Fueling India - With TCX Ethanol Technology

A Brief Introduction

February 2014
Discussion Topics

► Celanese Overview

► Celanese TCX® Ethanol Technology Overview and Advantages
Celanese is a global technology and specialty materials company

- **2012 Revenue:** $6.4B
- **Employees:** 7,600
- **Manufacturing Locations:** 27

### Advanced Engineered Materials
- Specialty thermoplastics used in automotive, electrical, electronics, more

### Acetyl Intermediates
- Acetic acid, vinyl acetate monomer, and additional intermediate chemistries

### Consumer Specialties
- Cellulose derivatives like acetate tow for filters
- Food ingredients including sweeteners, preservatives

### Industrial Specialties
- Emulsion polymers for paint, adhesives, nonwovens, carpets
- EVA polymers for flexible packaging, medical solutions

Celanese
The chemistry inside innovation™
Celanese’s major end-use segments

Global presence and diverse applications in growth segments

- **Food & Beverage**: 2%
- **Consumer & Industrial Adhesives**: 10%
- **Construction**: 2%
- **Chemical Additives**: 7%
- **Paper & Packaging**: 5%
- **Paints & Coatings**: 11%
- **Automotive**: 15%
- **Consumer & Medical Applications**: 11%
- **Industrial Performance Applications**: 7%
- **Filter Media**: 19%
- **Textiles**: 5%
- **Other**: 6%

*Note: End-use percentages based on Celanese 2012 net sales with strategic affiliates proportional revenue and Celanese internal management estimates.*

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Celanese’s integrated product portfolio

Building Blocks → Differentiated Intermediates → Specialty Products

Raw Materials

Acetyl Intermediates

- Acetic Acid
- Ethanol
- Anhydride and esters

Methanol, Olefin, & Acetone Derivatives

Emulsion polymers
EVA polymers
Cellulose derivatives
Food ingredients
Engineered Materials
Affiliates
Specialty Derivatives
Leading global footprint positioned to meet customer demand

Celanese Global Manufacturing Locations: Acetyl Intermediates

- Strategically positioned assets employ leading technology
- Downstream assets located in-region for low cost-to-serve
- Global assets economically scalable to facilitate growth

Celanese well-positioned globally to meet changing demand landscape
Discussion Topics

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Celanese TCX® technology ethanol introduction

Attractive growth opportunities extend advantage beyond acetylxs

Raw Materials → Chemical Technology → Products*

Coal → C₁ Chemistry → Acetic Acid
Natural Gas
Crude Oil → C₂ Chemistry → Ethylene
→ C₃ Chemistry → Propylene
→ C₄ Chemistry → Butylene Butadiene

Advantaged raw material chemistry
Unmatched core technology
Technology enabled growth

AOPlus®³ Technology
TCX® Technology
Under development
Exploratory

Traditional Acetyls
VAM
Ethanol
New Derivatives
Other Derivatives

*Not exhaustive
Source: Celanese internal management estimate, available public information

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Celanese TCX® Ethanol Production Process

Feedstock
- Natural gas
- Coal
- Pet coke

Integrated Complex
- Syngas
- Methanol
- Ethanol technologies
- Acetyl technologies
- >3,000 patents globally
- 30+ years of operational excellence and know-how

Products

TCX® Ethanol Technology Breakthrough Elements
- Conditions of operation
- Materials of construction
- Catalyst systems
- Process Controls

TCX® technology builds upon Celanese’s expertise in acetyl technologies

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AOPlus® Acetic Acid Technology Advantages

Key Highlights

► Highest raw material efficiency
  - 97-99.8%

► Lowest energy usage
  - 10% of Monsanto

► Superior environmental sustainability
  - Low carbon footprint

► Best capital efficiency
  - 3x the capital efficiency of other leading technologies by operating single-reactor-stream with capacity expansion

Source: Celanese internal management data and estimates

AO® Technology

Production Capacity (1000 tpy)

Source: Celanese internal management data and estimates

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Celanese TCX® Ethanol Technology Development and Commercialization

- **TCX® technology launched**: Nov. 2010
- **Announced acceleration of ethanol production in China**: Jun. 2011
- **Third-party engineering validation by Fluor**: Jul. 2011
- **JSC signed with Pertamina**: Jul. 2012
- **Technology Development Unit started up in Clear Lake**: Jul. 2012
- **MOU signed with Pertamina for Indonesian ethanol production**: Jan. 2013
- **Nanjing ethanol plant startup**: Jun. 2013
- **MOU signed with PetroChina**: Aug. 2013

**Industrial Ethanol**
- Diversified and value-added end-use applications
  - Automotive coatings
  - Architectural coatings
  - Printing inks
- Supports growth of demand without putting additional pressure on arable land

**Anhydrous Ethanol**
- Highly value-added end usage segment
  - Pharmacy
  - Personal cares
  - Electrical
  - Others
- Support huge potential domestic demand growth

**Fuel Ethanol**
- Meet significant and growing demand for fuel ethanol
- TCX® Provides an abundant source of a clean liquid fuel without impacting arable land
- Brings Celanese core competencies to fuel customers through
  - Advanced technology
  - Operational excellence
  - Leading cost position

**Strong commitment to commercializing TCX® technology with significant potential benefit for India in fuel applications**

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TCX® Technology Cost and Quality Advantage

**A Clean-Burning Fuel**

- Ethanol, at the right price, is an excellent fuel blending component

**Cost Advantaged**

- TCX® Technology produces the lowest cost alternative liquid fuel

**Low Cost Alternative**

- TCX® Technology produces ethanol with a lower long-term cost than gasoline

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1. Celanese proprietary models, Booz & Company analysis. $/bbl adjusted for historic market relationship to crude; price assumptions based on consensus outlook; 2. Source: Indicative model, based on Qinghuangdao5500 kcal/kg coal.

*All growth and value projections regarding TCX™ Technology are based on Celanese internal management current estimates and assumptions, including capital and raw material costs and availability, demand for ethanol, and continuing technology developments.*
TCX® would create significant benefits for India and Indian Refineries

Benefits of TCX® for India

► Reduces India’s dependence on foreign energy sources
► Does not use arable land nor competes for food products
► Government's drive to increase ethanol blending from current ~E2 to even E5 levels seems unachievable with domestic molasses route (eventual targets are E10 and E20). TCX® can help meet these national targets.
► Environmental improvements in tailpipe emissions¹:

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► Proven ability to meet India’s increasing gasoline standards
► Develops local demand and industry

Benefits of TCX® for Refineries

► Accepted globally as a high-octane fuel blending component
► Provides high-octane blending component at a projected cost lower than today’s alternatives
► Increases gasoline production at an advantaged price relative to crude-based gasoline
► Opportunity to reduce overall refinery cost and capital investment to meet octane requirements
► Reduced exposure to volatility of ethanol market prices and product availability

Ethanol is an excellent blendstock; Celanese TCX® ethanol technology provides a new solution to meet anticipated global needs

¹ Source: US EPA, Argonne National Lab, China NDRC of ethanol blended gasoline versus non-blended gasoline
² Source: Guide to Petroleum Product Blending, HPI Consultants, Inc.
End-product option Comparison for Petcoke in India

Fuel Ethanol is the highest value creating option by far, besides being most strategic.

Fuel Ethanol creates 5x to 7x more economic value than MTO or Methanol while SNG destroys value.

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Source: Estimated by Celanese internal analysis, by using 1800kta Petcoke for calculation
Global feedstock considerations:
Country-level framework for liquid fuel adoption

Energy policy case studies

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In response to the 1970s oil crisis, Brazil developed policies to encourage the development of sugar cane-based ethanol seeking to exploit a bountiful domestic resource.

U.S. seeks to reduce its dependence of foreign oil by mandating the use of corn-based ethanol, leveraging its global leadership in the production of corn.

Increasingly dependent on oil imports; unable to utilize abundant coal resources in transportation fuels.

Countries need to make appropriate, individual choices -

- Must minimize valuable foreign exchange outflows on oil imports, and
- Cannot afford to divert scarce land, water and other resources so critical for food security, to alternate fuel use.

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Indian Ethanol Supply and Demand –
Bio-ethanol alone cannot meet projected Fuel Blending demand.

- Current Bio-Ethanol Supply <E2%
- "Claimed" Bio-Ethanol Supply E5%

Assumptions: Demand in 2013- Potable Alcohol= 0.85mnT cagr 6%pa; Industrial Alcohol= 0.75mnT cagr 6%pa; Gasoline= 17mnT cagr 7%pa.

- India’s Fuel Ethanol demands will increase exponentially, in order to meet E5, E10 and E20 blending mandates.
- Even assuming domestic Bio-ethanol from molasses could somehow meet current E5 level demand, the ‘gap’ in ethanol supply for fuel blending will still gallop to 2mnT by 2018, 7mnT by 2023 and 10mnT by 2028.
- It is impractical and virtually impossible for bio-ethanol from sugarcane / molasses or other crops to meet the entire demand, and it would have disastrous consequences for India (from impact on food prices from diversion of land & resources for fuel purposes). *
- Seasonality and variability from weather and cropping patterns will continue to effect bio-ethanol supplies and pricing.
- Synthetic-ethanol should supplement - not replace - Bio-ethanol. There is critical demand and room for both.

* Source: ICRIER and NCAP Policy Papers
Summary - TCX® Delivers Multiple Value Propositions

► Provides **large quantity of predictably priced ethanol** to meet mandated blend requirements.
► Does **not utilize arable land**; does not impact food prices.
► **Does not require government subsidies** to be cost competitive.
► **Saves valuable foreign exchange** for India.
► Creates **economic development and job creation**.
► **Advantaged high-octane blending component** with superior environmental qualities-
  • Improves tailpipe emissions versus pure gasoline
  • Improves ability to meet increasingly stringent fuel standards with environmentally friendly octane component;
  • Significant cost savings potential for refiners’ gasoline blend stock
► Reduce **dependence on imported energy**