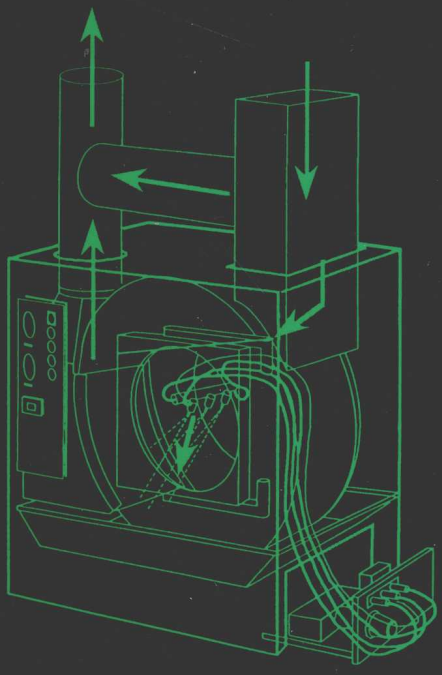
CATALYST MANUFACTURE

Second Edition



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ADDITIONAL VOLUMES IN PREPARATION

Preface

As I look back at the first edition, which was published a decade ago, I find that much of catalysis has remained the same, particularly with respect to secrecy. However, with respect to the catalysts, their operation and composition, there have in some cases been a great number of changes – in other cases the old standbys are still the old standbys. I do not belong to the old school that says, "Let well enough alone," but I believe that even in the cases in which there have not been a great number of changes and insignificant improvement, there still is room for research. I urge anybody with such an inclination to do research despite the fact that he or she may encounter from some quarters the statement, "This has been the standard for 50 (or however many) years, and the likelihood of making an improvement is very remote." I thoroughly disagree, both for personal reasons and because I know of cases in which such a statement has proved to be misleading and unwisely discouraging.

This second edition specifically addresses the changes that have been made in zeolites, which are high-temperature oxidation catalysts for total oxidation, particularly in conjunction with gas-fired turbines. The text gives much consideration to environmental catalysts and the problems related to the environment. There is some consideration of a unique CO oxidation catalyst about which there has been substantial publicity, but which has seen little adaptation to the commercial scale. We all recognize methane coupling as a subject that has been intensely considered for the synthesis of acetylene, ethylene, and aliphatic homologs of ethylene. In those cases in which catalyst manufacturing was described in detail in the first edition, both as to procedure and to equipment used, an effort has been made to bring the discussion up to date.

As one considers the environmental catalysts, one must also consider the shifting thoughts as to what constitutes the environment. "Environment" is much more broadly interpreted by government and other agencies than is the current practice. For example, it may include living conditions in the home, dietary choices, smoking and drinking habits, insect life, pesticides, and combinations of things such as the foregoing and clothing. These, for the most part, do not have anything to do with the environment we consider in speaking of catalysis. It is readily evident that this broader area of "environment" includes items that cannot be altered by simple catalytic means. Since we are consciously excluding enzymes, some of the foregoing environmental items drop out. However, one of the more important areas of environmental catalysis is the abatement of automotive fumes, and this subject is brought up to date and extended into the future by facts and, where indicated, appropriate speculation.

Areas of very great effort in the zeolite area concern the so-called phosphates and activated carbons derived from chlorinated polymers. Although they are termed zeolites, these are actually microporous solids that have zeolitic characteristics in that they selectively absorb molecules of a certain size and configuration. The phosphates, I believe, are being

used in the industry at only one site, and one of the drawbacks of the phosphates is that they are reportedly lower in stability than the silica aluminas.

Another very important subject considered in this edition is the utilization, recovery, and regeneration of used catalysts. This subject is of special importance to those selling catalysts or initiating a new catalytic process. Many of the components of catalysts are either water-soluble or weather to a soluble form, such as when chromites oxidize to chromates. Disposal and recovery methods vary widely, and it is our intention to describe the many alternatives.

Still another major change in the past ten years has to do with the safety requirements for various pieces of equipment. In the earlier edition many pieces of equipment were described; the manufacturers have provided us with information about alterations they have made in the equipment to comply with OSHA and this has been added appropriately in this edition.

Catalyst manufacture is one of the most interesting areas in which one can engage. It is characterized by having a great number of surprises and unique conditions that can be discovered only by much trial and error and, unfortunately, many false starts. I have now spent nearly sixty years in this discipline, and I have enjoyed every minute of it; I have always felt that many of the discoveries were derived not from intelligence alone but from intelligence guided by good luck and intuition.

I would like to extend special thanks to Theodore A. Koch, whose hard work and diligence made this second edition possible.

Alvin B. Stiles

Introduction

The second edition of *Catalyst Manufacture* has two primary purposes. The first is to bring up to date the current manufacturing procedure for those catalysts that have enjoyed significant beneficial changes in composition or preparation procedures. The second is to incorporate into the discussion of each catalyst manufacturing, use, discharge, and disposal procedure instructions or recommendations to make these procedures legal in light of EPA and OSHA regulations.

The EPA regulations concern the dust, aqueous discharges, organic solvents, and other contaminants that would be adsorbed by the catalyst during use or formed during oxidation or partial oxidations when exposed to air. The used catalyst itself, whether contaminated or not, also presents a challenge for disposal, regeneration, or recovery of metals values. In this book, each of the foregoing is considered in the light of each member of each family of catalysts. Furthermore, a listing of companies specializing in recovery of metals values is given in the Appendix. Regeneration and reuse schemes are provided

where appropriate; however, there is frequently a limit to the number of times a catalyst can be reused, and there is often the need to screen to remove fines that must be reprocessed by one or more of the procedures described.

Numerous regulations introduced by OSHA relate to the equipment and procedures used for manufacturing catalysts as well as discharging, storing, regenerating, and reusing or recovering the used catalyst. Inasmuch as the used catalyst is nonuniform from time to time, it must, as a general principle, be assumed to be coated with toxic materials.

In the equipment chapters, special attention is given to the need for special clothing, ventilation, and equipment guards. Much of this was not required when the first edition was published (but was very likely practiced due to corporate regulations). Governmental regulations and requirements are included herein to the extent that the application is known or can be visualized by the authors. Hazards resulting from slippery floors, tripping obstructions, or hot surfaces are considered here only in a general way but are, of course, noted by government inspectors.

One realm of regulation that was previously not of critical concern is the noise level of the operation. Examples of equipment used in catalyst manufacture that must be observed for this problem include grinders, crushers, ball mills, granulation mixers, tableting machines, and coaters.

The regeneration, reoxidation, or oxidation of catalysts for discharge may produce carbon monoxide, aldehydes, or, at times, unidentified toxic discharges. Catalytic combustion can usually be used to eliminate these by-products, but not if they include catalyst poisons such as halides, ash, sulfur, and solids that deposit on and blind the catalyst. These conditions may entail retaining a professional disposal company; such companies usually advertise in scientific or commercial journals and may even be listed in the Yellow Pages of the telephone directory.

Infractions of government regulations may entail substantial penalties of several types. As a consequence it behooves the business management to be familiar with their content and purposes. We hope that the foregoing and this book will help in avoiding costly problems.

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Part I
Equipment

1
Scope and Goals

The goal of this book is to present a lucid and accurate picture of catalyst preparation on a laboratory, pilot plant, and commercial scale. A further purpose is to present the pertinent available information, whether it is published, in the open literature, or in patents, without infringing upon any proprietary information. If the information is in unexpired patents, this is mentioned in the text. If the information is in expired patents that are in the public domain, it is not specifically identified as such. It is possible that certain features of the descriptions given herein are patented and have patent matter relating to them of which we are unaware. Therefore it is wise to make a patent search before engaging in commercial practice of any process. In many cases, catalyst manufacture is not patented because the owners prefer to keep the process secret and operate as a secret shop rather than disclosing the information in a patent that will eventually become public