Ethanol / Pipeline Technology Road Mapping Workshop

Pipeline Industry Needs and Experiences

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Pipelines & Renewable Fuels

A Complex equation

- **Technical Feasibility**
- **Logistics**
- **Economics**
- **Politics and Science**

Overcoming the technical challenges is a primary focus; however, focusing the other aspects is also needed

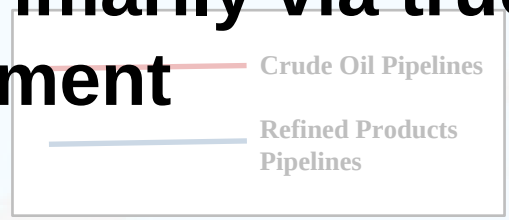
- **Technical Feasibility – our focus over the next day and a half**
- **Logistics – current infrastructure does not align with current production geography**
- **Economics – pipeline transportation must be competitive with existing / alternative modes (largely volume dependent)**
- **Politics and Science – Pipeline investors must be confident that ethanol is a long term component of the energy equation in the U.S. and potential changes to the renewable fuels industry (i.e. cellulosic breakthroughs, import policy changes, etc.) must be understood to make wise infrastructure decisions**

The U.S. Pipeline Industry

Approximately 100,000 miles of refined products lines

- Primarily transport fuels from Gulf Coast to Midwest and East Coast
- Over 6 billion barrels transported annually
- Safest and most cost effective mode of onshore transportation of fuels
- Most pipelines are common carrier versus proprietary
- Primarily multi-products pipelines (batch / fungible systems)

Today, ethanol is transported primarily via truck and rail with some barge shipment



Renewable Fuels Experiences

Ethanol

- **Limited in service experience through transmission pipelines**
  - **Producers transport via low pressure carbon steel pipelines with no reported problems**
  - **Terminal loading racks and piping have experienced problems**
- **Limited batch testing performed to understand quality issues in batch or fungible systems**
  - **Varying reports regarding product quality (discoloration, hydrocarbon pickup, etc.)**
- **Brazilian history of successfully transporting ethanol (primarily hydrous) in pipelines**
  - **500 pipeline miles, expanding to over 3,000 miles**
  - **Reported issues with valve and other elastomeric seals**
  - **Reported problems and emphasis on internal corrosion, not stress corrosion cracking (SCC)**

Biodiesel

- **Biodiesel has been tested in transmission pipeline systems**
- **No perceived material compatibility issues**
- **Concerns related to cross product contamination (jet fuel)**
- **Limited U.S. demand**

Technical Challenges

Corrosion and Stress Corrosion Cracking

- Experience shows that depending on many factors, ethanol can lead to a potent cracking environment or a potent corrosion environment
  - Stress corrosion cracking of tanks first reported in mid 90's
- Mode of damage varies based on composition and water content
  - Brazilian experience suggests: increase the water = corrosion versus cracking
  - U.S. experience suggests: reduce the water = cracking versus corrosion

Product Quality

- Ethanol absorbs foreign products typically left behind by other petroleum products (gums, inhibitors, water)
- Paradox 1
  - Increased ethanol concentration reduces quality concerns but increases corrosion / SCC concerns, while
  - Decreased ethanol concentration reduces corrosion / SCC concerns but increases product quality concerns
- Paradox 2
  - Small batch sizes increase quality issues but decrease damage potential by limiting exposure, while
  - Large batch sizes decrease quality issues but increase damage potential

Technical Challenges

Key Questions

- **What ethanol products can be shipped in existing infrastructure?**
  - **Is there a blend ratio below which damage does not occur (SCC, Corrosion, Elastomeric degradation)?**
  - **Are there batching operations that mitigate the initiation of damage?**
  - **What are the QA issues at various blend ratios in various fungible systems?**
- **What are mitigation strategies for ethanol products that cannot be immediately shipped in existing systems?**
  - **Are there inhibitors that mitigate the potential for SCC and corrosion**
  - **Are there needed changes to seals or other infrastructure (similar to ULSD modifications)**
- **What design considerations should be made for new pipeline systems for ethanol service?**
  - **New pipeline materials / manufacturing processes**
  - **Changes in welding practices**
  - **Specifications for equipment (pumps, valves, tanks, etc.)**
- **What changes must be made to fuel standards to enable transportation of ethanol products?**
- **What do we do if ethanol becomes contaminated (phase separation, water pickup, foreign product contamination, etc.)?**

Final Thoughts

- **Logistics**
  - Origin versus destination blending (what types of products to ship)
  - Pipeline infrastructure investment (new, conversion, etc.)
  - Can existing ethanol transportation modes support the growth?
- **Economic**
  - At what point does pipeline transportation become most desirable and is that sustainable?
  - Will other forces place downward pressure on ethanol supply?
- **Politics and Science**
  - Will the mandates stick?
  - Will imports become a reality?
  - Will other technologies displace ethanol demand over time?
- **Technical**
  - Understanding the mechanisms of damage sufficiently to transport ethanol products
  - Quantify allowable levels of various contaminants (prevent post production changes)
  - Controlling oxygen has been shown as a key variable in mitigating SCC
  - Variability has been seen across ethanol batches
  - What standards and guidelines are required for ethanol shipment?
  - What regulatory changes are necessary for ethanol shipment?