CHEMICAL INDUSTRY NEEDS FROM OILSEED CROPS

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FATTY ACIDS METHYL ESTERS

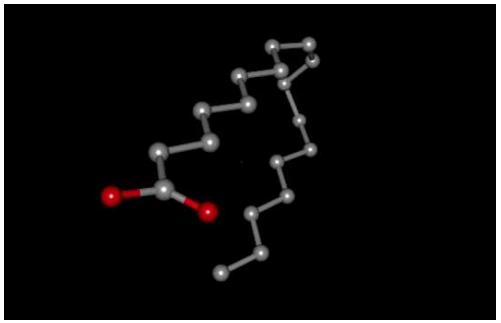
Major application: Biodiesel, Solvent

Process: transesterification.

- Methanol (alcohol) reaction with triglyceride. Coproduce glycerol.

Technical requirements:

- Cetane Index ➔ equivalent to Octane index for gasoline
- Viscosity ➔ impact on smoke
- Oxidation stability ➔ no degradation over time
- Cold flow properties ➔ liquid even in winter time
- Low corrosion ➔ no free fatty acids.



What does it mean in terms of appropriate fatty acid

- Oleic acid (C18:1)

Appropriate vegetable oils:

- Rapeseed oil (year round), Palm oil (summer), Soybean oil.

RENEWABLE DIESEL

Major application: Fuels

Process: Hydrogenation

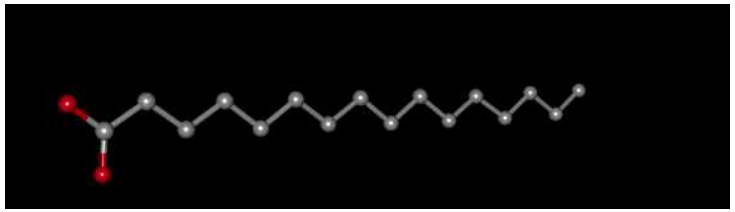
- Hydrogenation of triglyceride/fatty acids. Coproduce propane.

Technical requirements:

- Cetane Index ➔ equivalent to Octane index for gasoline
- Viscosity ➔ impact on smoke
- Oxidation stability ➔ no degradation over time
- Cold flow properties ➔ liquid even in winter time

What does it mean in terms of appropriate fatty acid

- Palmitic acid (C16:0), Stearic acid (C18:0)



Appropriate vegetable oils:

- Palm Oil, Beef tallow, Animal fats, Free fatty acids, Waste cooking oil.

INTERESTERIFIED FATS

Major application: margarine; cocoa butter equivalent…

Process: catalytic or enzymatic interesterification

- Mixed oils + catalyst/enzymes ➔ new triglyceride by chain redistribution

Technical requirements of final product:

- Crystallinity ➔ Melting point, Mouth feeling
- Stability

What does it mean in terms of appropriate fatty acid

- Depending on the targeted product. Need a blend of saturated and unsaturated fatty acids

Appropriate vegetable oils:

- Diverse. Includes fully hydrogenated vegetable oils ➔ No trans fatty acids.

FATTY AMIDES

Major application: Slip Agent, internal lubricants

Process: Amidification

- Reaction of fatty acid with ammonia (NH_3)

Technical requirements/Market:

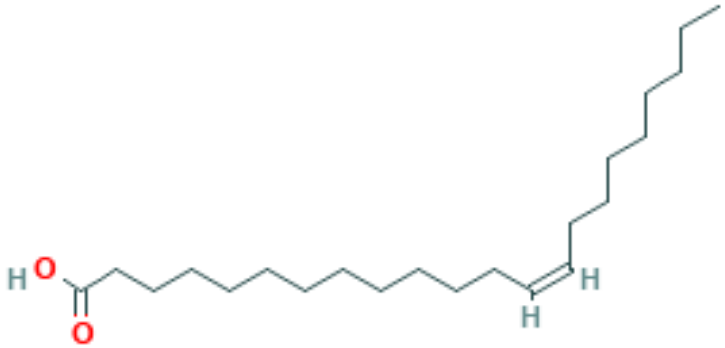
- Slip agent: avoid plastic films to stick on each other.

What does it mean in terms of appropriate fatty acid

- Erucic Acid (C22:1)

Appropriate vegetable oils:

- High Erucic Acid Rapeseed, Crambe,
- Ethiopian mustard, Pennycress (lower C22:1)



FATTY AMINES

Major application: Surfactants, Oilfield chemicals

Process: Ammoniation of fatty acids, and Hydrogenation

- Fatty acid + Ammonia ➔ Fatty amide
- Fatty amide + Hydrogen ➔ Fatty amine

Technical requirements:

- Surfactant properties
- Oxygen stability
- Low temperature properties

What does it mean in terms of appropriate fatty acid

- Palmitic acid (C16:0), Stearic acid (C18:0), Oleic acid (C18:1), Lauric acid (C12:0)

Appropriate vegetable oils:

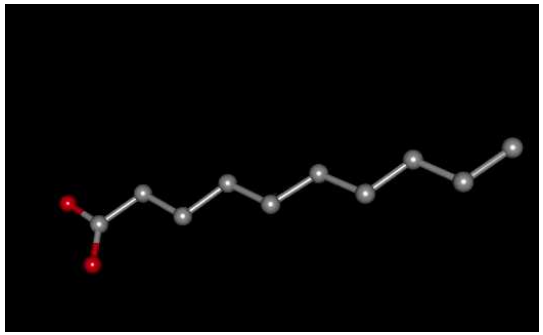
- Beef tallow, Animal fats, Palm oil, Coconut oil, Palm Kernel oil.

FATTY ALCOHOLS

Major application: Surfactants / Detergents

Process: Fatty acid / Fatty ester hydrogenation

- High pressure process. Fatty acid + Hydrogen ➔ Fatty ester ➔ Fatty alcohol



Technical requirements:

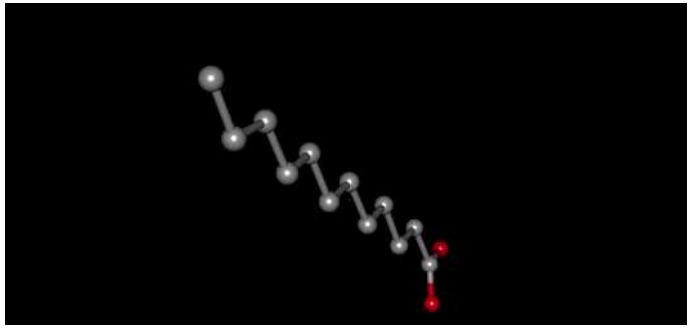
- Liquid soaps now preferred.

What does it mean in terms of appropriate fatty acid

- Lauric acid (C12:0); Capric acid (C10:0) ; Caproic acid (C8:0)

Appropriate vegetable oils:

- Coconut oil, Palm Kernel oil.



GUERBET ALCOHOLS

Major application: Biolubricants, Cosmetics

Process: Guerbet reaction

- 2 long chain alcohols ➔ Branched alcohols

Technical requirements:

- Cold flow properties ➔ branching on the chain
- Stability ➔ hydrogenated
- Boiling point ➔ chain length

What does it mean in terms of appropriate fatty acid

- Monounsaturated fatty acids (C8 +).
- Demand for C8, C10, C12, C16

Appropriate vegetable oils:

- Coconut oil, Palm Kernel oi, Palm Oil…

MONOMER/DIMER/TRIMER

Major application: paste soap, detergents, lubricants, printing inks, corrosion inhibitors…

Process: Diels Alders type reaction

- Diels alders reaction: 2 unsaturated fatty acids reacting together through double bonds ➔ generates diacids/triacids

Technical requirements:

- Low temperature liquid properties.

What does it mean in terms of appropriate fatty acid

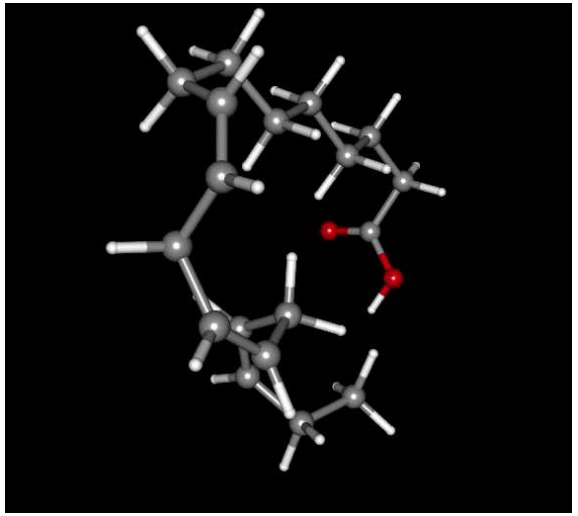
- Polyunsaturated fatty acids: Linoleic acid (C18:2), Linolenic acid (C18:3) sometimes combined with terminal unsaturated fatty acid

Appropriate vegetable oils:

- Linseed oil, Soybean oil, High Linoleic Sunflower, High Linoleic Safflower, Hemp, Cardoon oils

ALKYD RESINS

- **Major application: Paints and Varnishes**



- **Process: esterification with polyols.**

- **Technical requirements:**
  - Siccative property (self drying)

- **What does it mean in terms of appropriate fatty acid**
  - PolyUnsaturated Fatty Acids (PUFA). Linolenic acid (C18:3); Linoleic (C18:2)
  - Dehydrated Castor oil (conjugated linoleic acid C18:2),
  - Hydroxystearic acid (C18:0, OH)

- **Appropriate vegetable oils:**
  - Linseed oil, High Linolenic safflower oil, Camelina, Castor.

POLYAMIDE

Major application: Specialty Polymers

Processes: Oil dependant

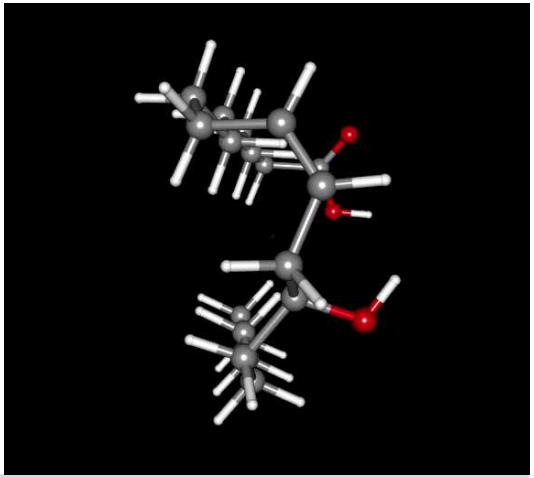
- Transesterification, thermal cleavage, hydrolysis, hydrobromination, ammonolysis ➔ Castor Oil to Polyamide 11
- Hydrolysis, alkaline cleavage, acidification (sebacic acid-DC10)/ ammoniation, hydrogenation (DA10) ➔ Castor oil to Polyamide 10.10

Technical requirements:

- Hydroxyfatty acid, with chain R'-$(CH_2)_n$-CH=CH-CH_2-CHOH-R

What does it mean in terms of appropriate fatty acid

- Ricinoleic acid (C18:1, OH); Lesquerolic acid (C20:1, OH)



Appropriate vegetable oils:

- Castor oil, Lesquerella oil

EPOXYDIZED OILS

- **Major application: Secondary plasticizers, polyols**

- **Process: epoxidation with peracids**
  - Oil + peracetic or performic acid ➔ epoxidized oil

- **Technical requirements:**
  - High number of epoxide functions

- **What does it mean in terms of appropriate fatty acid**
  - Linolenic acid (C18:3), Linoleic acid (C18:2)

- **Appropriate vegetable oils:**
  - Linseed oil, Soybean oil, Camelina oil

METATHESIS PRODUCTS

Major application: Monomers, Lubricants, pheromones

Process: self and cross-metathesis

- MUFA + Ethylene ➔ w-unsaturated fatty ester
- e.g: Methyl Oleate C18:1 + CH2=CH2 ➔ Methyl 9-Decenoate (C10:1) + 1-decene
- Cross metathesis:
- Methyl 10-undecenoate + CH_2=CH-CN ➔ NC-CH=CH-$(CH_2)_8$-$COOCH_3$ ➔ monomer
- Self metathesis: 2 Fatty acid ester ➔ Diester + olefin

Technical requirements:

- Chain length specific ➔ affects polymer crystallinity
- Low contamination with monofuntional fatty acids ➔ affects chain length
- Peroxide content

What does it mean in terms of appropriate fatty acid

- MonoUnsaturated Fatty Acids (MUFA): Oleic acid (C18:1); 9-decenoic acid; 10-undecenoic acid

Appropriate vegetable oils:

- Palm Oil; high oleic oils (HO Rapeseed, Sunflower, Soybean, Safflower, Camelina,….)

OXIDATIVE CLEAVAGE (OZONE O_3/H_2O_2) PRODUCTS

Major application:

- Azelaic (DC9) and Brassylic (DC13) acids ➔ Diacids, lubricants, plasticizers, monomers; flavor and Fragrances.
- Pelargonic acid (C9): Herbicide

Process: Ozonolysis or H_2O_2 cleavage

- Fatty acid + O3 ➔ Diacid + Monoacid (e.g;: oleic ➔ Azelaic (DC9) + Pelargonic)
- Fatty acid / Fatty ester / Fatty Nitrile + H2O2 ➔ Diacid/nitrile-acid + monoacid
- Reductive Ozonolysis ➔ Aldehyde production (Fragrances)

Technical requirements:

- Chain length selectivity ➔ affects polymer crystallinity
- Extremely low monofunctional content ➔ affects chain length

What does it mean in terms of appropriate fatty acid

- MonoUnsaturated Fatty Acid (MUFA): Oleic acid (C18:1);
- Gondoic acid (C20:1); Erucic acid (C22:1)

Appropriate vegetable oils:

- HO sunflower, HO safflower, HO Camelina, Crambe, HEAR, … HO Cardoon… Beef tallow, animal fats.

C18:1 AND C18:2 OILS

- C18:1,
- Rapeseed, Palm, High oleic sunflower, HO Safflower

- C18:2
- Sunflower, Safflower, Cardoon

C18:3 AND C22:1 OILS

- C22:1
- Crambe; High Erucic Rapeseed

- C18:3
- Linseed, Camelina, Soybean

HYDROXY FATTY ACIDS AND MEDIUM CHAIN OIL

- C18:1, OH – C20:1, OH
- Castor, Lesquerella

- C8, C10, C12
- Coconut, Palm Kernel

THANKS FOR YOUR ATTENTION

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