Polyol
(and other nice chemicals) Production from Canola Oil

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MTN Consulting Associates
on behalf of
Alberta Agriculture and Rural Development

BioIndustrial Development in Alberta

- The Alberta ministry of agriculture has ongoing research and development projects for new agricultural products for new markets
- The Bioindustrial Technology Division is involved with a number of programs that produce industrial products from crops
  - includes fibre insulation, cosmetic ingredients, and industrial chemicals
- Subject program began as Alberta Lipid Utilization Program, with a focus on bio-plastics from canola oil
  - Program is supported by government funds and the Canola Producers
  - A chemical reaction sequence was developed at the University of Alberta that produced a polyol monomer
  - Original target was for use in polyurethanes

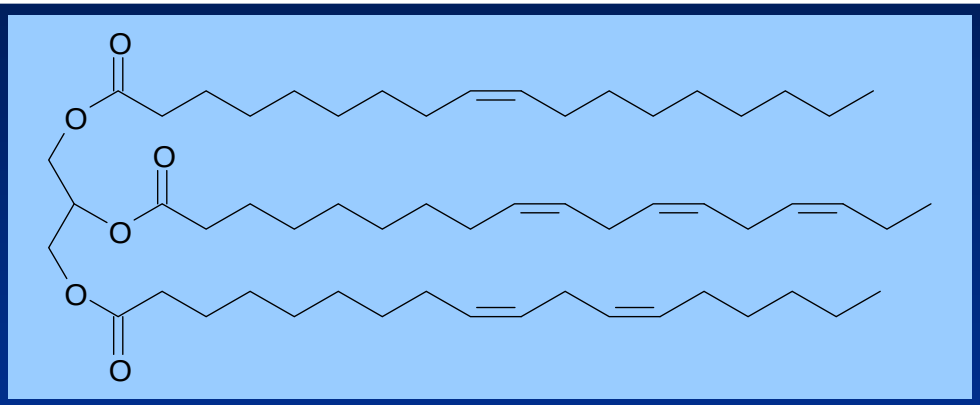
Bio-Based Chemicals Initiative

- Present focus is to advance biorefining and other technologies that will produce industrial organic chemicals as alternatives to petrochemicals
- Led by Alberta Agriculture and Rural Development, BioIndustrial Technologies Division
- Supported by Lipid Product Research Alberta (LiPRA) at the University of Alberta
- Current activity is related to chemicals derived from vegetable oils
  - Project has continued support from GoA funds and the Canola Producers
  - Focus is on the broader range of functional chemicals that can be derived from vegetable oils
  - Target applications include bioplastics, cosmetics, coatings, personal care products, and surfactants

The Oil-Based Chemicals Process

- A two step reaction sequence was developed starting from canola oil
- Results have been published (JAOCS, 2007, *84*, 173)
- Process has associated intellectual property
- A polyol was the primary target, but a series of industrially important by-product alcohols is also produced
- Opportunity is to market a range of biobased chemical building blocks/components

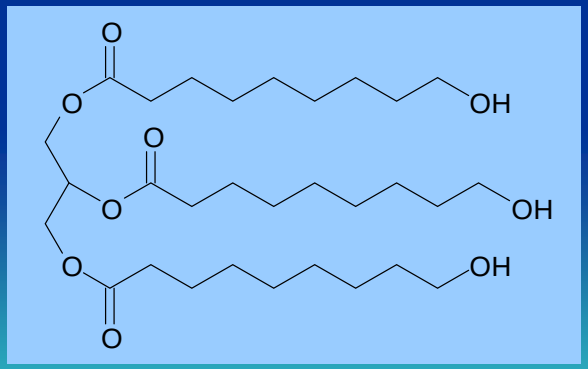
Polyol Production Process



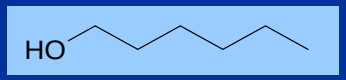
a triglyceride from canola oil

1. Ozonolysis
2. Hydrogenation

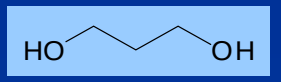
Narine et al
U of Alberta



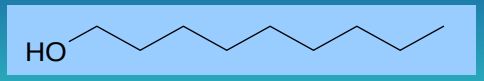
polyol monomer



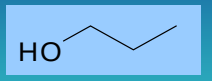
hexanol



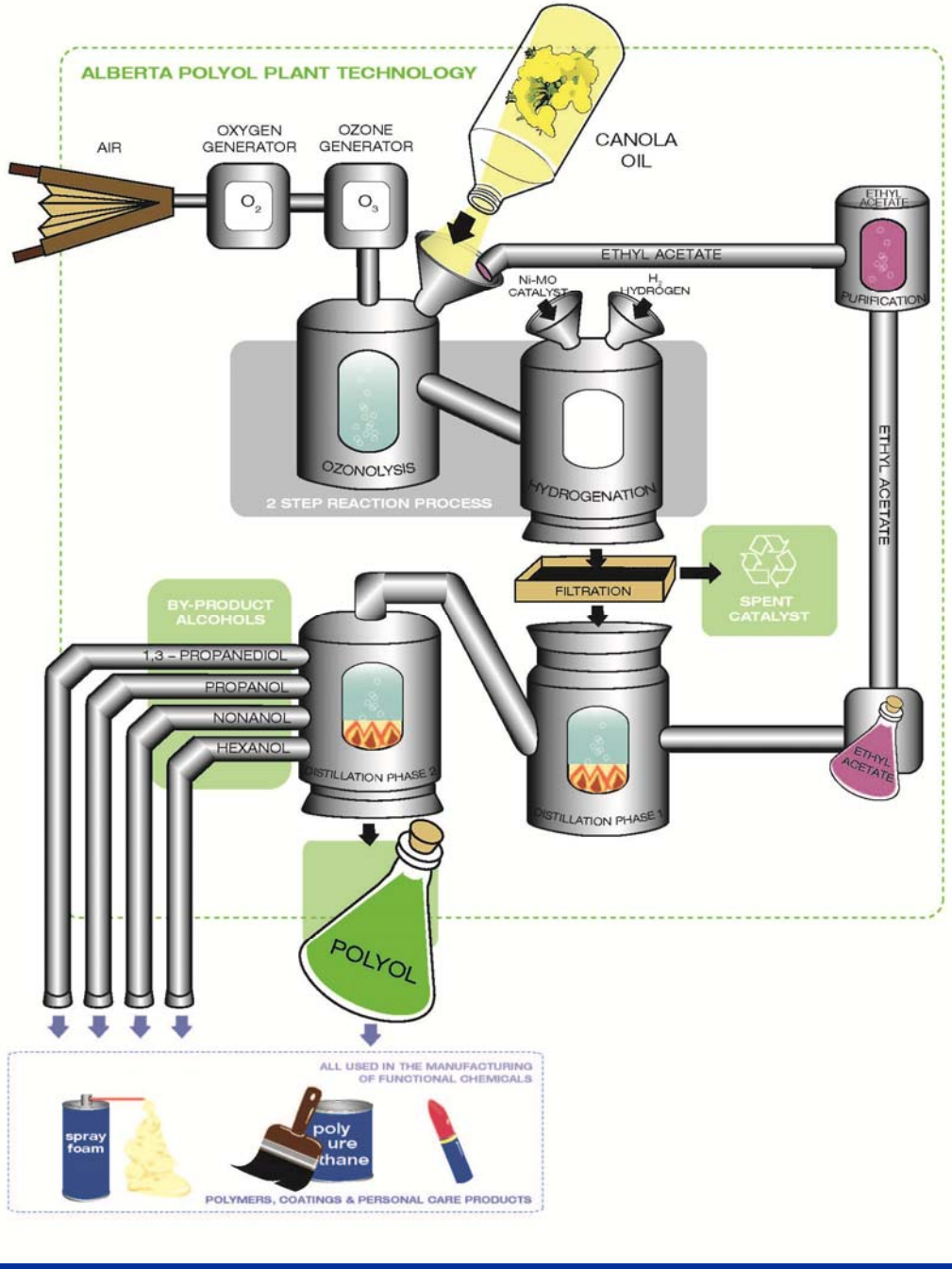
1,3-propanediol



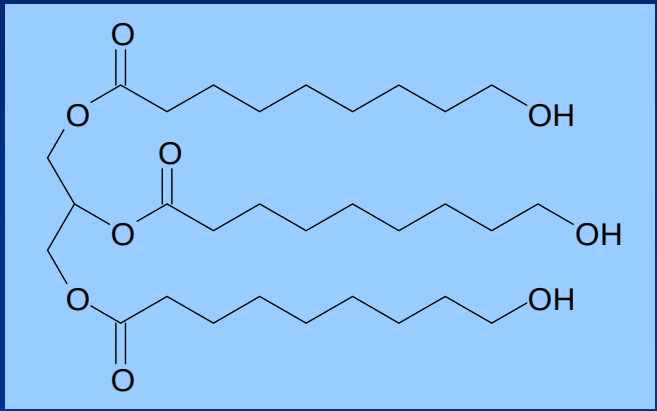
nonanol



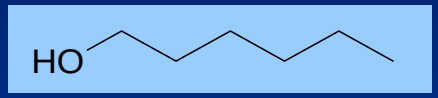
propanol


ALBERTA POLYOL PLANT TECHNOLOGY
AIR
OXYGEN GENERATOR
OZONE GENERATOR
CANOLA OIL
O_2
O_3
ETHYL ACETATE
Ni-MO CATALYST
H_2 HYDROGEN
PURIFICATION
OZONOLYSIS
HYDROGENATION
2 STEP REACTION PROCESS
ETHYL ACETATE
FILTRATION
SPENT CATALYST
BY-PRODUCT ALCOHOLS
1,3 – PROPANEDIOL
PROPANOL
NONANOL
HEXANOL
DISTILLATION PHASE 2
DISTILLATION PHASE 1
ETHYL ACETATE
POLYOL
ALL USED IN THE MANUFACTURING OF FUNCTIONAL CHEMICALS
spray foam
poly ure thane
POLYMERS, COATINGS & PERSONAL CARE PRODUCTS

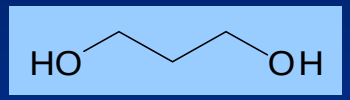
Primary Products



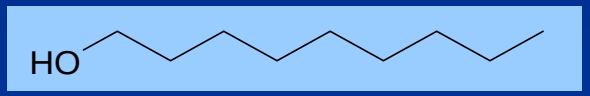
polyol monomer



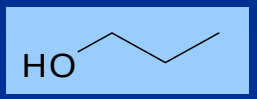
hexanol



1,3-propanediol



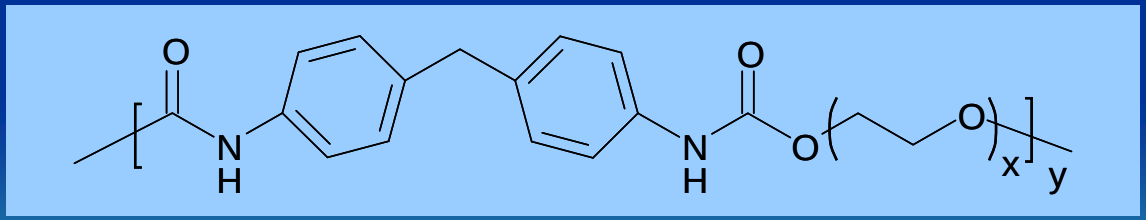
nonanol



propanol

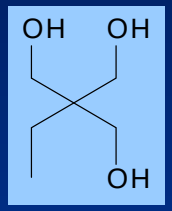
Why Make a Polyol?

- Polyols are important industrial chemicals
  - used mainly for branching and cross-linking in polymers and coatings
  - commercial polyols include polyether polyols, trimethylol propane, pentaerythritol
  - biobased polyols include glycerol, castor oil, sugar alcohols, epoxidized soy oil
- The triol triglyceride produced has value also as a replacement to castor oil in cosmetics and personal care products

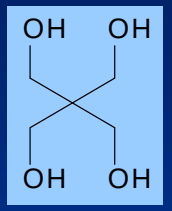


a polyurethane

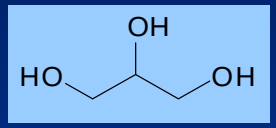
Common Polyols



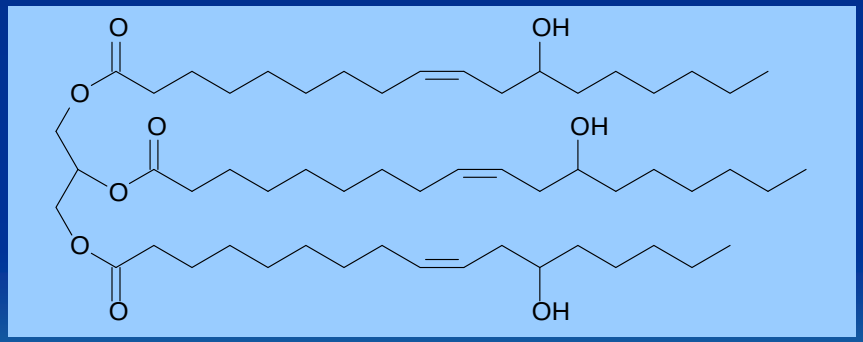
trimethylol propane (TMP)



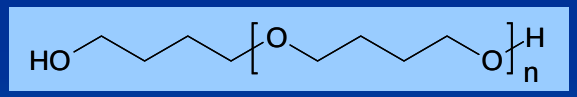
pentaerythritol (PE)



glycerol



caster oil (triricinoleate)



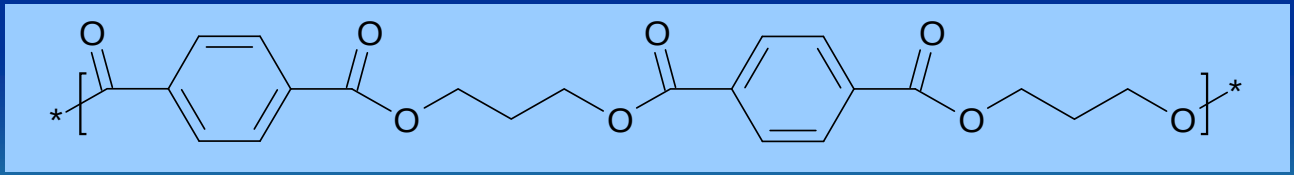
polyether polyol

1,3-Propanediol - Target Markets

- 1,3-Propanediol (PDO) is a unique industrially important chemical
  - currently manufactured (since app. 2005) only by Shell and DuPont
  - DuPont's PDO production has been widely publicized since it is bio-based and renewable, produced from corn starch using an engineered organism
  - primary application has been for polyester fibre (PTT)
  - PDO is also a personal care chemical, a biobased alternate to propylene glycol

1,3-Propanediol – Target Markets

- Diester analogues of propylene glycol
  - emollients: distearate, dicaprylate, dicaprate, dicocoate
  - dibenzoate is a solvent and plasticizer
- Engineered polyester resin analogues of butanediol (BDO)
- Larger scale production for PTT fibre manufacture is possible but in the longer term



Polytrimetyleneterphthalate (PTT)

Linear Alcohols - Target Markets

- Nonanol is a “plasticizer” alcohol, that can be used to make chemical additives
  - emollients
  - emulsifiers
  - plasticizers
- Nonanol produced would be pure linear C9 alcohol, whereas most commercial grades of linear alcohols are sold as mixtures of C_8/C_{10}, C_7/C_9, or C_9/C_{11}
- Hexanol and propanol are bio-based versions of commodity alcohols that have wide industrial uses as solvents, surfactants, plasticizers, etc.

Linear Alcohols - Target Markets

- Wide range of commercial functional chemical potential for nonanol
  - nonyl acetate is a fragrance
  - dinonyl phthalate and other diacid esters are widely used plasticizers for PVC
  - nonyl ethoxylate is a surfactant
  - esters of pelargonic (nonanoic) acid are widely used emollients
  - TMP or PE pelargonate esters are used as high performance synthetic ester lubricants

Value Proposition

- Alcohols will be price competitive and interchangeable with existing products
- Opportunity for chemical companies to introduce bio-based components and increase the renewable composition of their products

Program Status

- Intellectual property position is in place or will be sought for various applications of the polyol, as well as for advances in the development of the commercial process
- Small pilot facility has been installed (40 kg/day oil processing capacity)
  - process optimization is in progress
  - activities are addressing catalyst use efficiency, feedstock specifications, component separation, and product specifications

Program Status

- A team has been established to develop commercialization opportunities
  - Seeking a partner for process commercialization
  - companies are being identified as future partners and or customers of the alcohols and their derivatives
  - key issue is to match potential production capacity to target market size
  - interest has been expressed from the biopolymers and the personal care industry
- Future scale-up projected to be initially in the 10,000 T per year range

Future Considerations

- Product range can be impacted by using oils with different unsaturated fatty acids
- Chemical analogues of the alcohols could be produced
- First stage chemical derivatization will be considered

For Further Information

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