Discussion Topics

- Celanese Overview
- Utilization of Pet Coke in the Manufacture of Acetyls
- Value of Fuel Ethanol via Pet Coke for India
Celanese – An Overview

- $6.7 billion in net sales in 2014
- #399 on 2014 Fortune 500
- ~7,400 employees; 35 facilities in 18 countries
- Based in Irving, Texas
- Innovation is at the core of our business
- World’s largest acetic acid producer

We are a global technology and specialty materials company that engineers and manufactures a variety of products essential to everyday living.
Celanese Technologies and Businesses Builds Upon Core C₁ Technologies

- **Raw Materials**
  - Methanol
  - Carbon Monoxide
  - Ethylene

- **Technology-Enabled Chemistry**
  - Formaldehyde
  - Acetic Acid & Anhydride
  - TCX® Ethanol
  - Vinyl Acetate Monomer

- **Customer-Oriented Solutions**
  - Advanced Engineered Materials
  - Cellulosic Acetate
  - Nutrinova
  - Emulsions
  - Ethylene Vinyl Acetate

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Development of AOPlus® Acetic Acid Technology: Industry Leading 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
Discussion Topics

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Multiple Options to Build Upon Our Leading Acetic Acid Technology

**Raw Materials**
- Coal
- Natural Gas
- PetCoke

**Chemical Technology**
- C₁ Chemistry
  - Acetic Acid
- C₂ Chemistry
  - Ethylene
- C₃ Chemistry
  - Propylene
- C₄ Chemistry
  - Butylene
  - Butadiene

**Products**
- Traditional Acetyls
- VAM
- Ethanol
- New Derivatives
- Other Derivatives

**Technology enabled growth**

**Advantaged raw material chemistry**

**Unmatched core technology**

AOPlus®³ Technology

TCX® Technology

Under development

Exploratory

*Not exhaustive

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Celanese TCX® Technology Development

1943
- Celanese initiates acetyl business, the building block of TCX® Technology

2010
- TCX® Technology is announced

2010
- TCX® Technology is validated by Flour and Worley Parson

2012
- Development unit for TCX® ethanol production in Clear Lake started operation

2013
- TCX® industrial ethanol commercial unit with 275kTA capacity in Nanjing, China started operation

- Continued R&D focused on increasing efficiency, performance and flexibility

- Low cost
- Non toxic
- High octane
- Resource – efficient use of IOCL’s Pet Coke

Production capacity at a Celanese TCX® Technology facility would surpass that of a traditional ethanol facility by 2 to 3 times

www.celanesetcx.com

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Key Uses of Ethanol

- **Potable alcohol**
  - Produced via bio routes only given end-market requirements
  - Multiple products, primarily drinking alcohol and other personal care needs

- **Industrial Alcohol**
  - Produced via bio or synthetic routes
  - Applications include pharmaceuticals, paints, coatings, and other industrial applications

- **Fuel Ethanol**
  - Largest application for ethanol globally
  - Used for blending in gasoline as a direct replacement for gasoline at up to 10-12% by volume
  - Also provides benefits as a high-octane component and an oxygenate
Indian Ethanol Supply and Demand –
Bio-ethanol alone cannot meet projected fuel blending demand

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
Project Objective

- Assist the government with making up for expected long-term shortfall in available molasses-based ethanol (current blending at ~2%)

- Primarily end market will be fuel ethanol blending; Industrial ethanol also a potential option

- Production of 1.1 Million Metric Tons Per Annum (MMTPA) Synthetic Ethanol from gasification of 1.8 MMTPA (1.3 MMTPA from Paradip & 0.5 MMTPA from Haldia) of Raw Petroleum Coke (RPC)

- Blending of produced Pet coke Based Fuel Ethanol in gasoline (Petrol) as per the mandate of GOI (max blending mandate 10%)

- Potential to produce 170 MW of Power for refinery from existing Gas turbines (GTs) of Paradip refinery.
World largest acetic acid producer:
- Nanjing, China – 1.2 million tpa
- Clear Lake, Texas – 1.35 million tpa

Synthetic ethanol unit in Nanjing, China – 275,000 tpa.

Multiple proven syngas technologies have been reviewed

CECO, GE, Shell, CB&I and SES
Project Description

- Petcoke gasification: 1,800 Kilo Ton Per Annum (KTPA)
- Capacity of Acetic Acid: 1,500 KTPA (single train)
- Capacity of Ethanol Plant: 1,138 KTPA (single train)
- Methanol: 800 KTPA required for acetic acid production (make/buy decision to be completed during pre-feasibility study)
- JV partners: Indian Oil and Celanese Corporation
- Engineering estimate / feasibility study in progress by Fluor Daniel
- Marketing and logistics study in progress by PWC
Best Utilization of Indian Petcoke for Value-Added Processing

**Project Payback Period**

- Ethanol
- Direct CTL (Diesel)
- MEG
- Methanol to Gasoline
- Acetic Acid (non CE tech.)
- Indirect CTL (Diesel)
- Olefins
- Methanol
- Synthetic NG

**EBIT/Capital Investment**

- Synthetic NG
- Methanol
- Olefins
- Indirect CTL (Diesel)
- Acetic Acid (non CE tech.)
- Methanol to Gasoline
- MEG
- Direct CTL (Diesel)
- Ethanol
Additional Environmental Benefits and Coal Utilization Efficiencies

- Improved tailpipe emissions of E10 gasoline versus gasoline without ethanol (per ton basis)

<table>
<thead>
<tr>
<th>CO</th>
<th>GHGx</th>
<th>Toxics (Benzene)</th>
<th>PM</th>
<th>SOx</th>
<th>NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10~30%</td>
<td>-12~19%</td>
<td>-25%</td>
<td>-36%</td>
<td>-46%</td>
<td>-10%</td>
</tr>
</tbody>
</table>

(Source: US EPA, Argonne National Lab, China NDRC)

- Potential to address pollution issues associated with automobile emissions, particularly in urban settings

- Less water consumption and CO₂ emission versus other hydrocarbon to liquid technologies (XTL) utilizing coal, natural gas or pet coke

<table>
<thead>
<tr>
<th></th>
<th>Celanese TCX™</th>
<th>Direct CTL</th>
<th>Indirect CTL</th>
<th>MTG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Investment</td>
<td>100%</td>
<td>115%</td>
<td>150%</td>
<td>137%</td>
</tr>
<tr>
<td>Entire Plant Energy conversion efficiency</td>
<td>100%</td>
<td>95%</td>
<td>94%</td>
<td>104%</td>
</tr>
<tr>
<td>Target Products Energy conversion efficiency</td>
<td>100%</td>
<td>91%</td>
<td>88%</td>
<td>93%</td>
</tr>
<tr>
<td>CO₂ emission</td>
<td>100%</td>
<td>186%</td>
<td>180%</td>
<td>147%</td>
</tr>
<tr>
<td>H₂O consumption</td>
<td>100%</td>
<td>104%</td>
<td>154%</td>
<td>120%</td>
</tr>
<tr>
<td>Improves tailpipe emissions, environmentally friendly²</td>
<td>✔</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

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Durability, Engine and lab Testing Results

Summary

► Durability Test at China National Car Testing Center in Tianjin:
  - 8 cars: 4 gasoline cars and 4 TCX E10 cars
  - 80,000 km
  - Similar behavior in 80,000km durability testing comparing to regular gasoline
  - 1.3% higher gasoline consumption than regular gasoline car.

► Engine Tests for TCX E10 and Bio E10
  - Similar results in torque,
  - Similar result in gasoline consumption
  - Similar result in emission

► Lab Test for TCX E10 and Bio E10
  - Similar lab results comparing to bio ethanol in low temperature stability, high humidity stability and metal corrosion testing.
**Petcoke to Ethanol Project Creates Significant Value for India and IOC**

<table>
<thead>
<tr>
<th>Benefits of TCX® for India</th>
<th>Benefits of TCX® for IOC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utilizes local resources</strong> and enables India to reduce dependence on foreign, imported energy sources</td>
<td>Accepted globally as a high-octane fuel blending component</td>
</tr>
<tr>
<td><strong>Uses neither arable land nor competes for food products</strong></td>
<td>Provides high-octane blending component at a lower cost than today's alternatives</td>
</tr>
<tr>
<td><strong>Value added processing</strong> of abundant local petcoke in the production of clean liquid fuel</td>
<td>High-octane additive drives a lower cost of final gasoline product</td>
</tr>
<tr>
<td><strong>Reduces the government’s financial burden</strong> of gasoline subsidies and improves trade balance</td>
<td>Potential to allow changes in refinery operations to increase overall gasoline production</td>
</tr>
<tr>
<td>Proven ability to meet India’s increasing gasoline standards with an environmentally friendly blend product</td>
<td>Opportunity to reduce overall refinery cost and capital investments needed to meet octane requirements</td>
</tr>
<tr>
<td>Creates economic development and job creation</td>
<td><strong>Diversifies raw material sources</strong></td>
</tr>
</tbody>
</table>

Ethanol is an excellent blendstock; Celanese TCX® ethanol technology provides a new solution to meet India’s needs

1 Source: US EPA, Argonne National Lab, India NDRC