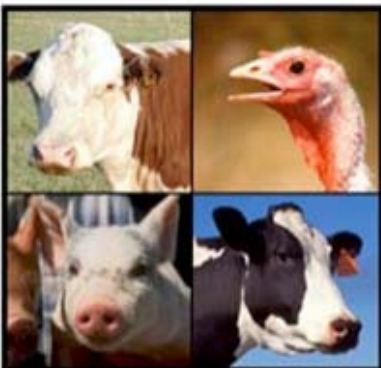
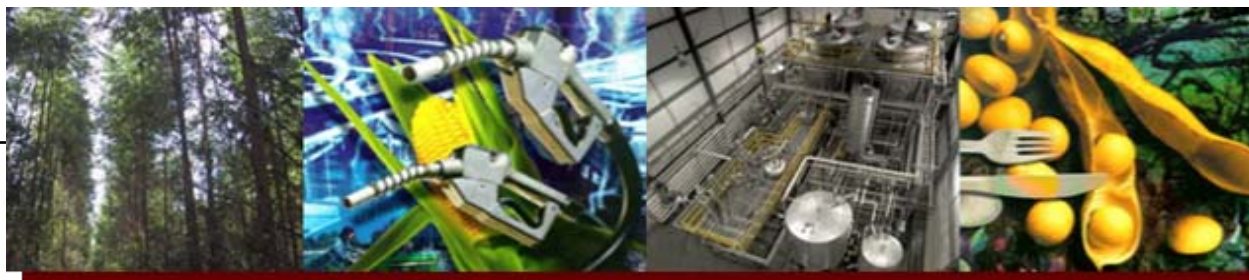




Overview: BioFuel Co-Products



Presented to:

1st Annual Kermit and Glenna Garske Seminar

Lake Region State College

Devils Lake, N.D.

January 10, 2008

Linda A. Benjamin, PhD

FDA, Center for Veterinary Medicine

Overview

- BioFuel Initiative

- BioFuel Co-products
 - Grain Ethanol
 - Biodiesel
 - Cellulosic Ethanol



Ready or Not.....

The Energy Policy Act of 2005 (H.R.6)

National renewable fuel standard (RFS) that doubles use of ethanol and biodiesel to 7.5 billion gallons a year in 2012. By 2013, the RFS must include a minimum of 250 million gallons a year of cellulose derived ethanol.

2006 BioFuel Initiative (BFI)

2030 Goal: Replace 30% current petroleum production with biofuel (*14 million barrels per day*)

4.2 million barrels biofuel per day = 62,471 million gallons per year

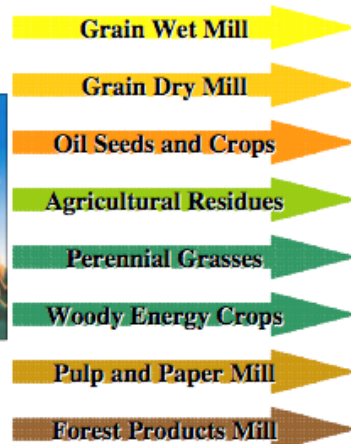
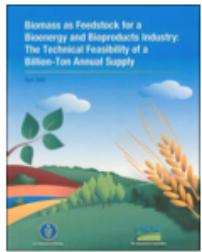
The Energy Independence and Security Act of 2007

RFS requiring fuel producers to use at least 36 billion gallons of biofuel in 2022. Corn-based ethanol rising from 6 billion gallons a year today to 36 billion gallons a year by 2022. After 2015, 21 billion gallons must be cellulose derived ethanol.

Biofuel is any fuel that is derived from biomass

- Biologically produced alcohols (ethanol, methanol, butanol, etc.)
- Biologically produced oils (biodiesel)
- Biologically produced gases (methane, syngas)
- Solid biofuels (wood, charcoal and dried dung)

Biomass Production Potential



Pathway	Resource Available (Million Dry Tons/Year)	% of Total Resources Available	Pathway Potential Fuel Production (mgj)	Pathway % of Total Potential Fuel Production	Co-Products
Wet Mill	7	1.03%	853	1.37%	Corn Fiber Corn Gluten Feed
Dry Mill	101	14.84%	12,254	19.62%	DDGS
Oil Seed Mill	7	0.97%	766	1.23%	Glycerin
Agricultural Residues Processing	269	39.54%	24,174	38.70%	Lignin
Perennial Crops Processing	164	24.16%	14,769	23.64%	Lignin
Pulp and Paper					
* Mills	0	0.00%	0	0.00%	Black Liquor Wood Residue
* Repurposing	0	0.00%	0	0.00%	
Forest Products					
* Mills	9	1.30%	610	0.98%	
* Processing Residues	123	18.17%	9,045	14.48%	Wood Residue
TOTAL	679	100.00%	62,471	100.00%	

* 62,471 million gallons per year = 4.2 million barrels per day

*Biomass as Feedstock for a Bioenergy and Bioproducts Industry
The Technical Feasibility of a Billion-Ton Annual Supply (April '05)*
http://feedstockreview.ornl.gov/pdf/billion_ton_vision

Overview

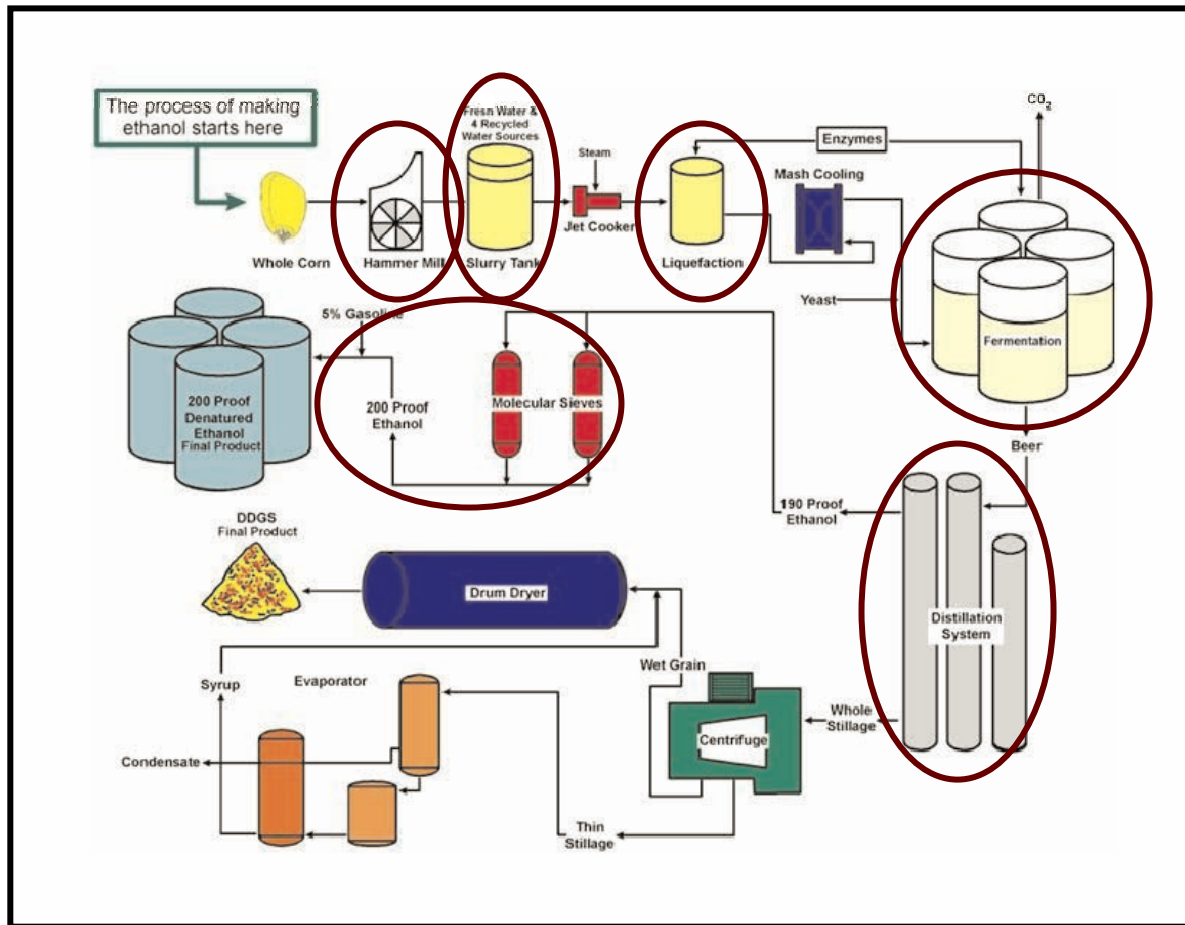
- BioFuel Initiative
- Ethanol Production Co-Product
- Biodiesel Production Co-Product

*The Center for Veterinary Medicine fosters public and animal health by approving **safe** and **effective** products for animals*

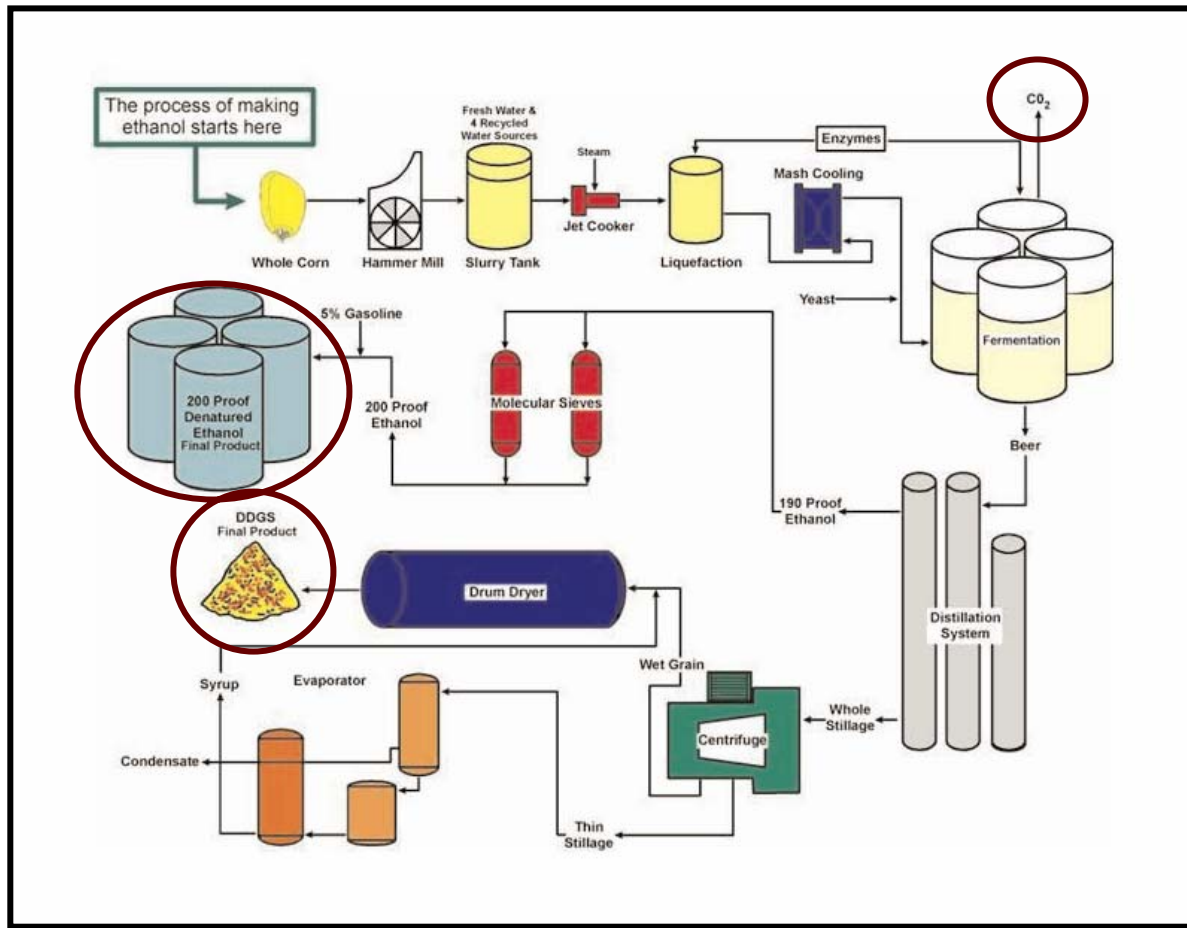
Ethanol Plant



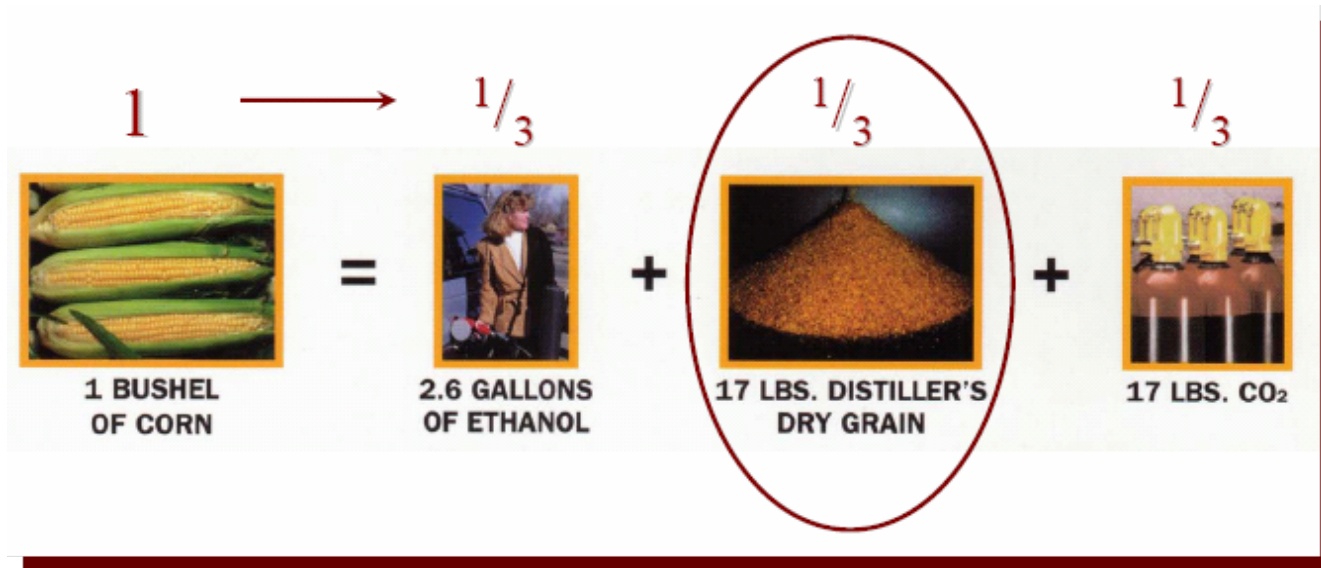
Dry Grind (Milling): Process



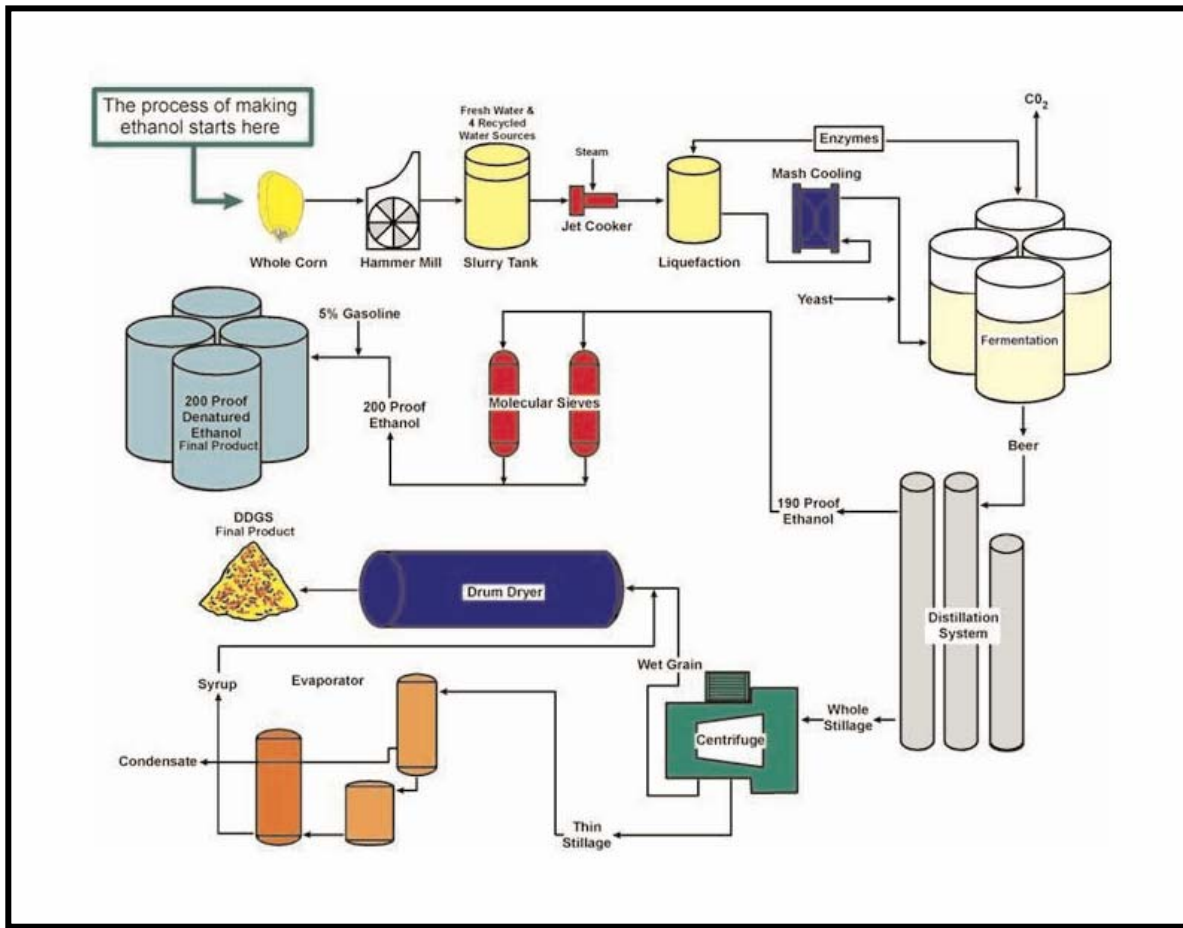
Dry Grind (Milling): Products



Ethanol Production



Dry Grind (Milling)

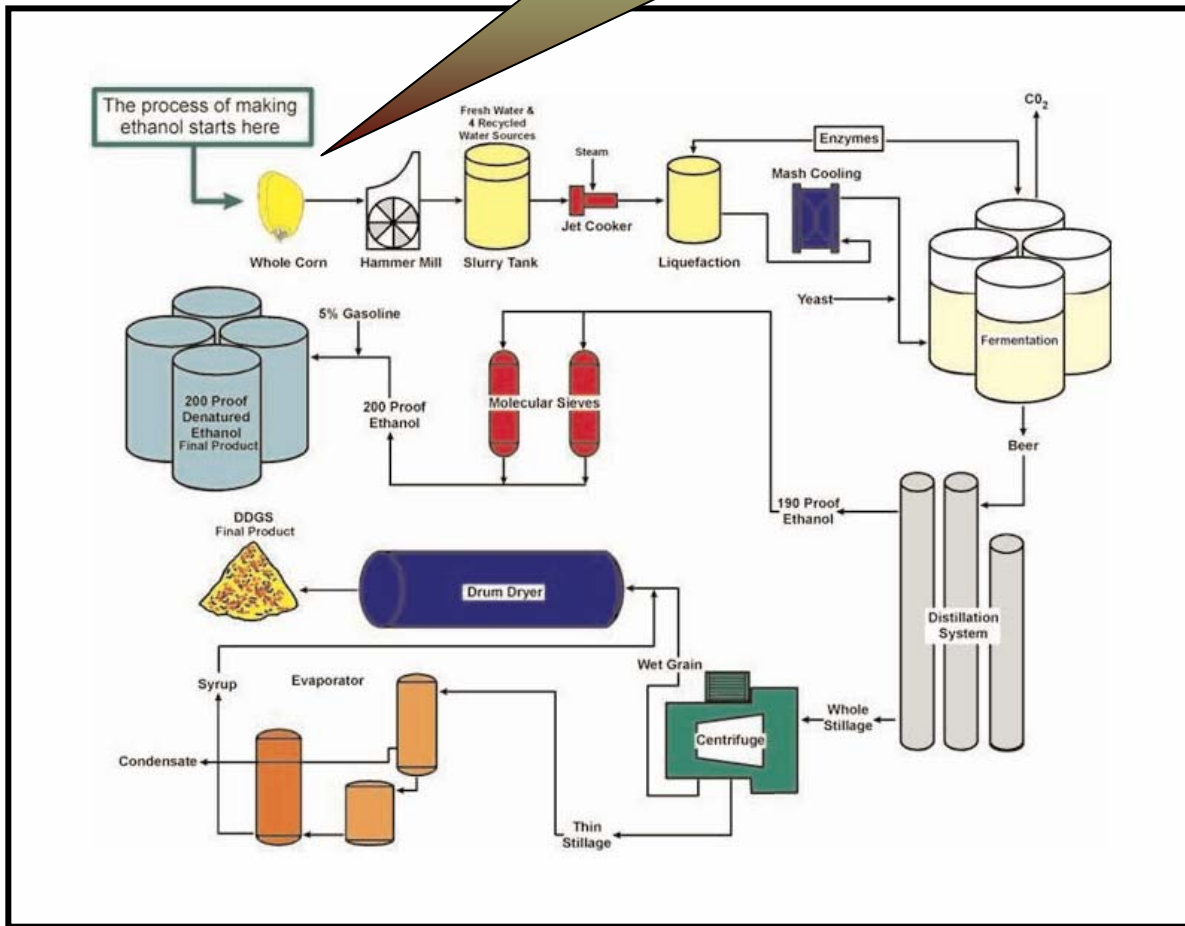


Current Activities

1. Grains
2. Processing Aids
3. Process Modification

Grains

Grain Quality, Next Generation Grains, Flexible Feedstocks

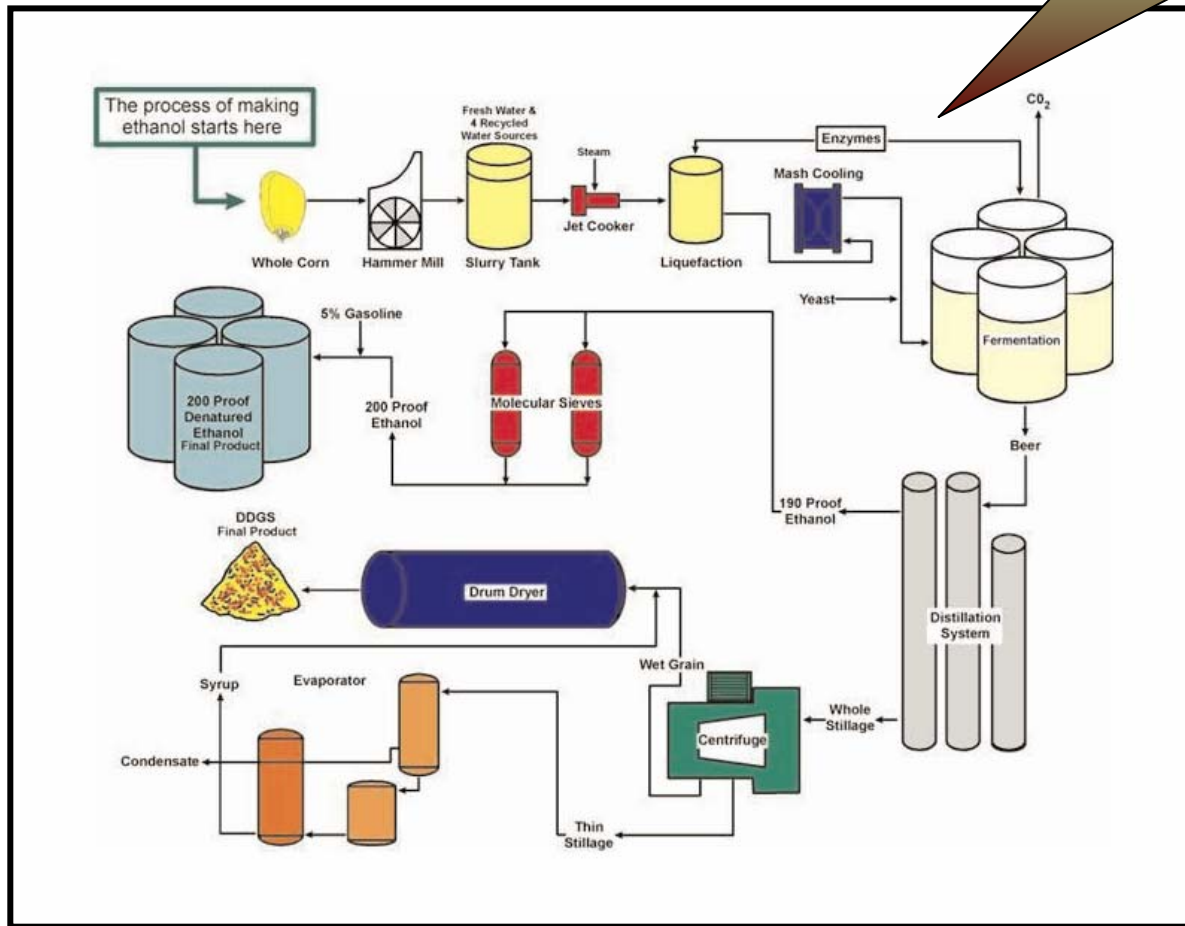


Concerns

1. Quality:
Mycotoxins,
Pesticides,
Heavy Metals,
Dioxins, etc.
2. Next Generation:
GMO Grains

Processing Aids

Enzymes, Yeasts,
pH adjusters,
Antifoulants, Defoamers,
Antibiotics, etc.



Concerns

1. Using ingredients not approved for use in animal feed
2. Increase in sulfur and salt levels in DDG
3. Antibiotic residues

Lactrol®

- Smith Kline Beecham → PhibroChem
- Virginiamycin with lactose; Lactose replaced with dextrose ('94)
- Antimicrobial - reduction of bacterial contamination during alcohol fermentation
 - Added during fermentation phase
 - Addition rates 2-6 ppm
 - Residue levels 0.2-0.5 ppm
- Safety assessment based on incorporation of 20% Distillers Grains

Virginiamycin*

1994

- Chickens (2-20 g/ton)
- Turkey (10-20 g/ton)
- Swine (5-100 g/ton)

2007

- Broilers¹ (5-20 g/ton)
- Turkey (10-20 g/ton)
- Swine² (5-100 g/ton)
- Cattle³ (11-22.5 g/ton)

* 21 CFR 558.635

¹ *Not for use in layers*

² *Not for use in breeding swine over 120 lbs*

³ *Not for use in breeding cattle*

Virginiamycin* Distillers Grains

1994

- Chickens (2-20 g/ton)
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2007

- Broilers¹ (5-20 g/ton)
- Turkey (10-20 g/ton)
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- Cattle³ (11-22.5 g/ton)

Traditional Usage

- Beef Cattle
- Dairy Cattle

Expanded Usage

- Broilers
- Turkeys
- Laying Hens
- Swine

* 21 CFR 558.635

¹ *Not for use in layers*

² *Not for use in breeding swine over 120 lbs*

³ *Not for use in breeding cattle*

Unknowns.....

- Use of other antibiotics
 - *May degrade to toxic metabolites*
 - *Not approved for use in all species*
 - *Not approved for use in feed*
 - *May have negative interaction with other antibiotics*

- Antibiotic resistance in non-targeted microbes

- May function as growth promoters

- Market demands

Sulfur

- '84 NRC max tolerable level - 0.4% ration
- Finding 0.6 to 1.3% sulfur (as is) in DDG
 - Some states have had unofficial complaints about feed refusal by cattle fed DDG; Finding sulfur levels of 0.77% as is in DDG.
- Regional Concerns
 - Some states are requiring firms to guarantee sulfur (max) levels in distiller feed products.

Salt

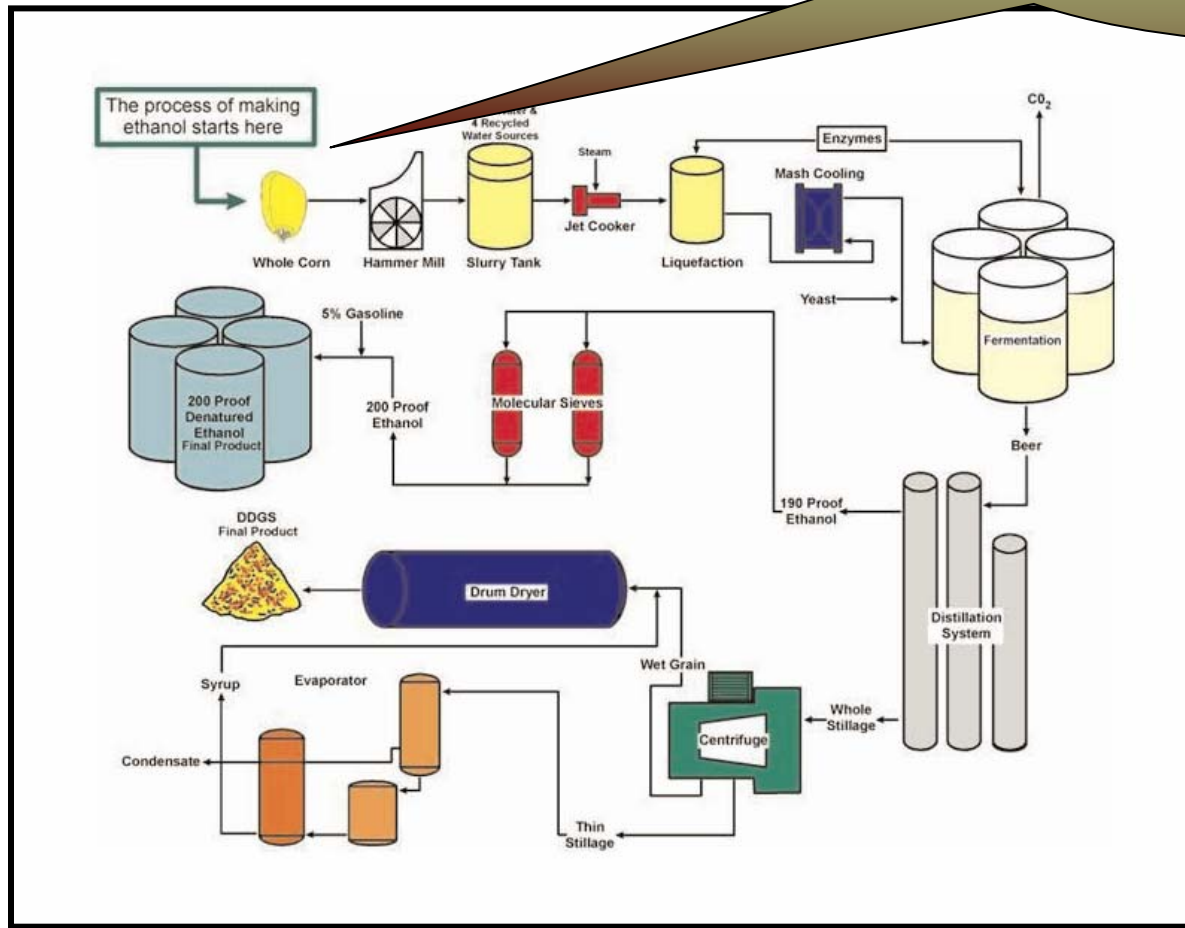
- '84 NRC requirements for poultry
 - 0.15% Na
 - 0.12% to 0.17% Cl

- Finding 0.4 to 1.0% salt levels in DDG

- Regional Concern
 - States would like to see a guarantee
 - Market driven

Process Changes

Bio-refinery Process, Renessen Process, Hydromilling Process, Quick-Germ/Quick-Fiber Process



Concerns

1. Consistency
2. Nutritional Composition

Corn Composition



Weight and composition of component parts of dent corn from seven midwest hybrids (%dwb)

	whole corn	germ	bran / tip cap	endo sperm
whole kernel	100	6.1	11.1	82.9
starch	73.4	8.3	7.0	87.6
protein	9.1	18.4	4.5	8.0
oil	4.4	33.2	1.1	0.8
ash	1.4	10.5	0.9	0.3
sugars	1.9	10.8	0.5	0.6
unaccounted for	9.8	8.8	85.6	2.7

The corn kernel contains three basic fractions:

• **endosperm** - high in starch and best source for ethanol production.

• **germ** - high in oil, protein and fiber and best fraction for edible oil production.

• **pericarp / tip cap** - best source for dietary food fiber, co-generation fuel or cellulosic ethanol production

Solaris Products

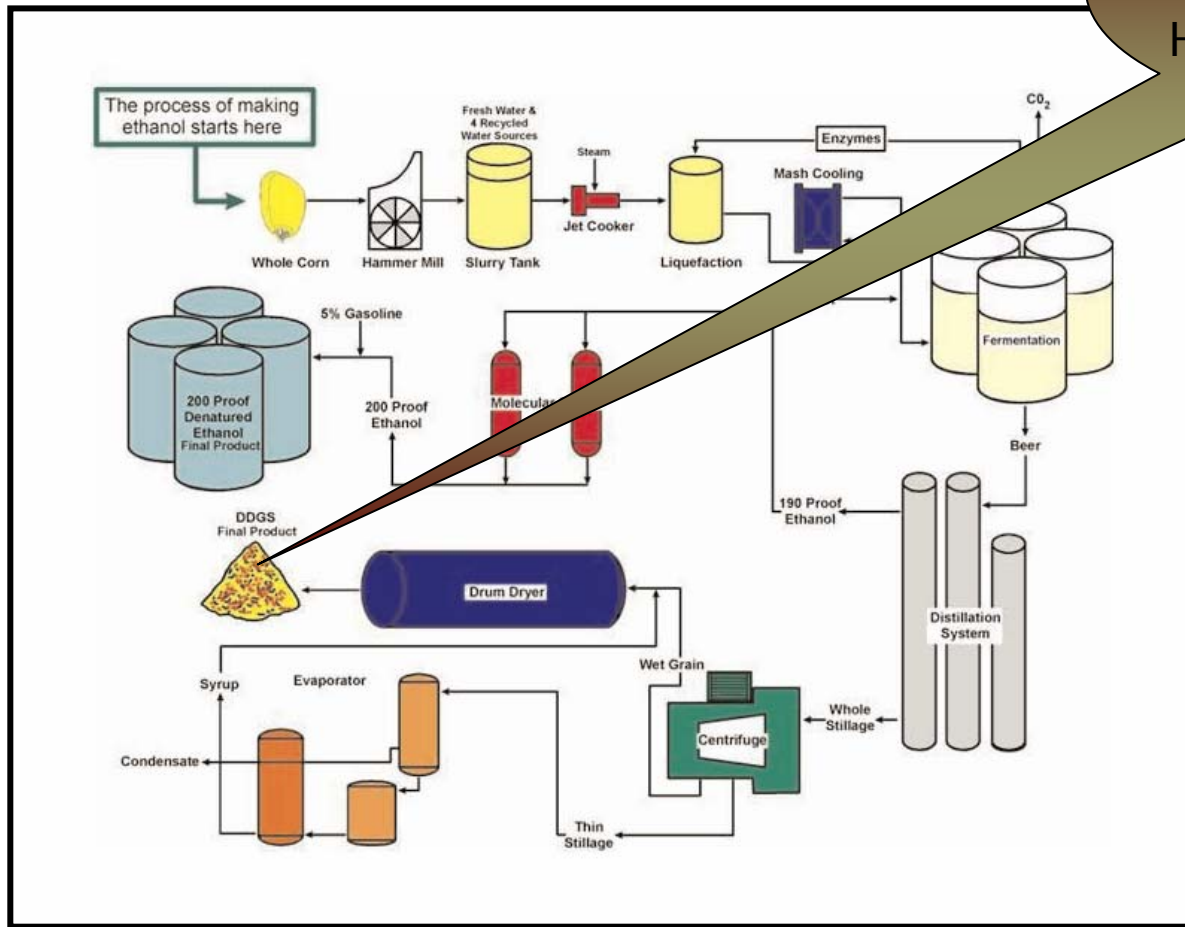
	Neutra-Germ	Neutra-Fiber	ProBran	Glutenol	Energia	Common DDGS
Dry matter, %	97.0	90.0	90.0	90.0	90.0	90.0
Crude protein, %	17.5	6.8	9.5	45.0	31.5	27.4
Fat, %	45.0	1.5	2.0	3.3	2.5	10.8
Fiber, %	6.0	17.1	16.6	3.8	8.2	8.3
Starch, %	8.1	6.8	6.0	1.5	3.8	nr
Ash, %	1.9	0.6	1.0	4.0	2.5	4.4

New Processes

- Bio-refinery Process (Poet)
 - Fractionate the bran, germ, and endosperm
- Renessen® Process (Cargill, Monsanto)
 - Fractionation technology with corn oil extraction step
- Solaris Hydromilling™ Process
 - Fractionation technology with germ and fiber (pericarp) are removed. Plant feedstock is high starch fraction (endosperm). DDG concentrated in protein
- Quick-Germ/Quick-Fiber Process
- Elutriation
 - Post fermentation process, concentration of non-fiber nutrients (de-branning)

DDG - a plants filter aid?

Water quality,
Fermenter cleanout,
Heat exchanger cleanout



Concerns

1. Water quality
Water source,
Recycled water,
Etc.
2. Unknown
containments

Distiller Co-product Questions....

- Feedstock
 - Grain Quality: Mycotoxins, Pesticides, Heavy Metals, Dioxins, etc.
 - GMO Grains
- Processing Aids/ Post Processing Aids
 - Using ingredients not approved for use in animal feed
 - Increase in sulfur and salt levels in co-products
 - Antibiotic residues
- Misc.
 - Water Usage: Quality, Source, Re-cycling
 - Filtering plant effluent stream





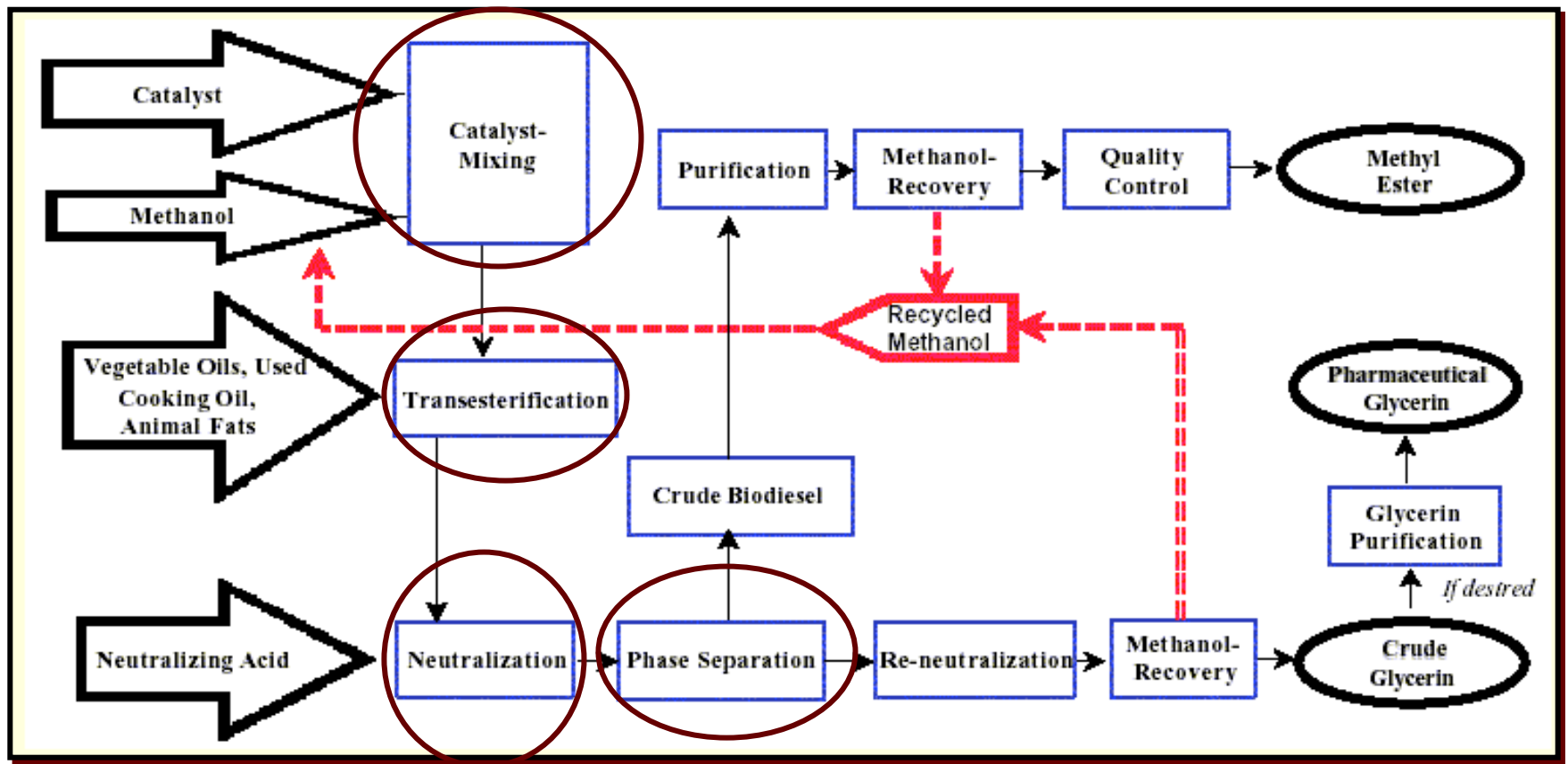
Overview

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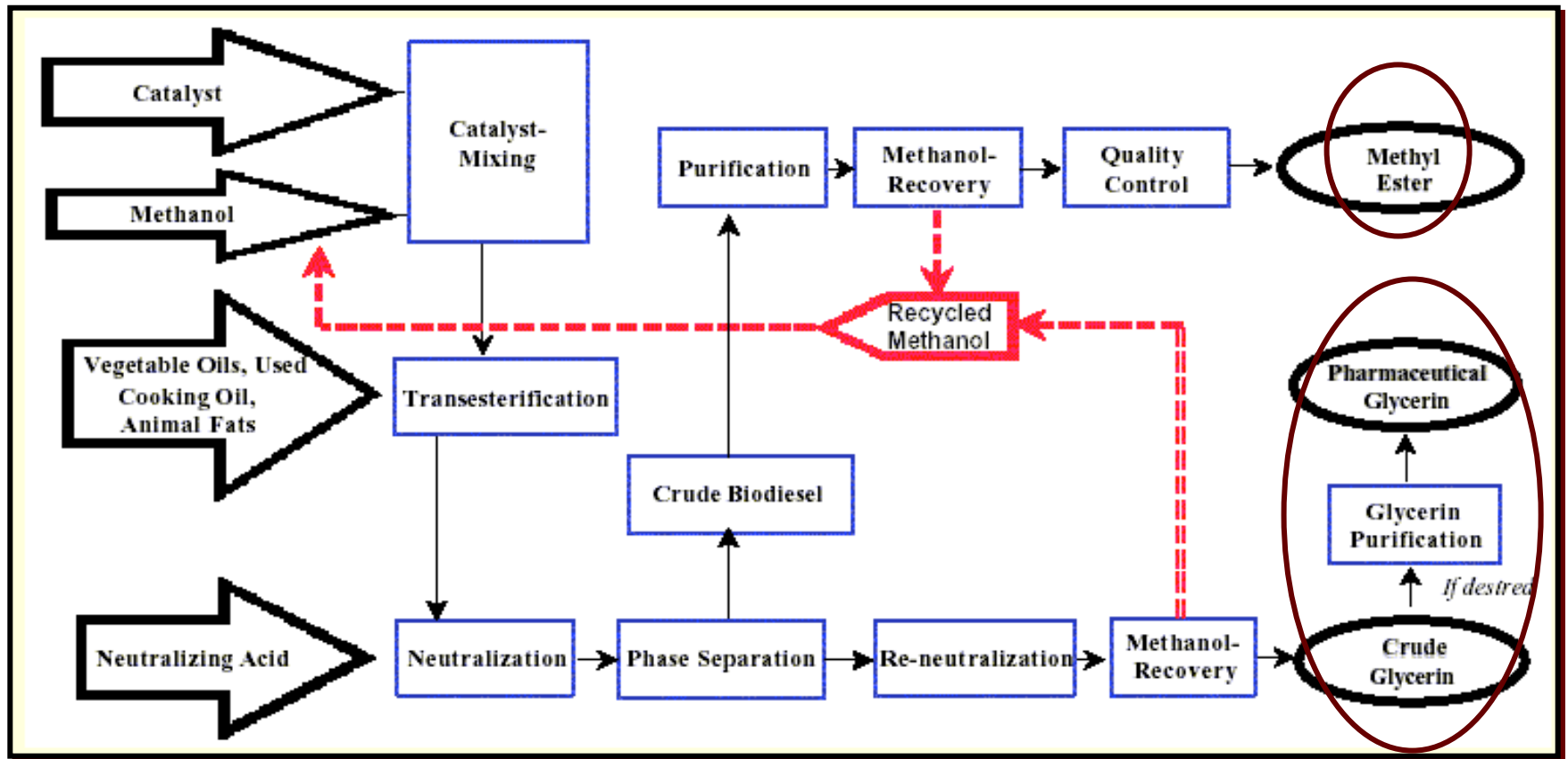
Biodiesel Plants



Biodiesel: Process



Biodiesel: Products



Biodiesel

Glycerin

PART 582: SUBSTANCES GENERALLY RECOGNIZED AS SAFE

Subpart B: General Purpose Food Additive

Sec. 582.1320: Glycerin.

- (a) *Product.* Glycerin.
- (b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

Glycerin From Different Purification Stages

Specification	Low Grade	Medium Grade	High Grade
Glycerin Assay	63%	85%	98%
Moisture Content	27%	1%	2%
Methanol	27% 27,000 ppm	0.04% 400 ppm	N/A



Can Glycerin From a Biodiesel Plant Be Used in Animal Feed?

Specification	USP Grade	FFC Grade
Assay	99.0% - 101.0%	95.0% - 100.5%
Moisture Content	5.0% max	None given
Color (compared to standard)	Pass	Pass
Specific Gravity	1.249 (min)	1.249 (min)
FA and Esters	None given	0.1% max
Chlorinated products, as Cl	0.001% (max)	0.003% (max)
Heavy Metals, as Pb	5 µg/g (max)	5 mg/kg (max)
Sulfate		None given
Readily Carbonizable Substances	None given	Pass
Residue on Ignition	0.01% (max)	0.01% (max)
Methanol	None given	Non given

Methanol levels

- 21 CFR 573.640 – 150 ppm
 - Methyl esters of higher fatty acids; free methyl alcohol not to exceed 150 ppm

- Initial Safety Assessment – 200 ppm
 - Primate blindness at 0.1 mL MeOH/kg bw, 100 fold safety factor
 - Glycerin compromises 10% complete feed, primate consumes 4% of its bw in feed per day

- Literature – 5 wt% in diet
 - Effect of methanol on methanogenesis and fermentation in the rumen simulation technique, J. of Animal Physiology and Animal Nutrition, Vol. 82, Issue 4, Dec. 1999

Glycerin Specifications

Specification	USP Grade	FFC Grade	Going into Feed
Assay	99.0% - 101.0%	95.0% - 100.5%	
Moisture Content	5.0% max	None given	
Color (compared to standard)	Pass	Pass	
Specific Gravity	1.249 (min)	1.249 (min)	
FA and Esters	None given	0.1% max	
Chlorinated products, as Cl	0.001% (max)	0.003% (max)	45,000 ppm
Heavy Metals, as Pb	5 µg/g (max)	5 mg/kg (max)	
Sulfate		None given	16,500 ppm
Readily Carbonizable Substances	None given	Pass	
Residue on Ignition	0.01% (max)	0.01% (max)	
Methanol	None given	Non given	5 to 20,000 ppm

Glycerin Questions.....



- Feedstock - Vegetable oil, fat, tallow, etc.
 - Quality
- Manufacturing Processing
 - Processing Aids - Catalyst/neutralizer choice - up to 6-8% inorganic salts
 - Purification - Methanol recovery
- Misc.
 - Feed handling issues



Questions



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