Chemistry And Technology Of Polyols For Polyurethane

Chemistry And Technology Of Polyols For Polyurethane Chemistry and Technology of Polyols for Polyurethane Polyurethanes PUs are a versatile class of polymers with diverse applications ranging from flexible foams to rigid coatings elastomers and adhesives Their remarkable versatility stems from their unique synthesis involving the reaction of polyols with isocyanates Polyols the cornerstone of PU synthesis are hydroxylcontaining compounds that dictate the final properties of the resulting polyurethane Understanding the chemistry and technology of polyols is crucial for designing and producing PUs with specific performance characteristics This article delves into the key aspects of polyol chemistry exploring their types synthesis properties and technological applications Types of Polyols Polyols can be broadly classified into two categories based on their origin Petrochemicalbased Polyols These are derived from petroleum feedstocks and represent the traditional polyol type They are further categorized into Polyether Polyols Synthesized through the polymerization of alkylene oxides eg ethylene oxide propylene oxide with polyfunctional initiators They offer excellent flexibility low viscosity and good hydrolytic stability Polyester Polyols Prepared by the polycondensation of polycarboxylic acids eg adipic acid phthalic acid with polyols These polyols exhibit higher hardness and better mechanical strength compared to polyethers Biobased Polyols These are derived from renewable resources such as vegetable oils sugars and starch They offer an environmentally friendly alternative to traditional polyols and are gaining increasing interest Synthesis of Polyols The synthesis of polyols depends on their type Polyether Polyols They are synthesized through a ringopening polymerization process Initiators Polyfunctional alcohols eg glycerol trimethylolpropane sucrose or amines act 2 as starting points for chain growth Alkylene Oxides Ethylene oxide EO and propylene oxide PO are common monomers The ratio of EO to PO in the polymer chain influences the final properties of the polyol Catalyst Basic catalysts eg potassium hydroxide sodium hydroxide are employed to accelerate the polymerization reaction Polyester Polyols Their synthesis involves the polycondensation reaction of polycarboxylic acids and polyols in the presence of a catalyst Polycarboxylic Acids Adipic acid phthalic acid and terephthalic acid are widely used Polyols Diols eg

ethylene glycol propylene glycol or triols eg glycerol are commonly employed Catalyst Catalysts like titanium alkoxides or tin compounds are used to facilitate the esterification reaction Biobased Polyols Their synthesis utilizes renewable feedstocks like vegetable oils sugars and starch Vegetable Oils Epoxidation and ringopening reactions are employed to convert vegetable oils into polyols Sugars and Starch These are converted into polyols through enzymatic or chemical modification methods Properties of Polyols The properties of polyols are crucial for determining the final properties of the resulting polyurethane Key parameters include Hydroxyl Number The number of hydroxyl groups present per gram of polyol which influences the amount of isocyanate required for reaction Molecular Weight Affects the viscosity and reactivity of the polyol Lower molecular weight polyols tend to be more reactive and exhibit lower viscosity Viscosity Influences the ease of handling and processing of the polyol Lower viscosity polyols are easier to mix and process Functionality Refers to the number of hydroxyl groups per molecule Higher functionality polyols contribute to the crosslinking density of the PU and impact its properties Chemical Composition The type of monomers eg EO PO and their ratio in the polyol chain influence the overall properties Thermal Stability Determines the temperature at which the polyol remains stable Technological Applications of Polyols 3 Polyols are integral components of polyurethane production playing a vital role in shaping the final properties of the material Their application varies depending on the desired PU properties and application Flexible Foams Lowdensity foams typically used in furniture bedding and packaging are often prepared using polyether polyols Rigid Foams Highdensity foams used in insulation construction and automotive parts often utilize polyester polyols or specialty polyethers Elastomers Polyols with high molecular weight and low functionality are used in producing resilient and durable elastomers for applications like shoe soles and tires Coatings Polyester polyols are commonly used for coatings offering good adhesion and scratch resistance Adhesives Polyols with high functionality and specific reactivity profiles are employed for adhesives ensuring strong bonds and desired properties Biobased PU Applications Biobased polyols are used to create environmentally friendly products such as biobased foams coatings and adhesives contributing to sustainability Current Trends and Future Directions The polyol industry is constantly evolving to meet the evergrowing demand for PU materials with enhanced performance and sustainability Key research areas include Biobased Polyols Development of new costeffective biobased polyols with improved performance and functionality Polyols with Specific Properties Tailoring polyols for specific applications such as flame retardancy thermal conductivity or specific mechanical properties Sustainable Synthesis Optimizing polyol synthesis processes for energy efficiency reduced environmental impact and lower carbon footprint

Polyol Blends Exploring the potential of blending different polyols to create unique and customized properties for specific applications Conclusion Polyols are the fundamental building blocks of polyurethane materials dictating the final properties of the product Understanding their chemistry and technology is critical for designing and producing PUs with specific performance characteristics The continuing advancements in polyol synthesis and applications are paving the way for the development of novel and sustainable PU materials satisfying the growing demand for diverse applications As research and development continue the chemistry and technology of polyols will play a crucial role in shaping the future of polyurethane materials 4

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Produce Soy-based Polyol for Polyurethane *Mihail Ionescu Arnold A. Lubguban Yebo Li Mihail Ionescu Mihail Ionescu Mihail Ionescu Mihail Ionescu Mihail Ionescu Ram K. Gupta Hazimah Abu Hassan S. M. Akenhead Mark F. Sonnenschein J. Ding Faris Y lmazB. Xu Ph.D, Michael Szycher Hongyu Fan Ikuo Ihara Pimphan Kiatsimkul*

this book considers the raw materials used to build the polyurethane polymeric architecture it covers the chemistry and technology of oligo polyol fabrication the characteristics of the various oligo polyol families and the effects of the oligo polyol structure on the properties of the resulting polyurethane it presents the details of oligo polyol synthesis and explains the chemical and physico chemical subtleties of oligo polyol fabrication this book will be of interest to all specialists working with polyols for the manufacture of polyurethanes and to all researchers that would like to know more about polyol chemistry

as global priorities shift towards sustainable resources there is a growing interest in alternatives to petroleum based raw materials for industrial polyurethane pu foam production polyurethane foams pufs produced from the reaction between a polyol a polymer with multiple hydroxyl groups and a diisocyanate are widely used for their versatility they range from flexible foams like those found in mattresses or furniture to rigid foams used for home insulation the market for pu foams is anticipated to grow due to rising demand for comfort historically petroleum based polyols have been favored for their availability and versatility however as petroleum supplies dwindle with oil reserves projected to be exhausted by around 2052 the pressing need for sustainable alternatives is clear to sustain the pu industry bio based substitutes such as polyols derived from palm soybean castor and sunflower oils have been extensively researched to replace the petroleum based polyol feedstock this book focuses on applying coconut oil derived polyols in polyurethane foam production offering a detailed examination of their potential benefits and associated difficulties the introductory chapter outlines the critical need for greener alternatives and emphasizes the significant role of coconut oil as a substitute for petroleum based polyols subsequent chapters delve into the chemistry and synthesis of coconut oil derived polyols and polyurethanes providing insights into their properties and contributions to polyurethane formulations this book further provides an overview of how coconut oil s high saturation impacts the polyol production process and explores methods to overcome these challenges it bridges the gap between raw material science and practical applications using coconut oil in polymer studies it provides valuable information for researchers and industry professionals aiming to innovate with sustainable polymer materials

this brief outlines the most recent advances in the production of polyols and polyurethanes from renewable resources mainly vegetable oils lignocellulosic biomass starch and protein the typical processes for the production of polyols from each of the above mentioned feedstocks are introduced and the properties of the resultant polyols and polyurethanes are also discussed

this first volume of the updated and extended 3rd edition of this work covers the basic chemistry and technology of oligo polyol fabrication the characteristics of the various oligo polyol families and the effects of their structure on the properties of the resulting pu this book is of interest to chemists and engineers in industry and academia as well as anyone working with polyols for the manufacture of pus

polyurethanes are one of the most dynamic groups of polymers they find use in nearly every aspect of modern life in applications such as furniture bedding seating and instrument panels for cars shoe soles thermoinsulation carpet backings packaging adhesives sealants binders and as coatings in 2004 10 6 million tons of polyurethanes were produced in 2014 the world production was close to 20 million tons in the last decade 2005 2015 important worldwide developments in the area of polyols for polyurethanes were carried out especially for polyols from renewable resources described in detail in this second edition of the book the main raw materials used for the production of pu are polyols and isocyanates the first of these is the subject of this two volume handbook volume 1 is dedicated to polyols for elastic pu flexible foams elastomers and so on volume 2 is dedicated to polyols for rigid pu rigid foams wood substitute packaging flotation materials and so on the book considers the raw materials used to build the pu polymeric architecture it covers the chemistry and technology of oligo polyol fabrication the characteristics of the various oligo polyol families and the effects of the oligo polyol structure on the properties of the resulting pu it presents the details of oligo polyol synthesis and explains the chemical and physico chemical subtleties of oligo polyol fabrication this book links data and information concerning the chemistry and technology of oligo polyols for pu providing a comprehensive overview of basic pu chemistry key oligo polyol characteristics synthesis of the main oligo polyol families including polyether polyols filled polyether polyols polyester polyols polybutadiene polyols acrylic polyols polysiloxane polyols aminic polyols polyols from renewable resources flame retardant polyols chemical recovery of polyols relationships between polyol structure and pu properties this book will be of interest to all specialists working with

POLYOLS FOR THE MANUFACTURE OF PU AND TO ALL RESEARCHERS THAT WOULD LIKE TO KNOW MORE ABOUT POLYOL CHEMISTRY

POLYURETHANES ARE ONE OF THE MOST DYNAMIC GROUPS OF POLYMERS THEY FIND USE IN NEARLY EVERY ASPECT OF MODERN LIFE IN APPLICATIONS SUCH AS FURNITURE BEDDING SEATING AND INSTRUMENT PANELS FOR CARS SHOE SOLES THERMOINSULATION CARPET BACKINGS PACKAGING ADHESIVES SEALANTS BINDERS AND AS COATINGS IN 2004 10 6 MILLION TONS OF POLYURETHANES WERE PRODUCED IN 2014 THE WORLD PRODUCTION WAS CLOSE TO 20 MILLION TONS IN THE LAST DECADE 2005 2015 IMPORTANT WORLDWIDE DEVELOPMENTS IN THE AREA OF POLYOLS FOR POLYURETHANES WERE CARRIED OUT ESPECIALLY FOR POLYOLS FROM RENEWABLE RESOURCES DESCRIBED IN DETAIL IN THIS SECOND EDITION OF THE BOOK THE MAIN RAW MATERIALS USED FOR THE PRODUCTION OF PU ARE POLYOLS AND ISOCYANATES THE FIRST OF THESE IS THE SUBJECT OF THIS TWO VOLUME HANDBOOK VOLUME 1 IS DEDICATED TO POLYOLS FOR ELASTIC PU FLEXIBLE FOAMS ELASTOMERS AND SO ON VOLUME 2 IS DEDICATED TO POLYOLS FOR RIGID PU RIGID FOAMS WOOD SUBSTITUTE PACKAGING FLOTATION MATERIALS AND SO ON THE BOOK CONSIDERS THE RAW MATERIALS USED TO BUILD THE PU POLYMERIC ARCHITECTURE IT COVERS THE CHEMISTRY AND TECHNOLOGY OF OLIGO POLYOL FABRICATION THE CHARACTERISTICS OF THE VARIOUS OLIGO POLYOL FAMILIES AND THE EFFECTS OF THE OLIGO POLYOL STRUCTURE ON THE PROPERTIES OF THE RESULTING PU IT PRESENTS THE DETAILS OF OLIGO POLYOL SYNTHESIS AND EXPLAINS THE CHEMICAL AND PHYSICO CHEMICAL SUBTLETIES OF OLIGO POLYOL FABRICATION THIS BOOK LINKS DATA AND INFORMATION CONCERNING THE CHEMISTRY AND TECHNOLOGY OF OLIGO POLYOLS FOR PU PROVIDING A COMPREHENSIVE OVERVIEW OF BASIC PU CHEMISTRY KEY OLIGO POLYOL CHARACTERISTICS SYNTHESIS OF THE MAIN OLIGO POLYOL FAMILIES INCLUDING POLYETHER POLYOLS FILLED POLYETHER POLYOLS POLYESTER POLYOLS POLYBUTADIENE POLYOLS ACRYLIC POLYOLS POLYSILOXANE POLYOLS AMINIC POLYOLS POLYOLS FROM RENEWABLE RESOURCES FLAME RETARDANT POLYOLS CHEMICAL RECOVERY OF POLYOLS RELATIONSHIPS BETWEEN POLYOL STRUCTURE AND PU PROPERTIES THIS BOOK WILL BE OF INTEREST TO ALL SPECIALISTS WORKING WITH POLYOLS FOR THE MANUFACTURE OF PU AND TO ALL RESEARCHERS THAT WOULD LIKE TO KNOW MORE ABOUT POLYOL CHEMISTRY

VOLUME 2 OF THE UPDATED AND EXTENDED 3RD EDITION OF THIS WORK FOCUSES ON THE CHEMISTRY AND TECHNOLOGY OF RIGID POLYURETHANES RECENT DEVELOPMENTS IN OBTAINING POLYOLS FROM RENEWABLE RESOURCES AND THE FIELD OF RIGID POLYURETHANES HAVE BEEN INCLUDED THIS BOOK IS OF INTEREST TO CHEMISTS AND ENGINEERS IN INDUSTRY AND ACADEMIA AS WELL AS ANYONE WORKING WITH POLYOLS FOR THE MANUFACTURE OF PUS

THIS FIRST VOLUME OF THE UPDATED AND EXTENDED 3RD EDITION OF THIS WORK COVERS THE BASIC CHEMISTRY AND TECHNOLOGY OF OLIGO POLYOL FABRICATION THE CHARACTERISTICS OF THE

VARIOUS OLIGO POLYOL FAMILIES AND THE EFFECTS OF THEIR STRUCTURE ON THE PROPERTIES OF THE RESULTING PU THIS BOOK IS OF INTEREST TO CHEMISTS AND ENGINEERS IN INDUSTRY AND ACADEMIA AS WELL AS ANYONE WORKING WITH POLYOLS FOR THE MANUFACTURE OF PUS

THIS BOOK IS ABOUT POLYURETHANE CHEMISTRY RENEWABLE POLYOLS AND ISOCYANATES

A COMPLETE OVERVIEW OF A KEY PLASTIC ONE OF THE MOST VERSATILE POLYMER MATERIALS POLYURETHANES HAVE A UNIQUE CHEMICAL NATURE THAT ALLOWS FOR SHAPING AND MOLDING TO FIT ALL SORTS OF CONSUMER AND INDUSTRIAL PRODUCTS SEAT CUSHIONS CARPETS INSULATION COATINGS AND REFRIGERATORS TO NAME A FEW DESPITE ITS POPULAR USES POLYURETHANE SCIENCE HAS ONLY RELATIVELY RECENTLY ACHIEVED APPRECIATION FOR THE RICHNESS OF ITS EXPRESSION AS A POLYMER FAMILY THIS BOOK PROVIDES A THOROUGH PRESENTATION OF POLYURETHANE SCIENCE TECHNOLOGY MARKETS AND TREND ANALYSIS BASED ON RECENT PATENTS ALTHOUGH IT DOES NOT PROVIDE ULTIMATE DETAIL SUCH AS EXPLICIT INFORMATION TYPICALLY IN PATENTS THE BOOK HAS A FLOW AND CONTINUITY THAT ALLOWS READERS TO FIND ALL THE BACKGROUND NECESSARY TO UNDERSTAND ANY OTHER MORE DETAILED POLYURETHANE INFORMATION FOUND ELSEWHERE ANYONE INVOLVED IN THE POLYMER AND PLASTICS INDUSTRY WILL FIND THIS BOOK A KEY RESOURCE WITH FEATURES THAT INCLUDE AN IN DEPTH SUMMARY OF THE CURRENT STATE OF POLYURETHANE RESEARCH AND KNOWLEDGE DISCUSSION OF THE APPLICATIONS MANUFACTURE AND MARKETS FOR POLYURETHANES ANALYTICAL METHODS REACTION MECHANISMS MORPHOLOGY THEORETICAL TECHNIQUES AND THE SELECTION OF CHAIN EXTENDERS POLYURETHANE FLEXIBLE AND RIGID FOAMS ELASTOMERS COATINGS ADHESIVES AND MEDICAL APPLICATIONS IN DEPTH COVERAGE OF GOVERNMENTAL REGULATIONS NON ISOCYANATE NON PHOSGENE ROUTES TO POLYURETHANE STRUCTURE AND INDUSTRIAL ROUTES TO ENVIRONMENTAL HEALTH AND SAFETY RISK MITIGATION

POLYURETHANES ARE FORMED BY REACTING A POLYOL AN ALCOHOL WITH MORE THAN TWO REACTIVE HYDROXYL GROUPS PER MOLECULE WITH A DIISOCYANATE OR A POLYMERIC ISOCYANATE IN THE PRESENCE OF SUITABLE CATALYSTS AND ADDITIVES BECAUSE A VARIETY OF DIISOCYANATES AND A WIDE RANGE OF POLYOLS CAN BE USED TO PRODUCE POLYURETHANE A BROAD SPECTRUM OF MATERIALS CAN BE PRODUCED TO MEET THE NEEDS OF SPECIFIC APPLICATIONS DURING WORLD WAR II A WIDESPREAD USE OF POLYURETHANES WAS FIRST SEEN WHEN THEY WERE USED AS A REPLACEMENT FOR RUBBER WHICH AT THAT TIME WAS EXPENSIVE AND HARD TO OBTAIN DURING THE WAR OTHER APPLICATIONS WERE DEVELOPED LARGELY INVOLVING COATINGS OF DIFFERENT KINDS FROM AIRPLANE FINISHES TO RESISTANT CLOTHING SUBSEQUENT DECADES SAW MANY FURTHER DEVELOPMENTS AND TODAY WE ARE SURROUNDED BY POLYURETHANE APPLICATIONS IN EVERY

aspect of our everyday lives while polyurethane is a product that most people are not overly familiar with as it is generally hidden behind covers or surfaces made of other materials it would be hard to imagine life without polyurethanes

selected peer reviewed papers from the 2012 international conference on advanced composite materials and manufacturing engineering cmme 2012 october13 14 2012 beijing china

handbook of polyurethanes serves as the first source of information of useful polymers this new book thoroughly covers the entire spectrum of polyurethanes from current technology to buyer s information discussions include block and heteroblock systems rubber plasticity structure property relations mi

polyurethane pu foams have great applications in industry the raw materials of pu polyol and isocyanate are conventionally derived from petroleum bio based polyols are promising substitutes for petrochemical polyols due to their sustainability this project studied water blown polyurethane pu foams made from soy polyols the flexible bio based pu foams were successfully produced by mixing petroleum polyol and commercial soy polyols with different hydroxyl numbers and functionalities the effect of hydroxyl number and functionality of soy polyols and the effect of tin catalyst cross linker levels and isocyanate index on foam properties were identified water blown rigid polyurethane pu foams were made from 0 50 soy phosphate polyol spp and 2 4 water as the blowing agent the effects of water content and isocyanate index on physical properties of spp pu foams were investigated low density soy polyol based rigid pu foams were modified with different concentrations of glass microspheres and nanoclay the physical properties especially the mechanical properties were studied the effects of high viscosity soy polyols 13 000 cp to 31 000 cp on water blown rigid polyurethane foams sbo pu foams containing 1 50 high viscosity soy polyols were investigated with regard to density compressive strength foams made from high viscosity 21 000 to 31 000 cp soy polyols demonstrated comparable or superior value to the control foam

for the past 10 years polyurethane polymers have been one of the fastest growing segments of the plastics industry over 900 million pounds of polyurethanes were used in 1970 approximately 30 of this amount was consumed in the form of rigid urethane foam products this study undertakes a comparison of the properties of rigid

urethane foams based on both a polyester polyol and polyether polyol of the same hydroxyl number prepared from alpha methylglucoside this comparison of ester and ether polyols in urethane foams is closer than in previous studies because 1 both types of polyols are based on alpha methylglucoside 2 they both have the same hydroxyl number and functionality and 3 the rigid foams in which they are used have been formulated to have essentially the same crosslink density several physical and thermal properties of the foam systems were determined a discussion of test results as they relate to the presence of the ester and ether linkages in the polyols is presented

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soy based polyol used in polyurethane applications are sustainable and renewable materials which have been reported to require less energy to produce and to have lower market price they also have less environmental impact expand soybean market for soybean farmers and help to reduce consumption of petrochemical based materials this project proposes new soy based polyols produced by enzymatic routes and having good reactivity in polyurethane foam production multiple enzymatic routes were evaluated to improve the functionality reactivity of soy based materials all enzyme reactions proposed in this work were successfully operated at low temperature less than 70oc and most of the reaction did not require organic solvent which was occasionally required to preserve enzyme activity the enzyme technology encourages the development of green chemistry and sustainability for urethane consumers the results conclusively demonstrated that selective enzymes can synthesize improved soy based polyols with high yield and selectivity in manners not possible with conventional chemistry

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