

HANDBOOK OF INDUSTRIAL CATALYSTS

HANDBOOK OF INDUSTRIAL CATALYSTS DESIGN OF INDUSTRIAL CATALYSTS FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES CATALYSIS INTRODUCTION TO CATALYSIS AND INDUSTRIAL CATALYTIC PROCESSES INDUSTRIAL CATALYSIS HANDBOOK OF INDUSTRIAL CATALYSTS PHYSICO-CHEMICAL ANALYSIS OF INDUSTRIAL CATALYSTS INDUSTRIAL CATALYSIS APPLIED INDUSTRIAL CATALYSIS FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES INDUSTRIAL CATALYSIS INDUSTRIAL CATALYTIC PROCESSES FOR FINE AND SPECIALTY CHEMICALS METAL-CATALYSIS IN INDUSTRIAL ORGANIC PROCESSES INDUSTRIAL CATALYSTS SIGNIFICANCE FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES CATALYSIS FOR FINE CHEMICALS HOMOGENEOUS CATALYSIS, INDUSTRIAL APPLICATIONS AND IMPLICATIONS INDUSTRIAL CATALYSIS FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES LAWRIE LLOYD DAVID L. TRIMM C. H. BARTHOLOMEW J.A. MOULIJN ROBERT J. FARRAUTO JENS HAGEN L. LLOYD JOHN LYNCH RUUD I. WIJNGAARDEN BRUCE LEACH ROBERT J. FARRAUTO MARK ANTHONY BENVENUTO SUNIL S JOSHI GIAN PAOLO CHIUSOLI AIDEN FEYNMAN ROBERT J. FARRAUTO WERNER BONRATH STANLEY J. GREEN ROBERT J. FARRAUTO

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MUCH HAS BEEN WRITTEN ABOUT FUNDAMENTAL ASPECTS OF CATALYSIS YET DESPITE THEIR UNIVERSAL APPLICATIONS DETAILS CONCERNING COMMERCIAL CATALYSTS AND INFORMATION ABOUT ACTUAL OPERATING CONDITIONS ARE NOT READILY AVAILABLE THIS BOOK PROVIDES UP TO DATE REVIEWS AND REFERENCES TO GUIDE THOSE WORKING ON INDUSTRIAL CATALYSTS IT WILL BE AN INVALUABLE GUIDE FOR CATALYSIS RESEARCHERS IN INDUSTRY AND ACADEMIA AND FOR STUDENTS

CATALYSIS IS CENTRAL TO THE CHEMICAL INDUSTRY AS IT IS DIRECTLY OR INVOLVED IN THE PRODUCTION OF ALMOST ALL USEFUL CHEMICAL PRODUCTS IN THIS BOOK THE AUTHORS PRESENT THE DEFINITIVE ACCOUNT OF INDUSTRIAL CATALYTIC PROCESSES THROUGHOUT FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES THE INFORMATION IS ILLUSTRATED WITH MANY CASE STUDIES AND PROBLEMS THIS BOOK IS VALUABLE TO ANYONE WANTING A CLEAR ACCOUNT OF INDUSTRIAL CATALYTIC PROCESSES BUT IS PARTICULARLY USEFUL TO INDUSTRIAL AND ACADEMIC CHEMISTS AND ENGINEERS AND GRADUATE WORKING ON CATALYSIS THIS BOOK ALSO COVERS FUNDAMENTALS OF CATALYTIC PROCESSES INCLUDING CHEMISTRY CATALYST PREPARATION PROPERTIES AND REACTION ENGINEERING ADDRESSES HETEROGENEOUS CATALYTIC PROCESSES EMPLOYED BY INDUSTRY PROVIDES DETAILED DATA ON EXISTING CATALYSTS AND CATALYTIC REACTIONS PROCESS DESIGN AND CHEMICAL ENGINEERING COVERS CATALYSTS USED IN FUEL CELLS

CATALYSIS IS A MULTIDISCIPLINARY ACTIVITY WHICH IS REFLECTED IN THIS BOOK THE EDITORS HAVE CHOSEN A NOVEL COMBINATION OF BASIC DISCIPLINES HOMOGENEOUS CATALYSIS BY METAL COMPLEXES IS TREATED JOINTLY WITH HETEROGENEOUS CATALYSIS WITH METALLIC AND NON METALLIC SOLIDS THE MAIN THEME OF THE BOOK IS THE MOLECULAR APPROACH TO INDUSTRIAL CATALYSIS IN THE INTRODUCTORY SECTION CHAPTER 1 PRESENTS A BRIEF SURVEY OF THE HISTORY OF INDUSTRIAL HETEROGENEOUS AND HOMOGENEOUS CATALYSIS SUBSEQUENTLY A SELECTION OF CURRENT INDUSTRIAL CATALYTIC PROCESSES IS DESCRIBED CHAPTER 2 A BROAD SPECTRUM OF IMPORTANT CATALYTIC APPLICATIONS IS PRESENTED INCLUDING THE BASIC CHEMISTRY SOME ENGINEERING ASPECTS FEEDSTOCK SOURCES AND PRODUCT UTILISATION IN CHAPTER 3 KINETIC PRINCIPLES ARE TREATED THE SECTION ON FUNDAMENTAL CATALYSIS BEGINS WITH A DESCRIPTION OF THE BONDING IN COMPLEXES AND TO SURFACES CHAPTER 4 THE ELEMENTARY STEPS ON COMPLEXES AND SURFACES ARE DESCRIBED THE CHAPTER ON HETEROGENEOUS CATALYSIS 5 DEALS WITH THE MECHANISTIC ASPECTS OF THREE GROUPS OF IMPORTANT REACTIONS SYN GAS CONVERSION HYDROGENATION AND OXIDATION THE MAIN PRINCIPLES OF METAL AND METAL OXIDE CATALYSIS ARE PRESENTED LIKEWISE THE CHAPTER ON HOMOGENEOUS CATALYSIS 6 CONCENTRATES ON THREE REACTIONS REPRESENTING EXAMPLES FROM THREE AREAS CARBONYLATION POLYMERIZATION AND ASYMMETRIC CATALYSIS IDENTIFICATION BY IN SITU TECHNIQUES HAS BEEN INCLUDED MANY CONSTRAINTS TO THE INDUSTRIAL USE

OF A CATALYST HAVE A MACROSCOPIC ORIGIN IN APPLIED CATALYSIS IT IS SHOWN HOW CATALYTIC REACTION ENGINEERING DEALS WITH SUCH MACROSCOPIC CONSIDERATIONS IN HETEROGENEOUS AS WELL AS HOMOGENEOUS CATALYSIS CHAPTER 7 THE TRANSPORT AND KINETIC PHENOMENA IN BOTH MODEL REACTORS AND INDUSTRIAL REACTORS ARE OUTLINED THE SECTION ON CATALYST PREPARATION CHAPTERS 8 AND 9 IS CONCERNED WITH THE PREPARATION OF CATALYST SUPPORTS ZEOLITES AND SUPPORTED CATALYSTS WITH AN EMPHASIS ON GENERAL PRINCIPLES AND MECHANISTIC ASPECTS FOR THE SUPPORTED CATALYSTS THE RELATION BETWEEN THE PREPARATIVE METHOD AND THE SURFACE CHEMISTRY OF THE SUPPORT IS HIGHLIGHTED THE MOLECULAR APPROACH IS MAINTAINED THROUGHOUT THE FIRST CHAPTER 10 IN THE SECTION ON CATALYST CHARACTERIZATION SUMMARIZES THE MOST COMMON SPECTROSCOPIC TECHNIQUES USED FOR THE CHARACTERISATION OF HETEROGENEOUS CATALYSTS SUCH AS XPS AUGER EXAFS ETC TEMPERATURE PROGRAMMED TECHNIQUES WHICH HAVE FOUND WIDESPREAD APPLICATION IN HETEROGENEOUS CATALYSIS BOTH IN CATALYST CHARACTERIZATION AND SIMULATION OF PRETREATMENT PROCEDURES ARE DISCUSSED IN CHAPTER 11 A DISCUSSION OF TEXTURE MEASUREMENT THEORY AND APPLICATION CONCLUDES THIS SECTION 12 THE FINAL CHAPTER 13 GIVES AN OUTLINE OF CURRENT TRENDS IN CATALYSIS TWO POINTS OF VIEW ARE ADOPTED THE FIRST ONE FOCUSSES ON DEVELOPMENTS IN PROCESS ENGINEERING MOST OFTEN THESE HAVE THEIR ORIGIN IN DEMANDS BY SOCIETY FOR BETTER PROCESSES THE SECOND POINT OF VIEW DRAWS ATTENTION TO THE AUTONOMOUS DEVELOPMENTS IN CATALYSIS WHICH IS BECOMING ONE OF THE FRONTIER SCIENCES OF PHYSICS AND CHEMISTRY IN THIS BOOK EMPHASIS IS ON THOSE REACTIONS CATALYZED BY HETEROGENEOUS AND HOMOGENEOUS CATALYSTS OF INDUSTRIAL RELEVANCE THE INTEGRATIVE TREATMENT OF THE SUBJECT MATTER INVOLVES MANY DISCIPLINES CONSEQUENTLY THE WRITING OF THE BOOK HAS BEEN A MULTI AUTHOR TASK THE EDITORS HAVE CAREFULLY PLANNED AND HARMONIZED THE CONTENTS OF THE CHAPTERS

INTRODUCES MAJOR CATALYTIC PROCESSES INCLUDING PRODUCTS FROM THE PETROLEUM CHEMICAL ENVIRONMENTAL AND ALTERNATIVE ENERGY INDUSTRIES PROVIDES AN EASY TO READ DESCRIPTION OF THE FUNDAMENTALS OF CATALYSIS AND SOME OF THE MAJOR CATALYTIC INDUSTRIAL PROCESSES USED TODAY OFFERS A RATIONALE FOR PROCESS DESIGNS BASED ON KINETICS AND THERMODYNAMICS ALTERNATIVE ENERGY TOPICS INCLUDE THE HYDROGEN ECONOMY FUELS CELLS BIO CATALYTIC ENZYMES PRODUCTION OF ETHANOL FUEL FROM CORN AND BIODIESEL FROM VEGETABLE OILS PROBLEM SETS OF INCLUDED WITH ANSWERS AVAILABLE TO FACULTY WHO USE THE BOOK REVIEW IN LESS THAN 300 PAGES IT SERVES AS AN EXCELLENT INTRODUCTION TO THESE SUBJECTS WHETHER FOR ADVANCED STUDENTS OR THOSE SEEKING TO LEARN MORE ABOUT THESE SUBJECTS ON THEIR OWN TIME PARTICULARLY USEFUL ARE THE SUCCINCT SUMMARIES THROUGHOUT THE BOOK EXCELLENT DETAIL IN THE TABLE OF CONTENTS A DETAILED INDEX KEY REFERENCES AT THE END OF EACH CHAPTER AND CHALLENGING

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NOW IN ITS 3RD EDITION INDUSTRIAL CATALYSIS OFFERS ALL RELEVANT INFORMATION ON CATALYTIC PROCESSES IN INDUSTRY INCLUDING MANY RECENT EXAMPLES PERFECTLY SUITED FOR SELF STUDY IT IS THE IDEAL COMPANION FOR SCIENTISTS WHO WANT TO GET INTO THE FIELD OR REFRESH EXISTING KNOWLEDGE THE UPDATED EDITION COVERS THE FULL RANGE OF INDUSTRIAL ASPECTS FROM CATALYST DEVELOPMENT AND TESTING TO PROCESS EXAMPLES AND CATALYST RECYCLING THE BOOK IS CHARACTERIZED BY ITS PRACTICAL RELEVANCE EXPRESSED BY A SELECTION OF OVER 40 EXAMPLES OF CATALYTIC PROCESSES IN INDUSTRY IN ADDITION NEW CHAPTERS ON CATALYTIC PROCESSES WITH RENEWABLE MATERIALS AND POLYMERIZATION CATALYSIS HAVE BEEN INCLUDED EXISTING CHAPTERS HAVE BEEN CAREFULLY REVISED AND SUPPORTED BY NEW SUBCHAPTERS FOR EXAMPLE ON METATHESIS REACTIONS REFINERY PROCESSES PETROCHEMISTRY AND NEW REACTOR CONCEPTS I FOUND THE BOOK ACCESSIBLE READABLE AND INTERESTING BOTH AS A REFRESHER AND AS AN INTRODUCTION TO NEW TOPICS AND A CONVENIENT FIRST REFERENCE ON CURRENT INDUSTRIAL CATALYTIC PRACTISE AND PROCESSES EXCERPT FROM A BOOK REVIEW FOR THE SECOND EDITION BY P C H MITCHELL APPLIED ORGANOMETALLIC CHEMISTRY 2007

THIS BOOK DESCRIBES THE PRINCIPAL PHYSICO CHEMICAL TECHNIQUES FOR CHARACTERISING THE CATALYSTS USED IN SEARCHING FOR NEW ACTIVE PHASES OPTIMISING THE FORMULATION AND MONITORING INDUSTRIAL PRODUCTION BASED ON COURSES GIVEN AT THE INSTITUT FRANCAIS DU PEUPLE FOR RESEARCH TECHNICIANS IN THE FIELDS OF KINETICS AND CATALYSIS THIS BOOK COVERS USEFUL BASIC THEORY AND PROVIDES NUMEROUS EXAMPLES OF INDUSTRIAL APPLICATIONS THIS GUIDE IS AN ESSENTIAL COMPANION FOR TECHNICIANS AND CHEMICAL ENGINEERS WHOSE WORK REQUIRES AN UNDERSTANDING OF THE FIELDS OF APPLICATION INCLUDING THE CAPABILITIES AND THE LIMITS OF TODAY'S COMPLEX CHARACTERISATION TECHNIQUES CONTENTS INTRODUCTION 1 D104URAL CHARACTERISATION OF CATALYSTS 2 ATOMIC ABSORPTION SPECTROMETRY 3 ATOMIC EMISSION SPECTROSCOPY 4 X RAY FLUORESCENCE 5 X RAY PHOTOELECTRON SPECTROSCOPY 6 ION IMPACT ANALYSIS 7 SCANNING ELECTRON MICROSCOPY 8 ELEMENTAL ANALYSIS IN THE ELECTRON MICROPROBE 9 TRANSMISSION ELECTRON MICROSCOPY 10 X RAY DIFFRACTION AND SMALL ANGLE SCATTERING 11 EXAFS 12 INFRARED ABSORPTION SPECTROMETRY 13 NUCLEAR MAGNETIC RESONANCE 14 THERMAL ANALYSIS METHODS INDEX

THIS IS A BOOK FOR DEVELOPERS OF CATALYSTS AND FOR PRACTITIONERS WORKING IN THE FIELD OF DESIGN OPERATION AND OPTIMIZATION OF CHEMICAL REACTORS IN WHICH HETEROGENEOUS CATALYSIS IS PERFORMED IT IS DESIGNED TO GIVE A BETTER UNDERSTANDING OF THE PHENOMENA WHICH CAN INFLUENCE CATALYST PERFORMANCE SINCE TWO DISCIPLINES CHEMISTRY AND CHEMICAL ENGINEERING MEET IN CATALYST RESEARCH AND DEVELOPMENT THIS BOOK COVERS THE CHEMICAL POINT OF VIEW FOR ENGINEERS AND THE ENGINEERING POINT OF VIEW FOR CHEMISTS IT STARTS WITH AN INTRODUCTION EXPLAINING SELECTIVITY ACTIVITY AND EFFECTIVENESS PROVIDING THE FUNDAMENTALS FOR THE NEWCOMER CATALYST PREPARATION AND CATALYST TESTING ARE ALSO DESCRIBED A METHOD IS INTRODUCED THAT CAN BE USED TO CALCULATE THE EFFECTIVENESS OF CATALYST PELLETS AS A FUNCTION OF SHAPE SIZE PORE SIZE TYPE OF KINETICS AND DIFFUSION AND TEMPERATURE AND PRESSURE CONDITIONS OPTIMIZATION OF CATALYSTS AND TROUBLESHOOTING ARE ALSO COVERED THIS IS A BOOK WITHOUT ANY RILVALS BECAUSE OF ITS PRACTICAL RELEVANCE

APPLIED INDUSTRIAL CATALYSIS VOLUME 1 PROVIDES A PRACTICAL DESCRIPTION OF CATALYSIS BY INDUSTRIAL SCIENTISTS THIS BOOK PROVIDES INFORMATION PERTINENT TO INDUSTRIAL CATALYSIS WHICH IS INFLUENCED BY SCIENCE BUSINESS ECONOMIC MARKETS AND POLITICS ORGANIZED INTO 10 CHAPTERS THIS VOLUME STARTS WITH AN OVERVIEW OF THE SIGNIFICANCE OF INDUSTRIAL CATALYSIS AND ITS EFFECT ON HUMAN LIFESTYLE AND ENVIRONMENT THIS TEXT THEN DESCRIBES HOW TO TAKE A LABORATORY CATALYST TO SUCCESSFUL COMMERCIALIZATION WITH MINIMUM PROBLEMS OTHER CHAPTERS CONSIDER IN DETAIL TWO MAJOR REFINERY PROCESSES NAMELY HYDROTREATING AND REFORMING THE READER IS INTRODUCED TO THE SPECIFIC PROCESSES FOR POLYETHYLENE AND POLYPROPYLENE MANUFACTURE THIS BOOK REVIEWS AS WELL ETHYLENE OXIDE SYNTHESIS AND EXPLAINS OXYCHLORINATION OF ETHYLENE TO ETHYLENE DICHLORIDE THE FINAL CHAPTER REVIEWS METHANOL CARBONYLATION TO ACETIC ACID WHICH IS PRODUCED BY CONTINUOUSLY REACTING METHANOL AND CARBON MONOXIDE IN A HOMOGENEOUS CATALYTIC REACTOR AT

WRITTEN BY AUTHORS WITH GREAT EXPERIENCE IN THE DESIGN DEVELOPMENT OF CATALYSTS CATALYTIC PROCESSES THIS TEXT CONTAINS DATA ON CATALYSTS REACTORS PROCESS DESIGN WHICH WILL BE VALUABLE TO THE PRACTISING DEVELOPMENT CHEMIST ENGINEER

INDUSTRIAL CATALYSIS PROVIDES AN EXCELLENT INTRODUCTION TO CATALYTIC PRINCIPLES AND PROCESSES ADDRESSING THE APPLICATIONS OF INORGANIC ORGANIC AND BIOCATALYSTS IN

INDUSTRIAL CHEMISTRY EACH CHAPTER IS FOCUSSED ON ONE CATALYTIC PROCESS AND DISCUSSES ITS LIFE CYCLE FROM SOURCE MATERIALS CATALYST SYNTHESIS THE CATALYTIC PROCESS LIFETIME AND RECOVERY THE BOOK ALSO INCLUDES A COMPREHENSIVE OVERVIEW ON INDUSTRIAL PROCESSES EMPLOYING CATALYSIS

INDUSTRIAL CATALYTIC PROCESSES FOR FINE AND SPECIALTY CHEMICALS PROVIDES A COMPREHENSIVE METHODOLOGY AND STATE OF THE ART TOOLBOX FOR INDUSTRIAL CATALYSIS THE BOOK BEGINS BY INTRODUCING THE READER TO THE INTERESTING CHALLENGING AND IMPORTANT FIELD OF CATALYSIS AND CATALYTIC PROCESSES THE FUNDAMENTALS OF CATALYSIS AND CATALYTIC PROCESSES ARE FULLY COVERED BEFORE DELVING INTO THE IMPORTANT INDUSTRIAL APPLICATIONS OF CATALYSIS AND CATALYTIC PROCESSES WITH AN EMPHASIS ON GREEN AND SUSTAINABLE TECHNOLOGIES SEVERAL CASE STUDIES ILLUSTRATE NEW AND SUSTAINABLE WAYS OF DESIGNING CATALYSTS AND CATALYTIC PROCESSES THE INTENDED AUDIENCE OF THE BOOK INCLUDES RESEARCHERS IN ACADEMIA AND INDUSTRY AS WELL AS CHEMICAL ENGINEERS PROCESS DEVELOPMENT CHEMISTS AND TECHNOLOGISTS WORKING IN CHEMICAL INDUSTRIES AND INDUSTRIAL RESEARCH LABORATORIES DISCUSSES THE FUNDAMENTALS OF CATALYTIC PROCESSES CATALYST PREPARATION AND CHARACTERIZATION AND REACTION ENGINEERING OUTLINES THE HOMOGENEOUS CATALYTIC PROCESSES AS THEY APPLY TO SPECIALTY CHEMICALS INTRODUCES INDUSTRIAL CATALYSIS AND CATALYTIC PROCESSES FOR FINE CHEMICALS INCLUDES A NUMBER OF CASE STUDIES TO DEMONSTRATE THE VARIOUS PROCESSES AND METHODS FOR DESIGNING GREEN CATALYSTS

CATALYSIS UNDERPINS MOST MODERN INDUSTRIAL ORGANIC PROCESSES IT HAS BECOME AN ESSENTIAL TOOL IN CREATING A GREENER CHEMICAL INDUSTRY BY REPLACING MORE TRADITIONAL STOICHIOMETRIC REACTIONS WHICH HAVE HIGH ENERGY CONSUMPTION AND HIGH WASTE PRODUCTION WITH MILD PROCESSES WHICH INCREASINGLY RESEMBLE NATURE S ENZYMES METAL CATALYSIS IN INDUSTRIAL ORGANIC PROCESSES CONSIDERS THE MAJOR AREAS OF THE FIELD AND DISCUSSES THE LOGIC OF USING CATALYSIS IN INDUSTRIAL PROCESSES THE BOOK PROVIDES INFORMATION ON OXIDATION HYDROGENATION CARBONYLATION C C BOND FORMATION METATHESIS AND POLYMERIZATION PROCESSES AS WELL AS ON THE MECHANISMS INVOLVED IN ADDITION TWO APPENDICES OFFER A CONCISE TREATMENT OF HOMOGENEOUS AND HETEROGENOUS CATALYSIS NUMEROUS EXERCISES REFERRING TO PROBLEMS OF CATALYTIC PROCESSES AND RESEARCH PERSPECTIVES COMPLETE THE BOOK THIS DEFINITIVE REFERENCE SOURCE WRITTEN BY PRACTISING EXPERTS IN THE FIELD PROVIDES DETAILED AND UP TO DATE INFORMATION ON KEY ASPECTS OF METAL CATALYSIS

INDUSTRIAL CATALYSTS SIGNIFICANCE EXPLORES THE VITAL ROLE OF CATALYSTS IN MODERN INDUSTRY FOCUSING ON THEIR FUNDAMENTAL PRINCIPLES APPLICATIONS AND ONGOING DEVELOPMENT CATALYSTS ACCELERATE CHEMICAL REACTIONS ENABLING THE EFFICIENT PRODUCTION OF EVERYTHING FROM FERTILIZERS TO PLASTICS ONE INTRIGUING FACT IS THAT THE HABER BOSCH PROCESS UTILIZING AN IRON CATALYST REVOLUTIONIZED FERTILIZER PRODUCTION AND AVERTED POTENTIAL FAMINE THE BOOK ARGUES THAT CATALYSTS ARE INDISPENSABLE FOR SUSTAINABLE INDUSTRIAL DEVELOPMENT CRUCIAL FOR TACKLING RESOURCE SCARCITY ENERGY EFFICIENCY AND ENVIRONMENTAL PROTECTION THE BOOK BEGINS WITH BASIC CATALYSIS CONCEPTS BEFORE EXAMINING APPLICATIONS IN FERTILIZER PRODUCTION AND PETROCHEMICAL PROCESSES IT THEN PROGRESSES TO THE LATEST ADVANCEMENTS IN CATALYST RESEARCH SUCH AS NOVEL MATERIALS AND COMPUTATIONAL MODELING A UNIQUE ASPECT IS ITS BRIDGE BETWEEN FUNDAMENTAL RESEARCH AND INDUSTRIAL APPLICATIONS PROVIDING A COMPREHENSIVE UNDERSTANDING OF REAL WORLD CATALYST PERFORMANCE CASE STUDIES AND EXPERIMENTAL DATA SUPPORT THE BOOK S CLAIMS MAKING IT A VALUABLE RESOURCE FOR SCIENTISTS ENGINEERS AND STUDENTS ALIKE EMPHASIZING THE NEED FOR SUSTAINABLE AND ENVIRONMENTALLY FRIENDLY CATALYTIC PROCESSES

A WIDE RANGE OF CHEMICAL PRODUCTS ESPECIALLY FINE CHEMICALS ARE IMPORTANT FOR A HEALTHY AND ENJOYABLE MODERN LIFE THEREFORE EFFICIENT SYNTHESSES OF THESE MATERIALS ARE ESSENTIAL TRADITIONAL STOICHIOMETRIC PROCESSES NEED TO BE REPLACED BY MODERN CATALYTICAL METHODS IN THE CHANGE TO SUSTAINABLE CHEMISTRY AND THE PRODUCTION OF LOWER AMOUNTS OF WASTE THIS BOOK SUMMARIZES THE WIDE VARIETY OF CATALYTIC METHODS THAT HAVE BEEN DEVELOPED AND APPLIED ON AN INDUSTRIAL SCALE IN RECENT YEARS TO FULFILL THIS GOAL THE SYNTHESIS OF COMPOUND CLASSES SUCH AS PHARMACEUTICALS AGROCHEMICALS FLAVORING AND FRAGRANCE COMPOUNDS AS WELL AS FOOD ADDITIVES SUCH AS VITAMINS EXEMPLIFY THE USE OF THESE MODERN CATALYTIC METHODS IN THE MODERN CHEMICAL INDUSTRY

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