Repsol Polímeros, S.A.
Excellence Petrochemicals in the Portuguese Industrial Cluster

Ordem dos Engenheiros – 21Nov2018
1. Historical summary

1972-1976
Decision
- Government decision to create a Petrochemical Complex at Sines in the Early ’70s
- Foundation of two companies: CNP, olefins EPSI, polyolefins

1976-1980
Construction
- Olefins plants
- Polyolefins plants
- Utilities plants

1981-1988
Star-up. First running years
- Test-runs
- Performance tests
- Improvements in product quality
- Feedstock adjustments

1989-2004
Acquisition & merging
- NESTE acquires polyolefins and rents olefins
- BOREALIS succeeds NESTE
- Construction of MTBE
- HDPE revamping
- Decommissioning PP
- ISO certifications
- REPSOL acquires the Site late 2004

2005- 2017
Modernization and competitiveness
- Cracker capacity increase
- EBA grades
- DCS in all process plants
- NG in steam boilers
- REPSOL acquires MTBE
- Extensive use of LPG in Cracker
- Cable grades in HDPE and LDPE

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2. Site and surrounding area overview

Site location

Lisbon 150 km Sines

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2. Site and surrounding area overview

Industrial Cluster
2 Site and surrounding area overview

Site general view
2. Site and surrounding area overview

Petrochemical port facilities general view
Site integration
3. Site Integration
From Crude Oil to Polymers

RAW MATERIAL

PROCESS I
Refinery: Distillation and cracking process

PRODUCTS & RAW MATERIAL
Nafta & LPG (C3, C4)

PROCESS II
Steam Cracker: Thermal Cracking process

PRODUCTS & RAW MATERIAL
Olefins: Ethylene Propylene

PROCESS III
Polymerization: Catalytic process

PRODUCTS
Poliolefins: HDPE LDPE / EBA

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3. Site integration

Site production plants

**Olefins**
- Butadiene 52 kt/a

**Steam Cracker**
- Etileno 410 kt/a
- Propileno 200 kt/a
- PyGas 200 kt/a
- FOPY 40 kt/a

**Poliolefins**
- HDPE 145 kt/a
- LDPE 150 kt/a

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3. Site integration

Interconnections
3. Site integration
Licensing technology and design capacities

<table>
<thead>
<tr>
<th>Steam Cracker</th>
<th>HDPE</th>
<th>LDPE</th>
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<tbody>
<tr>
<td>• Linde Engineering</td>
<td>• Mitsui Petrochemical Industries</td>
<td>• CdF Chemie</td>
</tr>
<tr>
<td>• Front end deethanizer</td>
<td>• Bimodal Slurry Process Ziegler-Natta Catalyst</td>
<td>• HP Autoclave Reactors up to 2000 bar</td>
</tr>
<tr>
<td>• Startup in 1981</td>
<td>• Startup in 1981</td>
<td>• Startup in 1981</td>
</tr>
<tr>
<td>• Design capacity of 410kta C₂=</td>
<td>• Actual capacity of 145kta (mix dependent)</td>
<td>• Actual capacity of 150kta (mix dependent)</td>
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## 3. Site integration
Licensing technology and design capacities

<table>
<thead>
<tr>
<th>Butadiene</th>
<th>MTBE</th>
<th>Power Plant</th>
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</thead>
<tbody>
<tr>
<td>Nippon Zeon</td>
<td>UOP/Huels</td>
<td>Electrobel</td>
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<tr>
<td>DMF extractive</td>
<td>Acidic cationic resins</td>
<td>Combined Heat &amp; Power Cycle</td>
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<tr>
<td>distillation</td>
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<td></td>
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<tr>
<td>Startup in 1982</td>
<td>Startup in 1991</td>
<td>Startup in 1981</td>
</tr>
<tr>
<td>Design capacity of</td>
<td>Design capacity of 48kta MTBE</td>
<td>Design capacity of 3x190 t/h HPS</td>
</tr>
<tr>
<td>52kta 1,3-BD</td>
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<td></td>
</tr>
</tbody>
</table>
3 Site integration
Steam Cracker block diagram

Steam Cracking and Quenching
Oil and Water Quench
Cracked Gas Compression
Precooling Drying Deethanizer
C\textsubscript{2} Hydrogenation
Cold train Demethanizer
C\textsubscript{2} Splitter

Naphtha
Propane
Butane + Raff 2

Ethane recycle

C\textsubscript{2} Splitter

C\textsubscript{3}\textsuperscript{+}

C\textsubscript{3}\textsuperscript{+}

C\textsubscript{5}\textsuperscript{+}

Pyrolysis Oil
Pygas

C\textsubscript{5} recycle

Pygas Hydrogenation

Debutanizer

C\textsubscript{3} Stripping C\textsubscript{3} Splitter

Fuelgas
Ethylene

H\textsubscript{2} fraction
CH\textsubscript{4} fraction

Crude C\textsubscript{4}
Propylene

C\textsubscript{3} Hydrogenation

Depropanizer

FCC C\textsubscript{3}

CH\textsubscript{4} fraction

Propane recycle

Process Steam

Propylene

C\textsubscript{3}\textsuperscript{+}

C\textsubscript{5}\textsuperscript{+}

C\textsubscript{2}\textsuperscript{-}

C\textsubscript{2}\textsuperscript{-}

Ethane recycle

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3. Site integration
HDPE block diagram

- Catalyst Preparation
- Polymerization Reaction
- Drying & Separation
- Compounding and Extrusion
- Solvent Distillation
- Additives
  - Ethylene to Steam Cracker
  - HDPE Natural Pellet Classification and Expedition
  - HDPE Coloured Pellet Classification and Expedition

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3 Site integration
LDPE block diagram

- Ethylene
- AT/BA
- Initiators
- Non-reacted ethylene
- Non-reacted ethylene
- Additives
- Ethylene to Steam Cracker
- MPR
- EXTRUDER
- DEGASSING AND PACKAGING

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3. Site integration

Butadiene block diagram

Crude C₄

1ˢᵗ Extractive distillation

1ˢᵗ Stripping

Butadiene Compression

2ⁿᵈ Extractive distillation

2ⁿᵈ Stripping

Butadiene Recovery

Offgas Compression

Butadiene Fractionation

Lean DMF

Solvent purification TAR removal

Dimer TAR

Raffinate 1

Offgas

1,3-Butadiene

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3. Site integration

MTBE block diagram

- Etherification Reaction
- Butenes Distillation
- Washing
- Complete Saturation Process
- Methanol / Ethanol Purification

Inputs:
- Raffinate 1
- Methanol / Ethanol

Outputs:
- MTBE/ETBE
- Raffinate 2
- Vent Gas

Other:
- Water
- H₂
3. Site integration

Harbour block diagram

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3. Site integration

Power plant block diagram

- 3 Main Boilers
- Auxiliary Boiler
- Natural Gas
- Pyrolysis Fuel Oil + Dimer
- Fuel Gas + Vinyl Acetylene + Off Gas

3 Main Boilers

- 22 MW BPT
- 6 bar
- 21 bar
- 46 bar

Electricity Imported from grid

Plants

- 23 MW

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3. Site integration
Within the Group

La Coruña
Bilbao
Puertollano
Tarragona
Santander
Cartagena
Sines

Products: North America

raw materials
products
raw materials
& products
4. Site main figures

General

- 440 employees and an average of 450 contractors
- Production around 1,000,000 t/y of Olefins and Polyolefins
- Exports 85 - 90% of its production for over 60 countries
- In the top 10 major Portuguese exporters
- 60 - 70% of raw materials import and products export is made by sea
4. Site main figures

Certificates

ISO 9001-2015
ISO 14001-2015
OSHAS 18001:2007

ISO 50001-2011

SEVESO III
(DL 150/2015)

ISCC EU
MTBE & ETBE
4 Site main figures
Repsol Química Competitiveness Plan

- **Feedstock flexibility**
  Ability to take advantage of the business opportunities in an easy mode
- **LPG cracking**
  Modulate the ratio between liquid/gas feedstock based on the market
- **Energy efficiency**
  Minimize energy costs and take advantage of the LPG cracking yields
- **Differentiation**
  New products and specialty applications for demanding markets
4. Site main figures

Repsol Sines highlights

- **Steam Cracker**
  - Increase in production rates and utilization rate levels
  - High LPG feedstock processing (20-60% ratio market prices optimized)
  - Longest plant running period in history: 691 days (previous of 204 days)
  - Reliability index above 98%
  - Energy consumption 4% decrease (2013 baseline)
  - Process Losses 35% reduction (2013 baseline)

- **Butadiene**
  - Moderate rates and occupation levels due to Cracker CC4 unavailability & market shortage
  - Longest plant running period in history: 893 days
  - Plant production records in 2016 due to spot CC₄ availability
  - First time in history plant follows site turnaround period (2012-2018)

- **bio-ETBE / MTBE**
  - Low rates and occupation levels due to Butadiene Raffinate unavailability & market shortage
  - Longest plant running period in history: 647 days
  - Very high reliability index
  - Operation mode switch from/to MTBE to/from bio-ETBE in 2015 and 2017
4. Site main figures
Repsol Sines highlights

• **HDPE**
  - New cable grades development and production
  - Last 12 years continuous on stream period record without plant shutdowns – 125 days
  - Increase in production rates
  - Energy consumption 5% decrease (2013 baseline)

• **LDPE / EBA**
  - Record of 133 days continuous on stream period of both LDPE L₁ and L₂
  - Record of 157 days continuous on stream period of both LDPE L₁
  - Record of 97,1% plant utilization rate (best ever)
  - High reliability indexes

• **Power Plant and Utilities**
  - Cracker-Power Plant integration in steam/fuels due to LPG cracking
  - Increase of internal electrical production – change to self-producing regime
  - Backpressure turbine derating – efficiency increase
Reliability Improvement
4. Reliability Improvement

Reliability programme

Common project to all Repsol production sites

It started in Sines in 2015

Multidisciplinary Cells lead by Operations

Root Cause Analysis based in Lean Methodology

Safety enhancement by knowing the failure mechanisms and acting proactively

DailyFlow just started onsite
4. Reliability Improvement

Reliability Sines Site

Sines Site Reliability Index

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Polyethylene is the most important final product from Sines Complex

- High chemical stability material
- Easy to sterilize and manipulate
- Can be easily recycled and reused
6. Sines polyethylene grades

Applications for High Density Polyethylene (HDPE)

Family grades:
- **Pipe**: piping for water, gas and effluents
- **Fibers**: ropes, fishing nets, packaging for agro-products
- **Moulding**: packaging for hygiene, cleaning products and lubricants
- **Film**: food package and bags
- **Electrical cables**: isolation for LV and communication cables

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6. Sines polyethylene grades

Applications for Low Density Polyethylene (LDPE)

Family grades:

- **Film**: food package, bags and coating/lamination
- **Injection**: food package
- **Retractable film**: packaging (EBA)
- **Foams and profiles**: household and footwear (EBA)
- **Electrical cables**: coating for HV and VHV power cables (EBA)
Olefins other products
7. Olefins products and markets

Products

- **Olefins** are another important family of products exported by the Site

  - **Propylene**, raw material to polypropylene

  - **1,3-butadiene**, raw material for synthetic rubber.

  - **Pyrolysis gasoline**, for benzene extraction

  - **M/ETBE**, to improve octane rating in commercial fuels.
8. Markets

2013-2017 worldwide (Olefins + Polyolefins)

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8. Markets

2013-2017 Europe (Olefins + Polyolefins)

- 34% Espanha
- 26% Holanda
- 20% Alemanha
- 7% Bélgica
- 4% França
- 2% Itália
- 2% Grécia
- 1% Reino Unido

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Significant investments in recent years
9. Significant investments in recent years

- **Raw gas turbine and condenser**: 16 M€
- **Furnaces convection revamping**: 12.7 M€
- **Electrical grid and substations**: 10.3 M€
- **Motor Hypercompresor L2LDPE**: 3.6 M€
9. Significant investments in recent years

Total 80M€ between site turnarounds
9. Significant investments in recent years

Safety and Environment [M€]

Renovation [M€]

Development & Efficiency [M€]

Infrastructures & Other operational improvements [M€]

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Ethylene worldwide market outlook
10. Ethylene market outlook

Ethylene production by feedstock

Million Tons

Source: PCI Wood Mackenzie
10. Ethylene market outlook

Source: Wood Mackenzie
What’s next?
11. What’s next?
Competitiveness, flexibility and resilience…
Thank you