipment, design and construction materials.

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Eindhoven, 1991
Wim Herman de Groot

ABOUT THE AUTHOR

Wim Herman de Groot worked for more than thirty years for Unilever, mainly in Research and Engineering. Before retiring in 1990 he was Unilever's world-wide expert on sulphonation matters. Since 1984 he has been a part-time professor in the Chemical Engineering Department of the Eindhoven University of Technology, The Netherlands. Professor Herman de Groot is a course director for an annual "Practical Sulphonation Course" in Amsterdam under the auspices of the "Center for Professional Advancement", New Jersey, U.S.A.

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1 APPLICATION OF SULPHONATES AS ANIONIC SURFACTANTS IN HOUSEHOLD PRODUCTS

1.1 Introduction

The main constituent in a detergent product is a surfactant, a material containing in a single molecule, a lipophilic oil soluble "tail" (usually an organic molecule with C_{12}-C_{14} chain e.g. RSO_3^-) and a hydrophilic water soluble "head" (usually an anionic e.g. Na^+).
The cleaning process by anionic surfactants (active detergents) is based upon the following phenomena:

i) thorough wetting of substrate and dirt due to reduction of water/substrate and water/dirt surface tension;
ii) removing of dirt from substrate;
iii) maintaining the dirt in a stable solution or suspension.

A variety of organic molecules are used in practice as a base material for detergents, either based on mineral oil, crude oil resources or from natural products. The most important organic feedstocks are: Linear Alkyl Benzene (LAB), Primary Alcohols (PA), Primary Alcohol Ethers (PAE) and Alpha-Olefins (AO).

1.2 Most important sulph(on)ates

(i) LABS (Linear Alkyl Benzene Sulphonate), low molecular weight (230 - 245).

This category anionic is among the major surfactants used in all ranges of household detergent formulations, mainly in dishwashing liquids in combination with other anionic surfactants, for example with Lauryl Ether Sulphate and promoting high detergency foam stability, degreasing capacity, good tolerance for hard water.
Common ranges of Active Detergent (AD) levels in liquid detergent products are as follows:

LABS	10 - 15% (30%)
PAS/LES	3 - 5% (10%)

The figures in brackets are maximum values for concentrated products.

(ii) LABS (Linear Alkyl Benzene Sulphonate), high molecular weight (245 - 260).

These are the major anionic surfactants used in all ranges of household detergents formulation, but especially in heavy duty laundry products, sometimes in combination with nonionics, alcohol sulphates of the tallow range and soaps.