

Glycerol To Propylene Glycol

Equilibrium Limitations and Selectivity on Conversion of Glycerol to Propylene Glycol

The production of ethylene glycol and propylene glycol from biorenewable resources, i.e. sorbitol, has been parametrically examined numerous times. However, the current selectivity is too low to be economically feasible. In order to develop improved catalyst systems, a better understanding of the reaction mechanism is required. Sorbitol, due to its many functional groups is quite complex. Thus, in order to begin understanding of this system, analysis of the products is required. The study of the degradation of the product glycols and reaction of glycerol under hydrogenolysis conditions gives foundational insight. The effects of pH, competitive adsorption, and product degradation are determined for these smaller polyols. A mathematical model for the glycerol reaction and product degradation is developed which includes an instantaneous selectivity parameter, which is more accurate than an overall selectivity that does not account for product degradation. This foundation was built upon with an understanding of the effects sulfur has on the reaction. Sulfur, a known catalyst poison, lowers the reaction rate while increasing the selectivity toward propylene glycol. The limiting step in the reaction is proposed to be the catalytic diffusion of sulfur adatoms away from the adsorbed polyol during the dehydrogenation step. Finally, higher polyols are studied. The reaction rate of higher polyols is correlated to the configuration of the polyol. Analysis of the product distribution of various polyols shows that the decarboxylation reaction is occurring along with the retro-aldol reaction. A selectivity map is fitted to the product distribution to determine which hydroxyl groups are preferentially dehydrogenated. Sulfur decreases the dehydrogenation fraction of the primary alcohol group.

Since its introduction in 1967, Alexander A. Fisher's Contact Dermatitis has been the one essential text for American dermatologists who see patients with contact dermatitis. The sixth edition is an encyclopedic reference that discusses all aspects of contact dermatitis. It features a full color atlas section as well as color images for the first time. The 6th edition provides updates on the following sections: statistics and sources of rubber allergy; allergy to plastic chemicals, especially epoxies and acrylics; textile dyes and permanent press allergy; photo dermatitis; allergy to newer preservatives and other ingredients in skin and hair care products and cosmetics such as cocamidopropyl betaine, emulsifiers, methyldibromoglutaronitrile; and metal allergy especially gold, nickel, rare metal allergy and allergy to dental materials, cardiovascular and orthopedic implants.

This research is focused on developing a method that is applicable to the industrial-scale production of propylene glycol from glycerol with considerably high conversions and yields. The fundamental understanding behind this glycerol

technology paves the way for future work on exploring some more commodity chemicals that will be derived from natural resources. Acetol was successfully isolated from dehydration of glycerol as the transient intermediate indicates that the reaction process for producing propylene glycol with high selectivity can be done in two steps. Reactive distillation technology was employed to shift the equilibrium towards the right and achieve high yields. This catalytic process provides an alternative route for the production of propylene glycol from renewable resources. The low-pressure vapor-phase catalytic processing using copper-chromite catalyst has been proven as feasible for producing propylene glycol from glycerol. This approach was demonstrated in a continuous process to address the concerns of scalability and suitability for large scale production. The vapor-phase reaction approach allows glycerol to be converted to propylene glycol in a single reactor. A two-step reaction process to produce propylene glycol from glycerol via an acetol intermediate was proposed and validated. A large scale process is thereby potentially viable.

Using a 300 mL batch pressure reactor, preliminary experiments were first conducted to determine the most influential process parameters and to establish the appropriate experimental designs. Based on the preliminary results, thorough experiments were conducted to investigate the effects of reaction temperature, reaction time, and water to glycerol mass ratio by applying Raney nickel catalyst. Different reactant formulations were used to explore the possible pathways of the desired reactions leading to ethanol and propylene glycol. A response surface regression was used to determine the optimum conditions for maximizing propylene glycol and ethanol yields.

Propylene glycol and glycerol drench treatments were administered to fifty-six dairy cows immediately postpartum. Blood samples were drawn at zero, one, five, nine, twelve and twenty-four hours post-treatment. Samples were analyzed for plasma levels of glucose, non-esterified fatty acids, and beta-hydroxybutyrate.

This book contains the proceedings of the XIth International Symposium on Ruminant Physiology. The papers address ruminant comparative physiology, the rumen ecosystem and metagenomics, nutrient digestion and absorption, methanogenesis, tissue metabolism and gene expression, pregnancy, lactation and growth, adaptation to heat-stress, nitrogen use, nutrition and reproduction, nutrition and welfare and nutrition for sustainable ruminant production. These topics are in line with the current challenges for animal breeding: production efficiency, meat and milk quality, environment (greenhouse gases, nitrogen use), animal welfare and health. The contributions come from research teams in 49 countries of all continents, showing a world-wide interest in ruminant nutrition and physiology. They show the latest techniques and results on ruminant nutrition physiology, including fundamental and integrative approaches, presented in the book on the following sections: (1) Digestion and absorption; (2) Metabolism and hormonal regulations; (3) Nutrition and reproduction; (4) Nutrition and welfare. Proceedings from past ISRP symposia have had a major influence on

research and teaching in animal science over the years. Without a doubt, this book, which is of interest to all professionals and researchers who are concerned with ruminant nutrition and physiology, will contribute to this fine tradition.

The present invention provides a process for preparation of low molecular weight polyols from high molecular weight polyols in a hydrogenolysis reaction under elevated temperature and hydrogen pressure. The process comprises providing in a reaction mixture the polyols, a base, and a metal catalyst prepared by depositing a transition metal salt on an inert support, reducing the metal salt to the metal with hydrogen, and passivating the metal with oxygen, and wherein the catalyst is reduced with hydrogen prior to the reaction. In particular, the process provides for the preparation of glycerol, propylene glycol, and ethylene glycol from sugar alcohols such as sorbitol or xylitol. In a preferred process, the metal catalyst comprises ruthenium which is deposited on an alumina, titania, or carbon support, and the dispersion of the ruthenium on the support increases during the hydrogenolysis reaction.

Biomass use is growing globally. Biomass is biological material derived from living, or recently living organisms. It most often refers to plants or plant-based materials which are specifically called lignocellulosic biomass. Biomass (organic matter that can be converted into energy) may include food crops, crops for energy, crop residues, wood waste and byproducts, and animal manure. It is one of the most plentiful and well-utilized sources of renewable energy in the world. Broadly speaking, it is organic material produced by the photosynthesis of light. The chemical materials (organic compounds of carbons) are stored and can then be used to generate energy. The most common biomass used for energy is wood from trees. Wood has been used by humans for producing energy for heating and cooking for a very long time. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal, chemical, and biochemical methods. Biomass gasification is the conversion of solid fuels like wood and agricultural residues into a combustible gas mixture. The gasification system basically consists of a gasifier unit, a purification system and energy converters- burner or engine. This book offers comprehensive coverage of the design and analysis of biomass gasification, the key technology enabling the production of biofuels from all viable sources like sugar beet and sweet sorghum. It aims at creating an understanding of the nature of biomass resources for energy and fuels, the variety of processes that are available for conversion of the wastes into energy or fuels. The book discusses the overview of the Biomass Energy along with their Properties, Composition, Benefits, Characteristics and Manufacturing Process of Biomass based products. Also it contains suppliers contact details of plant & machinery with their photographs. The content includes biomass renewable energy, prospective renewable resources for bio-based

processes, biochemical from biomass, biomass based chemicals, biofuel production from biomass crops, biomass gasification, reuse of bio-genic iron oxides and woody biomass fly ash in cement based materials and agricultural areas, biofuel briquettes from biomass, biomass based activated carbon, environmental aspects. It will be a standard reference book for Professionals, Decision-makers, Engineers, those studying and researching in this important area and others interested in the field of biomass based products. Professionals in academia and industry will appreciate this comprehensive and practical reference book, due to its multidisciplinary nature.

This report presents a cost analysis of Propylene Glycol production from glycerol using a vapor-phase process. The process examined is similar to Davy Technologies process. In this process, technical grade glycerol (99.5 wt% glycerol content) is used as feedstock and ethylene glycol is generated as by-product. This report was developed based essentially on the following reference(s): Keywords: Glycerin, Davy Process Technology, DPT, Propane-1,2-diol, Hydrogenolysis, Cargill, Ashland

This Standard specifies the gas chromatographic determination method for 1,2-propylene glycol and glycerol in tobacco and tobacco products. This Standard applies to the determination of 1,2-propylene glycol and glycerol in tobacco and tobacco products.

(Cont.) In vitro skin electrical current measurements can be used effectively to rank aqueous contacting solutions containing surfactants and humectants (the enhancer), relative to a PBS aqueous contacting solution (the control), based on their ability to perturb the skin aqueous pores. Specifically, an in vitro ranking metric was introduced using the enhancement in the skin electrical current induced by an enhancer relative to the control. For this study, I considered aqueous contacting solutions of the following chemicals: (1) humectants - Glycerol and Propylene Glycol, (2) surfactants - SDS and C12E6 (Dodecyl Hexa (Ethylene Oxide)), and (3) a control - PBS. Utilizing the in vitro ranking metric, the aqueous solutions above contacting the skin were ranked as follows (from the mildest to the harshest): Glycerol

Hydrogenolysis of glycerol to propylene glycol was performed at lower temperatures and pressures using concentrated glycerol. Reactions were carried out at 180, 200, 220, and 240°C and at a system pressure of 1, 2, and 4 bars in the presence of a copper-chromite catalyst. The effect of temperature, pressure, residence time, water content, and H₂: Glycerol mole ratios were evaluated. All results indicate that lower temperatures and higher pressures promote the selectivity on conversion of glycerol to propylene glycol. The amount of byproducts decreased with decreasing the residence time. Product quality correlates with lower water content. Catalyst productivity increased with decreasing H₂: Glycerol mole ratio. An optimal H₂: Glycerol mole ratio is near 15:1. Lower temperatures (220°C) are the preferred operated conditions to increase the catalyst productivity. The results are also fully consistent with a two-step reaction in which the second step of conversion of acetol to propylene glycol is equilibrium limited. This book comprehensively covers the chemical and physical properties and manufacturing and handling procedures of glycerine

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and the use of this material in cosmetic and personal care products and in other industrial areas such as testing laboratories and manufacturing and marketing sectors.

The current research is based on developing an improved and fundamental understanding of technology that will allow the conversion of this crude glycerin to a propylene glycol based antifreeze product. Hydrogenolysis of glycerol to propylene glycol was performed using copper chromite catalyst. At temperatures above 200°C and hydrogen pressure of 200 psi, the selectivity to propylene glycol decreased due to excessive hydrogenolysis of the propylene glycol. The yield of propylene glycol increased with decreasing water content. The main causes for the deactivation were reduction of the cuprous chromium active species into metallic copper species, metal leaching, and blocking of sites by strongly adsorbed inorganic and organic species present in the feed or generated during the reaction. A new reaction pathway for converting glycerol to propylene glycol via an intermediate was validated by isolating the acetol intermediate. In the first step involves dehydration of glycerol to acetol with subsequent hydrogenation of acetol to propylene glycol. High acetol selectivities ([greater than] 90%) were achieved using copper-chromite catalyst and operating in semi-batch reactive distillation mode. The acetol from this reaction readily hydrogenates to form propylene glycol with selectivities exceeding 95%.

This important book is an overall analysis of different innovative methods and ways of recycling in connection with various types of materials. It aims to provide a basic understanding about polymer recycling and its reuse as well as presents an in-depth look at various recycling methods. It provides a thorough knowledge about the work being done in recycling in different parts of the world and throws light on areas that need to be further explored. Emphasizing eco-friendly methods and recovery of useful materials The book covers a wide variety of innovative recycling methods and research, including • Green methods of recycling • Effective conversion of biomass and municipal wastes to energy-generating systems • A catalyst for the reuse of glycerol byproduct • Methods of adsorption to treat wastewater and make it suitable for irrigation and other purposes • Disposal of sludge • The use of calcined clay to replace both fine and coarse aggregates • Recycling of rubbers • The production of a sorbent material for paper mill sludge • Replacing polypropylene absorbent in oil spill sanitations • The use of natural fibers for various industrial applications • Cashew nut shell liquid as a source of surface active reagents • Integrated power and cooling systems based on biomass • Recycling water from household laundering • much more

This book explains how the use of whole plants and by-products can maximize efficiency in the European oil-crop supply chain. Processes and systems for converting glycerol to propylene glycol are disclosed. The glycerol feed is diluted with propylene glycol as the primary solvent, rather than water which is typically used. The diluted glycerol feed is sent to a reactor where the glycerol is converted to propylene glycol (as well as other byproducts) in the presence of a catalyst. The propylene glycol-containing product from the reactor is recycled as a solvent for the glycerol feed.

The goal of this work is to provide experimental measurements of thermal conductivity of water, ethylene glycol, glycerol, and propylene glycol as a function of temperature. The transient hot wire method was used to measure the thermal conductivity over

temperatures ranging from 235-340 K. This work also involved in-house apparatus fabrication along with integration of data acquisition and processing software. The experiments are carried out for a fixed current of 250 mA and the resulting temperature rise of a 95.33 mm long, 25-micron radius platinum wire is used to infer the thermal conductivity using the known solution to the heat conduction equation for a continuous line source in an infinite medium. It is important to account for the variable temperature coefficient of resistance of the platinum wire as a function of temperature when seeking to obtain the correct temperature dependence of the thermal conductivity. A data reduction procedure that improves the accuracy of the reported values by identifying the onset of convection in the fluid is proposed. We use the peak value of the slope (S) obtained using a third order polynomial fit to the apparent linear region to estimate the thermal conductivity. The high-resolution data acquired at closely spaced temperature intervals is used to derive a correlation between thermal conductivity values and the fluid temperature. Additionally, numerical results for temperature and velocity field near the heated wire are also presented to help understand the non-idealities present in the experiments. The experimental temperature rise obtained from the transient hot-wire experiments is compared to computed values for water at room temperature, and a good agreement is found. There is a fair agreement between the current data sets and the very limited data for the four liquids reported in the literature. This work provides robust and comprehensive experimental data for thermal conductivities of the four common heat transfer fluids over the typical range of temperatures they are frequently used.

Electronic cigarette liquid (e-liquid) is a solution of propylene glycol and/or glycerol with varying concentrations of nicotine and flavorants. Inhalation of vaporized e-liquid is a method of nicotine delivery that is growing in popularity and is commonly regarded as safe relative to smoking traditional tobacco products. The thermal decomposition of glycerol and propylene glycol is typical of alcohols and has been investigated, although not exhaustively. In this work, samples of propylene glycol and glycerol were vaporized using an electronic cigarette (e-cigarette) and were analyzed for evidence of decomposition using nuclear magnetic resonance (NMR) spectroscopy. E-cigarettes are shown to degrade glycerol and propylene glycol into a diverse array of oxidation and dehydration products including glyceraldehyde, lactaldehyde, dihydroxyacetone, hydroxyacetone, glycidol, acrolein, propanal, acetone, allyl alcohol, acetic acid, acetaldehyde, formic acid, and formaldehyde. Evidence is presented that the abundance of these decomposition products may depend upon the temperature of the metal heating element but could also depend upon some catalytic aspect of the metal surface. The combination of formaldehyde with alcohols such as glycerol and propylene glycol was explored; hemiformals are stable hemiacetals that can be detected by NMR spectroscopy and are shown to be subject to hydrolysis when diluted in water. Investigations into smoking a glycerol-based tobacco mixture known as shisha using charcoals instead of metal heating elements also resulted in the dehydration of glycerol and sugars.

In the last decade, there has been renewed interest in the use of granulocyte transfusions to treat infections in individuals with compromised immune systems. However, granulocytes only remain functional for about a day after isolation and this short shelf life is a significant drawback. Cryopreservation would allow long term storage of granulocytes, but an effective cryopreservation

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method is currently unavailable. The following study was performed to provide membrane permeability values for multiple cryoprotectants in hopes of aiding the optimization of cryoprotectant addition and removal and minimizing the detrimental effects of the process. The granulocytes were separated from whole blood using centrifugation with Polymorphprep as the separating agent. The cellular membrane permeability values were then measured using a Beckman Coulter Counter Multisizer 3 under custom setup conditions. The cryoprotectants studied were glycerol, DMSO, ethylene glycol, and propylene glycol at the respective total concentrations of 1, 2, 2, 1 Osm/kg at temperatures of 4, 21, and 37 °C. The resulting membrane solute permeability values at 20 °C reference temperature for DMSO, ethylene glycol, glycerol, and propylene glycol were respectively 5.96, 7.84, 0.950, and 3.45 $\mu\text{m}/\text{min}$ and the Arrhenius activation energies were respectively 60.4, 58.7, 68.2, and 62.3 kJ/mol. The resulting hydraulic permeability values in the same order and temperature were 0.196, 0.189, 0.259, and 0.113 $\mu\text{m}/(\text{atm min})$ and the Arrhenius activation energies were respectively 56.3, 60.7, 68.5, and 47.1 kJ/mol. It is anticipated that these permeability values will aid in the development of successful cryopreservation procedures for granulocytes.

This book depicts how practical limitations posed by glycerol chemistry are solved based on the understanding of the fundamental chemistry of glycerol.

This report presents a cost analysis of Propylene Glycol production from glycerol using a liquid-phase process. The process examined is similar to Suppes process. In this process, technical grade glycerol (99.5 wt% glycerol content) is used as feedstock and ethylene glycol is generated as by-product. This report examines one-time costs associated with the construction of a United States-based plant and the continuing costs associated with the daily operation of such a plant. More specifically, it discusses: * Capital Investment, broken down by: - Total fixed capital required, divided in production unit (ISBL); infrastructure (OSBL) and contingency - Alternative perspective on the total fixed capital, divided in direct costs, indirect costs and contingency - Working capital and costs incurred during industrial plant commissioning and start-up * Production cost, broken down by: - Manufacturing variable costs (raw materials, utilities) - Manufacturing fixed costs (maintenance costs, operating charges, plant overhead, local taxes and insurance) - Depreciation and corporate overhead costs * Raw materials consumption, products generation and labor requirements * Process block flow diagram and description of industrial site installations (production unit and infrastructure)

Keywords: Glycerin, Senergy Chemical, Propane-1,2-diol, Hydrogenolysis

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