

US EPA ARCHIVE DOCUMENT

Emerging Issues About Biofuels Under EPA's Emergency Response Program

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Presentation Overview

- Legislative Initiatives
 - Relevant Biofuel Laws and Mandates
- Biofuel Generation, Storage, and Distribution
 - Biofuel Supply Chain
 - Conversions Technologies
 - Biofuel Integration into *Existing/New* Storage and Distribution Infrastructure
 - Pipelines, Storage tanks, Transloading, Terminals
- Emergency Response and Regulatory Management
 - Biofuels and Regulatory Programs

Legislative Initiatives

➤ **Energy Security Act (1980)**

- Established the Office of Alcohol Fuels in DOE
- Established the Synthetic Fuels Corporation
 - Eliminated by the Consolidated Omnibus Budget Reconciliation Act (1985)

➤ **Energy Policy Act of 1992**

- Light duty alternative fuel vehicles in certain Federal Fleets
- Federal support for renewable energy technologies

Legislative Initiative (continued)

- **Energy Policy Act of 2005** (P.L. 109-58)
 - Biofuel mandates increase from 4 bgy (2006) to 7.5 bgy (2012)
 - Requires EPA to promulgate regulations implementing a renewable fuel program. (§ 1501)
 - Specifies the total volume of renewable fuel used in gasoline sold
 - Specifies the total volume increases over time
 - **Renewable Fuel Standard (RFS 1)**
 - Provides **enhanced tax incentives** for biofuel usage.
 - Energy Policy Tax Incentives (Title XIII)
 - **Renewable diesel** from “thermal depolymerization process”

Legislative Initiatives (continued)

- **Energy Independence & Security Act (EISA) (2007)**
 - Requires EPA to develop a new RFS. (§ 202)
 - Expand biofuels to 36 billion gallons by 2022
 - Lifecycle GHG assessments of different fuel types and blends compared to petroleum fuel
 - Ethanol pipeline feasibility study (§ 243)
 - Biofuels distribution and advanced biofuels infrastructure (§ 248)
 - R&D on existing transportation fuel distribution infrastructure and new alternative distribution infrastructure.

Legislative Initiatives (continued)

➤ Energy Independence & Security Act (EISA) (2007)

➤ Focus on the physical/chemical properties of biofuels and efforts to prevent or mitigate against adverse impacts of those properties in the areas:

- ***corrosion*** of metal, plastic, rubber, cork, fiberglass, glues, or any other material used in ***pipes and storage tanks***;
- ***dissolving of storage tank sediments***;
- clogging of filters;
- ***contamination from water*** or other adulterants or pollutants;
- poor flow properties related to low temperatures;
- ***oxidative and thermal instability*** in long-term storage and uses;
- ***microbial contamination***;
- problems associated with electrical conductivity

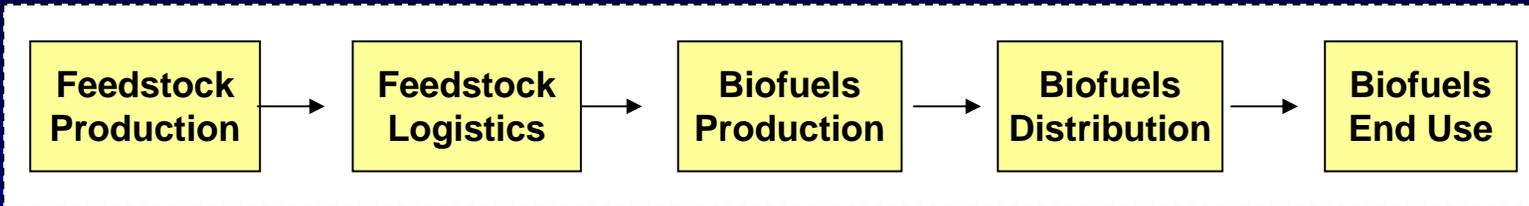
Legislative Initiatives (continued)

- **Energy Improvement and Extension Act (EIEA) (2008)**
 - Division A - Emergency Economic Stabilization Act (2008)
 - Division B – EIEA (*P.L. 110-343*)
 - **Extends certain tax credits** to December 31, 2010
 - **Broadens definitions for new conversion processes to qualify eligibility for tax credits**
 - Expanded renewable diesel tax credits by removing the term “thermal depolymerization process”
 - Replaced term “diesel fuel” with “liquid fuel”
 - Aviation fuels from renewable materials
 - Places limits on **“Splash and Dash” (§ 203)**
 - **“Splash and Dash”** - 100% biodiesel shipped to U.S., 0.1% petroleum diesel added (splash), and shipped to another country (dash), thus qualifying for a tax credit.

Biofuels Regulatory Mandates

- Renewable Fuel Standard (RFS) 1 & 2
 - 40 CFR part 80 – Regulation of Fuels and Fuel Additives
 - RFS - 1 (EPA Act 2005)
 - Federal Register on May 1, 2007 (72 FR 23900)
 - Assessed first order impacts including emissions, air quality, and GHG impacts of RFS standards
 - RFS - 2 (EISA) – Under Development
 - Expand use of renewable fuels to 36 billion gallons per year (bgy) by 2022
 - Ethanol production from corn starch is capped at 15 bgy
 - Cellulosic Biofuel (renewable fuel from any cellulose, hemicellulose, lignin)
 - 0.5 billion gallons by 2012
 - 3 billion gallons by 2015
 - 16 billion gallons by 2022
 - Advanced Biofuels (biomass-based diesel, other biofuels)

Biofuels Supply Chain



Ag Crops
 Ag Residues
 Energy Crops
 Forest Residues
 Wastes
 Algae



Harvesting & Collecting
 Storage
 Pre-Processing
 Transportation



Fuel types
Biochemical Conversion
Thermochemical Conversion
Biological Conversion
Chemical Conversion



Distribution by barge, truck, rail, pipeline
Storage in tanks
Dispensing

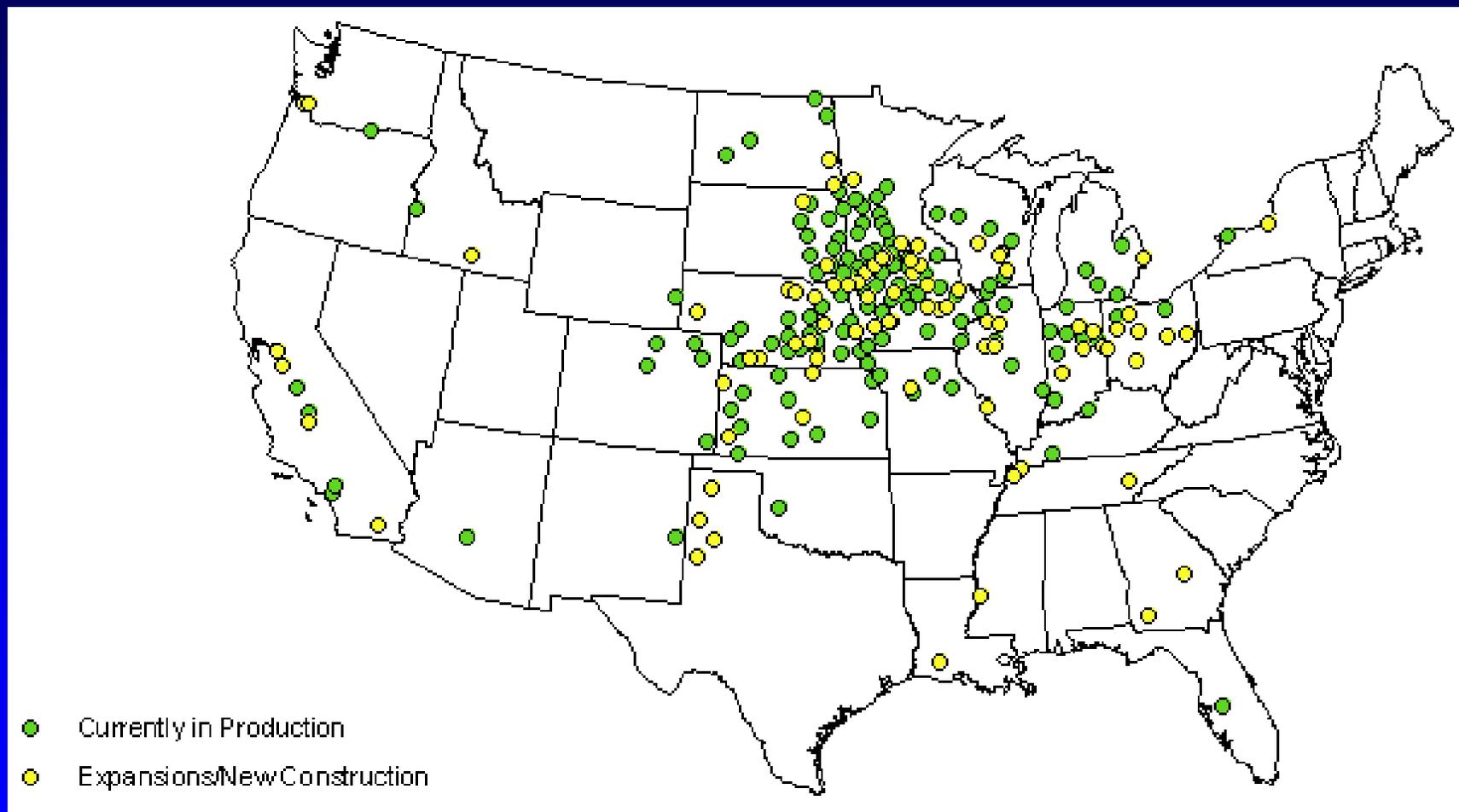


Transportation fuels in light & heavy duty vehicles & trucks, Off-Road vehicles, Locomotives, Flight technologies, Boats/Ships
 Power & Generators
 Feedstocks for Manufacturing

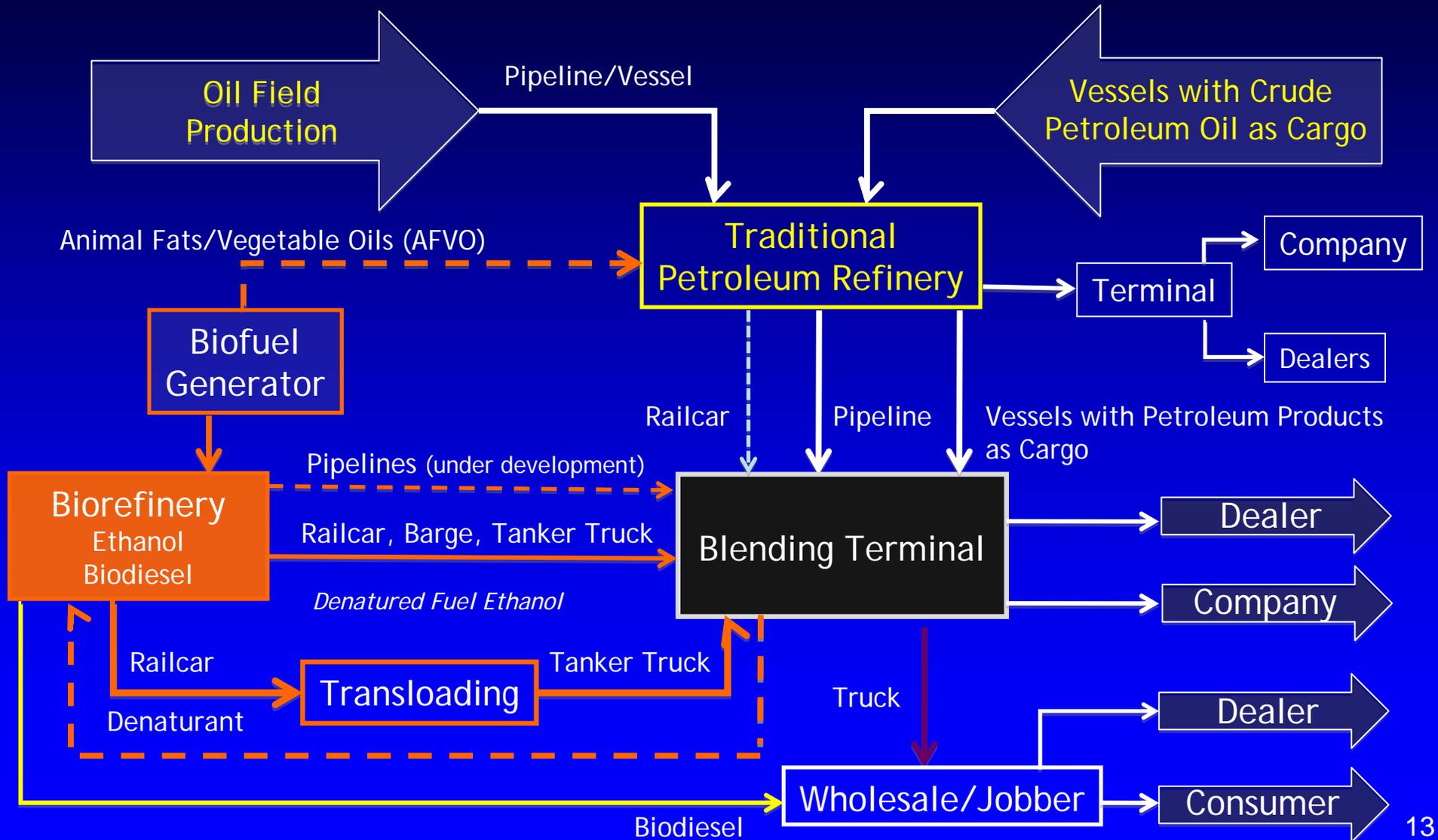
Feedstocks, Conversion Processes, and Fuel Types

Feedstock	Conversion Technology	Products and Uses
<p>Agricultural Crops</p> <p>Agricultural Residues</p> <p>Animal Residues</p> <p>Food Processing Waste</p> <p>Woody Biomass</p> <p>MSW and Construction and Demolition (C&D) Wastes</p>	<p>Thermo-chemical:</p> <ul style="list-style-type: none"> - Pyrolysis - <i>Hydrothermal Depolymerization</i> - Gasification - Combustion - Fuel Synthesis <p>Biochemical:</p> <ul style="list-style-type: none"> - Fermentation - Acid Hydrolysis - Pretreatment & Enzymatic Hydrolysis - Anaerobic Digestion <p>Chemical:</p> <ul style="list-style-type: none"> - Transesterification 	<p>Fuel Types:</p> <ul style="list-style-type: none"> - Ethanol - Biodiesel - Renewable Diesel - <i>Green Diesel</i> - <i>FT Diesel & Gasoline</i> - Higher Alcohols - Dimethyl Ether - Synthesis Gas, Biogases, & H₂ - Hydrogen <p>Other Products:</p> <ul style="list-style-type: none"> - CHP (steam & electricity) - Chemical Feedstock

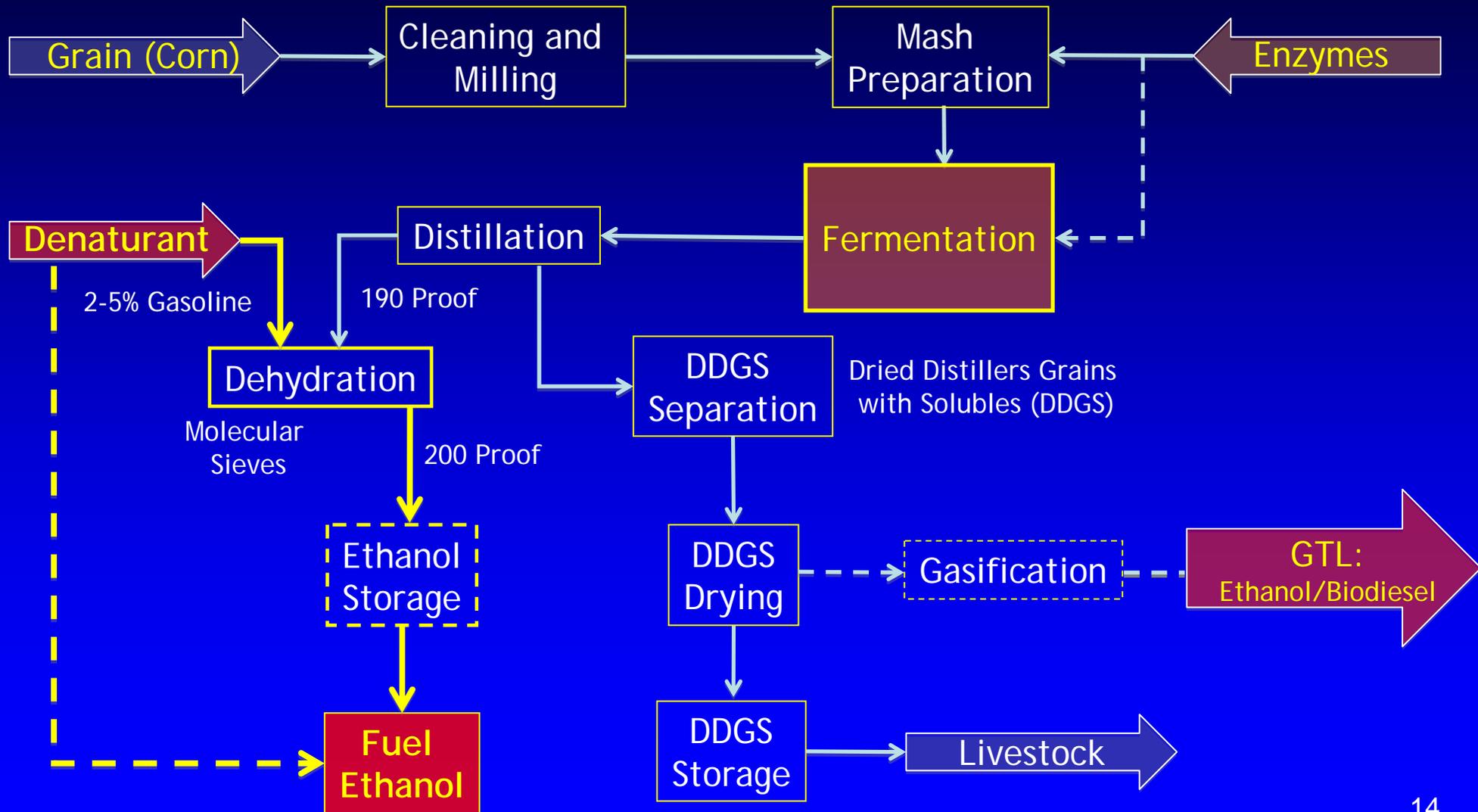
Recent Ethanol Plant Locations



Biofuels Integration Roadmap



Typical Ethanol Dry Mill Process



Denaturant (Ethanol) – Why & How Much

- Alcohol and Tobacco Tax and Trade Bureau (TTB)
 - Render alcohol unfit for human consumption
 - Alcohol for fuel use is regulated under two categories in ATF regulations
 - Fuel alcohol produced at an alcohol fuel plant (AFP)
 - Completely denatured alcohol (CDA) formula no. 20 at a distilled spirits plant (DSP)
 - At least 2 gallons of denaturant to every 100 gallons of fuel ethanol
 - Natural Gasoline
 - Conventional Unleaded Gasoline
 - Straight Run Gasoline
 - Naphtha
 - Kerosene

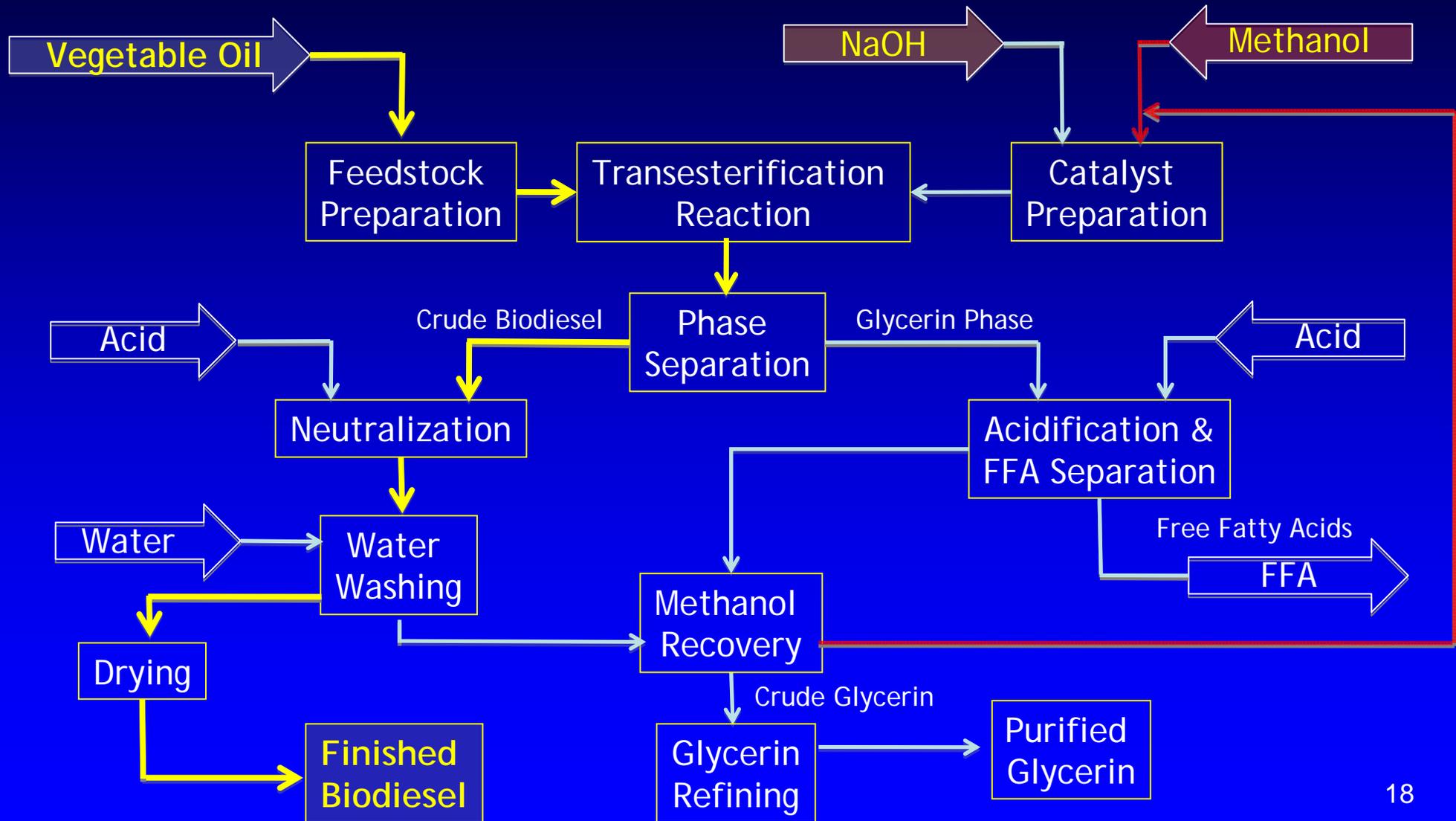
Denaturant (Ethanol) – Why & How Much

- Ethanol producers traditionally add ~ 4.76 % (volume)
- ASTM Standards for fuel ethanol blends
 - ASTM D4806 - 08a **Standard Specification for Denatured Fuel Ethanol for Blending** with Gasoline for Use as Automotive Spark-Ignition Engine Fuel
- Food, Conservation, and Energy Act of 2008
 - Calculation of volume of alcohol for fuel (§ 15332)
 - Encourages **2% denaturant** use to receive applicable tax credit
 - Internal Revenue Bulletin (IRB) 2009-3 (Notice 2009-6) (page 311)

Ethanol Plant Process Chemicals

- **Ethanol production process (pH adjustment, nutrients)**
 - Sulfuric Acid - Corrosive
 - Sodium Hydroxide (Caustic Soda) – Corrosive
 - Ammonia Source - Anhydrous, Hydrous - Corrosive
- **Cleaning chemicals keep fermentation clean**
 - Chlorine-based Solution - Corrosive
 - Caustic Soda - Corrosive
- **General water treatment chemicals**
 - Chlorine- or Bromine-based Solution - Corrosive
 - Ammonia-related Solution - Some Hazards
 - Surfactants - Some hazards, typically mild

Typical Biodiesel (e.g., FAME) Generation



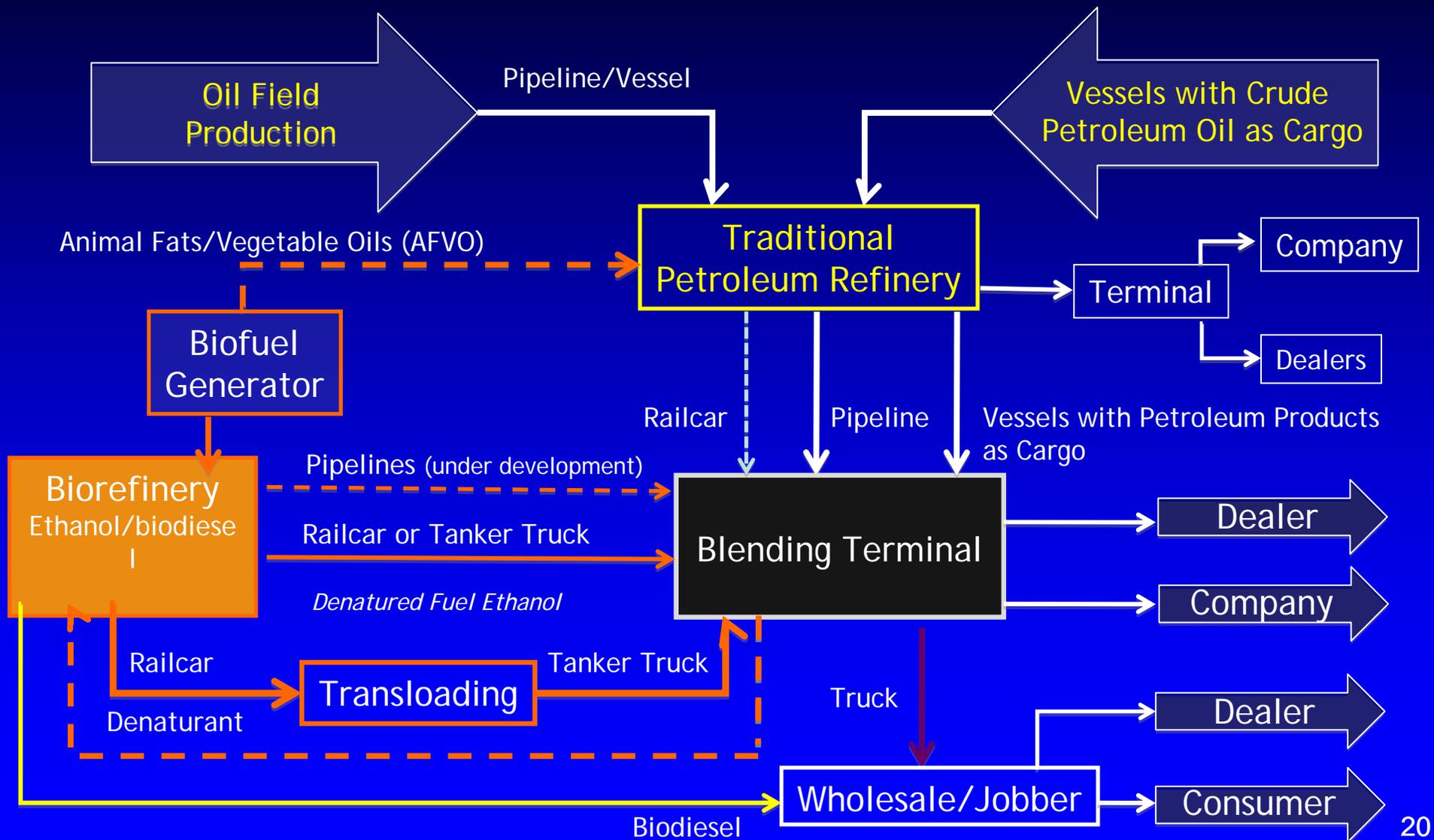
Biodiesel Plant Process Chemicals

Biodiesel production process

- **Methanol**
 - Volatile; Flammable (Class 3)
- **Sodium Hydroxide (Caustic Soda)**
 - Corrosive; Catalyst
- **Potassium Hydroxide**
 - Corrosive; Catalyst
- **Sodium Methylate**
 - Catalyst
- **Hexane**
 - Volatile; Flammable (Class 3)
- **Glycerol (glycerine)**



Biofuels Integration into Infrastructure



Biofuels Infrastructure

Infrastructure includes:

- Pipelines, rail lines/railcars, barges/waterways, tank trucks
- Terminals, Storage tanks, Blending facilities, Transfer hubs

Ethanol and biodiesel currently do not use many of the traditional petroleum products infrastructure (i.e., pipelines)

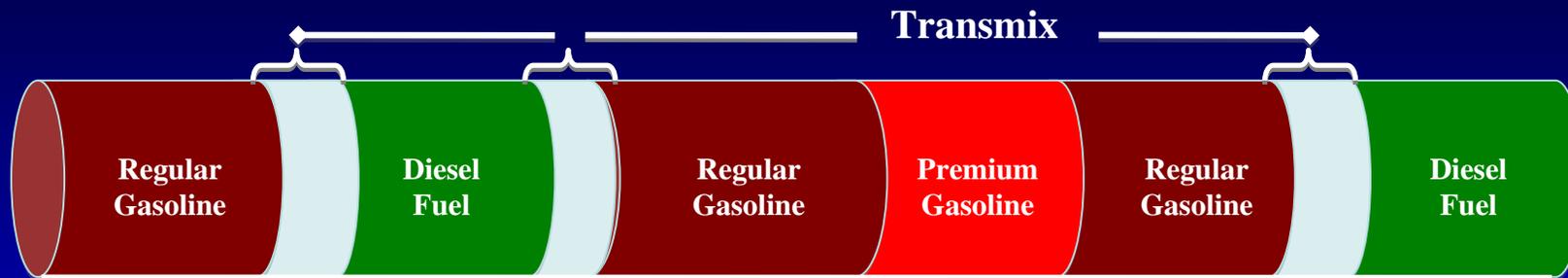
Ethanol and biodiesel infrastructure needs may be different

In 2005, rail: 60% of ethanol (approximately 2.9 billion gallons of ethanol), Tank trucks: 30%, and barges: 10%

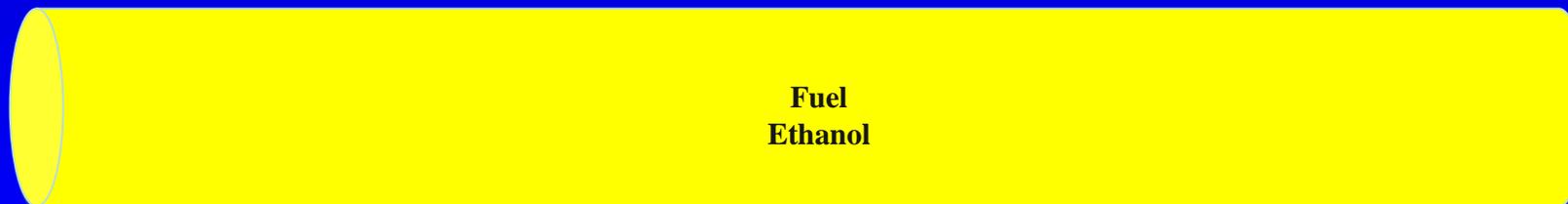


Transport of Biofuels Through Pipelines

Current Multi-Products Pipeline



Potential Future Options for Biofuel Pipelines – Multi-products & Dedicated



Storage Tank & Pipeline Issues – Denatured Fuel Ethanol

- Survey suggests:
 - Number of leaks have occurred in equipment handling fuel ethanol due to cracking of the carbon steel
 - Number of cases of cracking and leaks have been reported in various types of equipment
 - Includes storage tanks, piping and associated handling equipment in the distribution systems for fuel ethanol,
 - A concern for ethanol pipelines (similar grades of steel)
- Technical factors affecting storage and transportation of denatured fuel ethanol
 - **Moisture**
 - **Material compatibility**
- Ethanol can dissolve and carry impurities that are present inside storage tanks and multi-product pipeline systems

Storage Tank & Pipeline Issues - Ethanol

- Stress Corrosion Cracking (SCC) - SCC is the formation of brittle cracks in a material that occurs as a result of corrosion processes and stress
- Factors that may lead to ethanol SCC
 - Fuel ethanol meeting the ASTM D4806 guidelines
 - **Chloride** and methanol content
 - Appear to increase susceptibility, but are not essential for SCC to occur
 - **Dissolved oxygen** content
 - Galvanic contact with corroded steel
 - Plate steels (e.g., ASTM A36)

Storage Tank & Pipeline Issues - Ethanol

- Cracks are typically branched and intergranular (low chloride ethanol), occasionally transgranular (high chloride or methanol-containing ethanol)
- SCC has occurred in less than one year
- Historical data suggests SCC appears at distribution terminals
- Tank liners, selective post-weld heat treatment, and the coating of internal critical zones may help
- API Technical Report 939-D - **Stress Corrosion Cracking of Carbon Steel in Fuel Grade Ethanol: Review, Experience Survey, Field Monitoring, and Laboratory Testing, Second Edition**
- API Technical Report 939-E - **Identification, Repair, and Mitigation of Cracking of Steel Equipment in Fuel Ethanol Service, First Edition**

Biodiesel Storage and Distribution Issues

- Storage and Distribution Modes
 - Tanker Truck / Rail car / Pipeline / Barge
 - Some terminals do not have rail spurs
 - Some terminals do not have water access
 - Currently biodiesel blends are not in the pipeline system
 - Biodiesel systems are typically heated
 - Feedstock tanks and lines
 - Truck and rail off-loading system and lines
 - Loading rack lines, valves, and meters
 - Blend system for 2 - 4 % biodiesel blend may be different than system needed for >5% system

Transloading Biofuels

- Federal and local jurisdictional issues
- Typical individual railcar capacity
 - ~30,000 U.S. gallons
- Shipped in unit trains
 - Can be as high as 100 railcars
- Transferred from rail cars to tank trucks for delivery to blending terminals
- Transfer process equipment not necessary “fixed” in a single location



Relevant Emergency Response Issues

- ▶ Fires and spills involving ethanol and ethanol/gasoline blends pose some complex challenges for emergency responders
- ▶ Ethanol is a polar/water-miscible flammable liquid (one that mixes readily with water)
 - ▶ Degrades the effectiveness of fire fighting foams that are not alcohol resistant
- ▶ DOT Guide 127 - Flammable Liquids Polar/Water-miscible, 2004 Emergency Response Guidebook (ERG2004)



Relevant Emergency Response Issues

- Alcohol-Resistant – Aqueous Film Forming Foam (AR-AFFF)
 - Effective with ethanol blends from E10 through E95
 - E10 can be extinguished with AFFF and AR-AFFF but require higher application rates to prevent burn back
 - Passes a sprinkler application, which is typical of the fire suppression systems at many storage terminal loading racks
 - Creates a physical, polymer-membrane barrier between the foam blanket and fuel surface
 - Alcohol Resistant – Film Forming Fluoroproteins (AR-FFFP)
 - Burn back test

Ethanol/Gasoline blends and Placards

- DOT Federal Register notice (73 FR 4699)
 - Published on January 28, 2008

Ethanol/Gasoline Blend	Example of Shipping Name
Gasoline, with not more than 10% ethanol	Gasohol, UN1203 or Gasoline, UN1203
Gasoline/ethanol blends with more than 10% ethanol	Ethanol and Gasoline Mixture, UN3475
E85 (85% ethanol, 15% gasoline)	Ethanol and gasoline mixture, UN3475
Alcohol mixtures containing up to 5% gasoline E95 (95% ethanol, 5% gasoline)	Denatured alcohol, NA1987 Alcohols, n.o.s., UN1987

E100

Ethanol or Ethyl Alcohol, UN1170

Regulatory Implications

- Spill Prevention, Control, and Countermeasures
- Facility Response Plans
- Risk Management Plans
- Emergency Planning and Community Right to Know



Biodiesel Feedstock Spill

- Properties similar to petroleum
 - Light non-aqueous phase liquid (LNAPL).
- Harmful effects: coating of feathers, fur, and gills
 - Absence of odor and sheen results in reduced avoidance.
 - Reduces thermal insulation and buoyancy.
- May burn if ignited
- May clog water treatment plants (due to the polymerization property).

Effects of Biodiesel Feedstock Spills

- High BOD may cause oxygen depletion
 - Greater effect on DO than petroleum oils
- Unsaturated oils (liquids at cold temperatures) are subject to (abiotic) oxidation
 - Polymerization due to chemical oxidation and cross-linking
 - Rancid odors may develop rapidly
 - Unsaturated oils form gum balls and varnishes in presence of oxygen, which resist biodegradation
- Some saturated or unsaturated oils turn solid or semi-solid at cool temperatures, highly resistant to biodegradation
- May be toxic or form toxic products
 - Especially free fatty acids and chemical oxidation products.

SPCC Applicability

- 1975 Federal Register Notice
 - Addressed applicability of 40 CFR part 112 to non-petroleum oils
 - Re-affirmed that non-petroleum oils such as AFVOs are subject to oil spill reporting and other requirements under Section 311 of FWPCA
- 2002 Revised SPCC rule amendments
 - Includes new subparts outlining the requirements for various classes of oil (pursuant to EORRA)
- 2006 Revised SPCC rule amendments
- 2008 Revised SPCC rule amendments
 - Establishes an alternative integrity testing option for AFVOs that are regulated under FDA (21 CFR part 110) and meet certain criteria

Biofuels & Facility Response Plans

▶ EPA (OSWER) letter to the Renewable Fuels Association on FRP applicability (November 07, 2006).

- ▶ Ethanol denatured with oil (e.g., gasoline) is subject FRP

▶ Many existing and new biodiesel or ethanol plants may be subject to FRP requirements due to their storage capacity and potential for significant harm.

▶ A number of existing ethanol plants have a FRP

- ▶ Total oil storage capacity (e.g., largest tank) greater than 1 million gallons

▶ Biodiesel plants are likely to require an FRP given large oil storage capacity (AFVO feedstocks *and* finished products)

Biofuels & Hazardous Chemical Reporting

Section 311 & 312

Gasoline – 75,000 gallons

- At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)

Gasohol (90% gasoline and 10% ethanol) – 75,000 gallons

- At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)

Diesel – 100,000 gallons

- At a retail gas station, stored entirely underground, in compliance at all time in the previous calendar year with UST requirements)

All other Non-EHS hazardous chemicals – 10,000 lbs

- Alternative Fuels (Ethanol and Methanol mixtures; E85, E95, M95), aviation fuel, heating fuel, kerosene

Summary

- Recent energy legislation mandates biofuel usage.
 - Requires EPA to develop a new Renewable Fuel Standard.
 - Expand biofuels to **36 billion gallons by 2022.**
 - Lifecycle GHG assesement
- New generation, storage, and distribution infrastructure challenges
 - Integrating biofuels into traditional fuel supply chain
 - Infrastructure needs
- Fires and spills involving ethanol and ethanol/gasoline blends pose some complex challenges for emergency responders
- Current biofuels: Ethanol and biodiesel; **Future biofuels: ?**

Additional Resources

DOT PHMSA Guide 127 - Flammable Liquids Polar/Water-miscible.

- 2004 Emergency Response Guidebook (ERG2004)
 - <http://hazmat.dot.gov/pubs/erg/g127.pdf>

Ethanol Emergency Response Coalition (EERC)

- <http://www.ethanolresponse.com>

Guidebook for Handling, Storing, & Dispensing Fuel Ethanol (DOE)

- <http://www.nrel.gov/docs/fy02osti/30849.pdf>

EPA Region 5 - Ethanol & Biodiesel Response Manuals

- OSC website

EPA Region 7 - Ethanol & Biodiesel plant Manuals

- http://epa.gov/region07/priorities/agriculture/biodiesel_manual.pdf
- http://epa.gov/region07/priorities/agriculture/ethanol_plants_manual.pdf