Simulation of Ethylene Plants in SPYRO® Software

Susan Cooper-Lenes – Pyrotec Sales Engineer
Agenda

1. Introduction
2. SPYRO® Suite 7
3. SPYRO® in Dynamic Modeling: SPYDRE
4. Material Balance Module (MBM)
Introduction
# TechnipFMC key facts

<table>
<thead>
<tr>
<th>2</th>
<th>$3.1B</th>
<th>$15.2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Exchange listings – NYSE and Euronext Paris</td>
<td>Total company Revenue (1)</td>
<td>Total company backlog (2)</td>
</tr>
<tr>
<td>48</td>
<td>19</td>
<td>37,000+</td>
</tr>
<tr>
<td>Countries in which we operate</td>
<td>Vessels (including one under construction)</td>
<td>Employees</td>
</tr>
</tbody>
</table>

**Footnotes**
1. Revenue as of Q3, 2018
2. Backlog as of Q3, 2018
Unique worldwide footprint

Netherlands
Technip Benelux B.V.

Zoetermeer, The Netherlands
(250+ employees)

- Technology center for
  - Ethylene Technology
  - Hydrogen Technology
  - SPYRO® product line (Pyrotec department)
  - Development of new product lines

- Full EPC capabilities
  - Strong front-end engineering capabilities
  - Advisory services portfolio
  - Procurement, Expediting, QA/QC
  - Construction, Commissioning, Startup
  - Project Management

- No. 1 in furnace revamp projects (200+)

- Alliances with DOW and Air Products
SPYRO® Suite 7
SPYRO® Product Line

Best software for simulation of steam cracking process:

- Used by TechnipFMC for cracking furnace design
- Used by ethylene producers to simulate their furnace operations

**SPYRO® Suite 7**

*Standalone application*

**Integrated SPYRO®**

*Integrated in 3rd party applications*

- Offline furnace simulations
  - Yield and coking prediction
  - Full furnace simulations
  - Multiple furnace simulations
  - ...

- Advanced Process Control (APC)
- Real-Time Optimization (RTO)
- ...

SPYRO® History

Genesis of SPYRO®

Mario Dente  Eliseo Ranzi


Integrated applications
SAPC, SRTO, SPSL

Integrated SPYRO®

SPYRO® Suite 7

MBM

PYROTEC
(commercialization)
Ethylene Market Coverage

WORLDWIDE ETHYLENE CAPACITY

More than 300 active licenses around the world
SPYRO® Suite 7

Offline simulation of furnace operations

- Product yields
- Coke formation
- Fuel gas, HP steam, etc.

- Feedstock evaluation
- Optimization of operating conditions
- Prediction of furnace run lengths
- Generation of input data for production planning
SPYRO® Kinetic Scheme

Fundamental reaction model, applicable to any furnace design

**KS9306**

- 128 components
  - Individual
  - Lumped
- Hydrocarbons C$_1$ – C$_{42}$
- Over 3000 reactions
Full Furnace Simulation

Most detailed models of ethylene furnaces

- Convection section
  - FPH
  - ECO
  - DSSH
  - HPSSH
  - HTC

- Radiant section
  - Radiant Coil
  - Firebox

- TLE and Steam Drum
Radiant Coil

Crucial element of any furnace model

- Kinetics modeled in the coil itself and in adiabatic zones
- Rigorous coking model
- Any coil design can be configured by Pyrotec
Transfer Line Exchanger

Simulating the process gas cooling and steam generation

- Residual reactions in tube side
- Rigorous coking model (same model, different conditions)
- Any TLE design can be configured by Pyrotec
Firebox

Rigorous simulation of heat release in the radiant section

- Any burner location: floor, elevated, sidewall
- Fuel gas definition by individual components
  - Accurate prediction of TMT profile, fuel gas consumption, etc.
Convection Section

- Simulation of any bank, e.g.:
  - Feed preheater
  - Economizer
  - Dilution steam superheater
  - High pressure steam superheater
  - High temperature coil

- Simulation details:
  - Reactions in lower banks
  - Shock duty calculation
  - Tube finning
  - Corbelling
SPYRO® in Dynamic Modeling
SPYRO® in Dynamic Modeling

- **What?**
  - SPYRO® is TechnipFMC’s proprietary software for an ethylene cracker yield model for furnace design and performance prediction

- **How?**
  - The hydrocarbon cracking reaction kinetic model and radiant coil heat transfer embedded in SPYRO® is integrated into the Dynamic Simulator via DLL I/O

- **Why?**
  - Take advantage of the rigorous radiant coil cracking solution provided by SPYRO® in Dynamic Simulator to predict overall system dynamic behavior
  - Overcome limitations of regression-based OTS models
SPYRO® in Dynamic Modeling

Graphical Flowsheet
Material Balance Module (MBM)
Material Balance Module (MBM):

- Add-on module to SPYRO Suite 7
- Input data and results – in MS Excel
- Configured and tuned by PYROTEC

Available in 2019
Flow rates and compositions of:
- Final products
- Recycle streams
- Intermediate fractions

Overall material balance based on SPYRO simulations
Conclusion

SPYRO®: the modeling solution for

• Steam cracking furnace
• Dynamic furnace behaviour
• Full ethylene plant

The tool to improve your ethylene plant performance
Thank you!

Susan Cooper-Lenes
Pyrotec Sales Engineer
susan.cooper-lenes@technipfmc.com
+31 793 293 703