Simulation of Ethylene Plants in SPYRO® Software

Ethylene
Middle East
Technology
Conference

EMET
CONFERENCE

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Agenda

1. Introduction

2. SPYRO® Suite 7

3. SPYRO® in Dynamic Modeling: SPYDRE

4. Material Balance Module (MBM)

Introduction

TechnipFMC key facts

2
Stock Exchange listings – NYSE and Euronext Paris

$3.1B
Total company Revenue [1]

$15.2B
Total company backlog [2]

48
Countries in which we operate

19
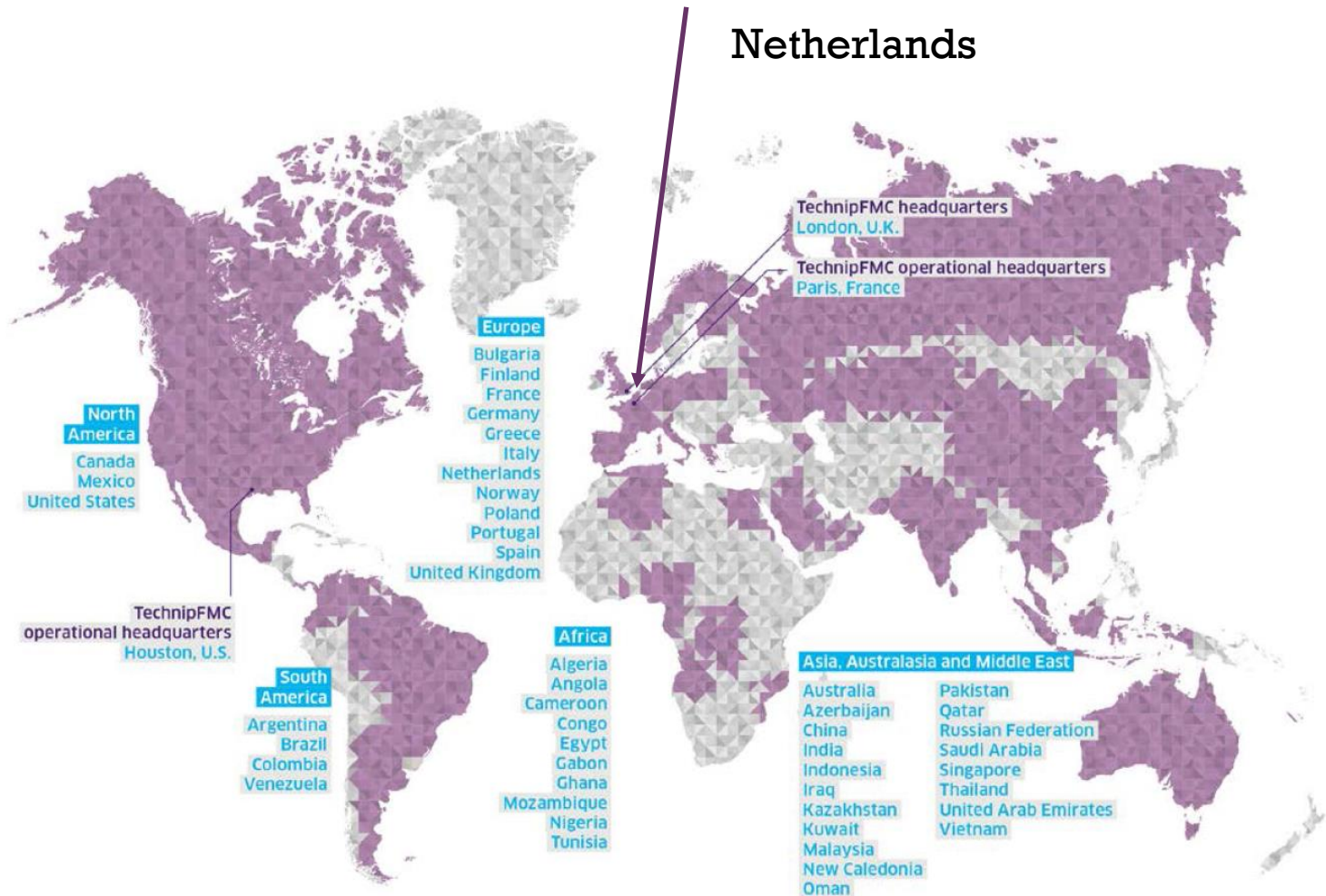Vessels (including one under construction)

37,000+
Employees

Footnotes
1. Revenue as of Q3, 2018
2. Backlog as of Q3, 2018

Unique worldwide footprint

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

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

Integrated SPYRO®

Integrated in 3rd party applications

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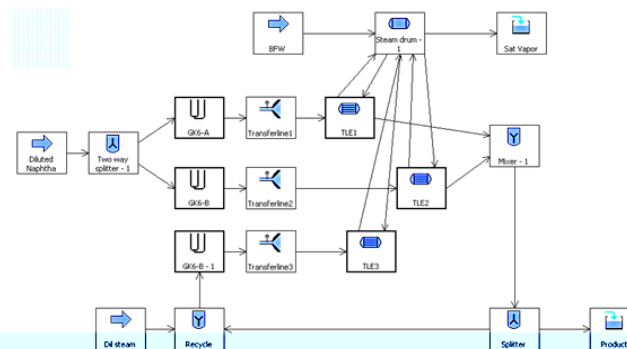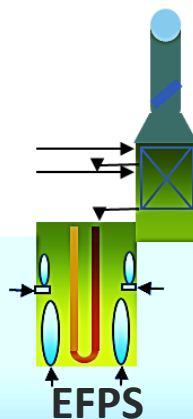- **Real-Time Optimization (RTO)**
- **. . .**

SPYRO® History

Genesis of SPYRO®

Mario Dente

Eliseo Ranzi

EFPS

SPYRO® Suite 7

MBM

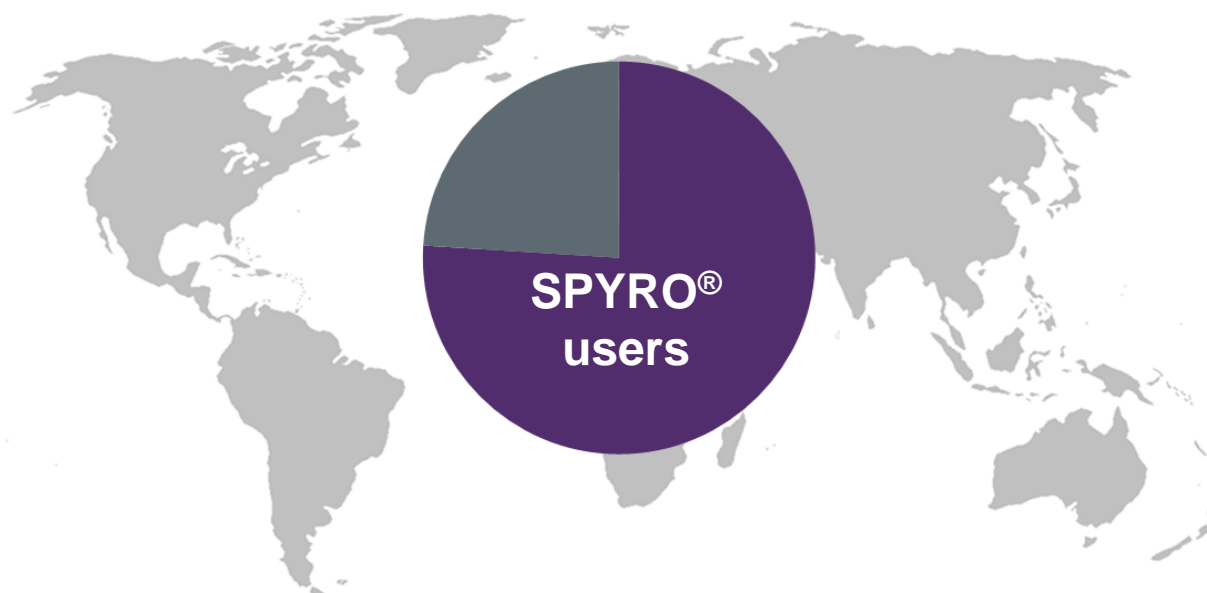1965   1979   1980   1990   2000   2010   2020

PYROTEC
(commercialization)

Integrated applications
SAPC, SRTO, SPSL
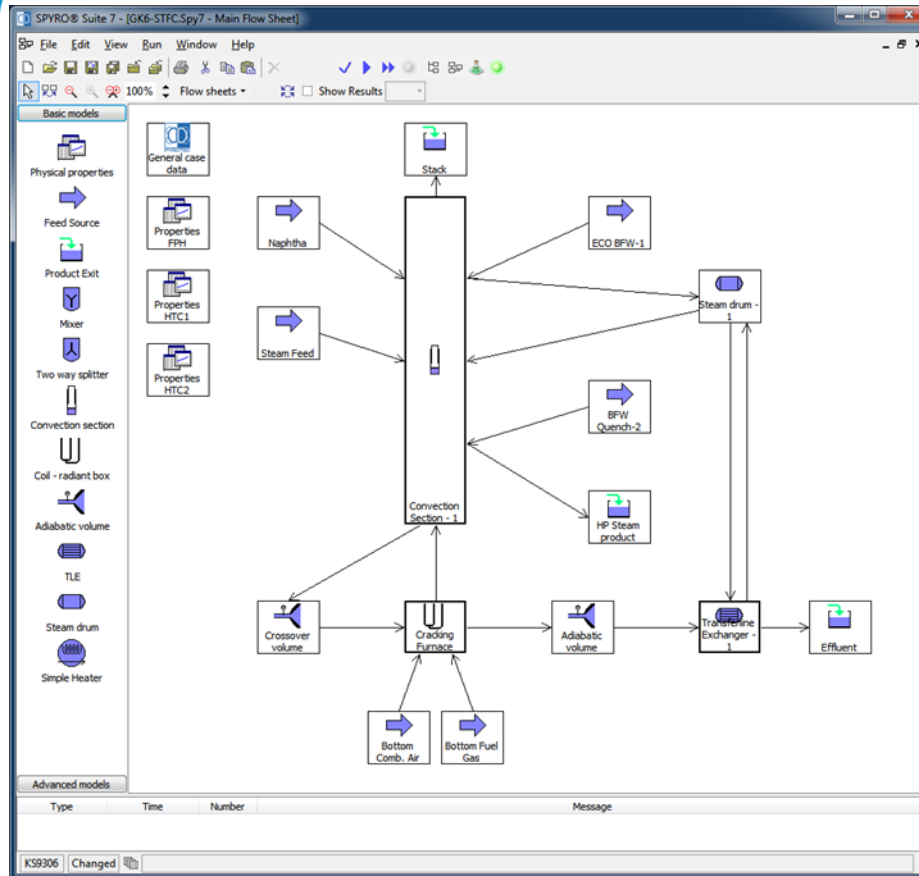
Integrated SPYRO®

9

Ethylene Market Coverage

WORLDWIDE ETHYLENE CAPACITY

**SPYRO®
users**

More than 300 active licenses around the world

SPYRO® Suite 7

Offline simulation of furnace operations

- Product yields
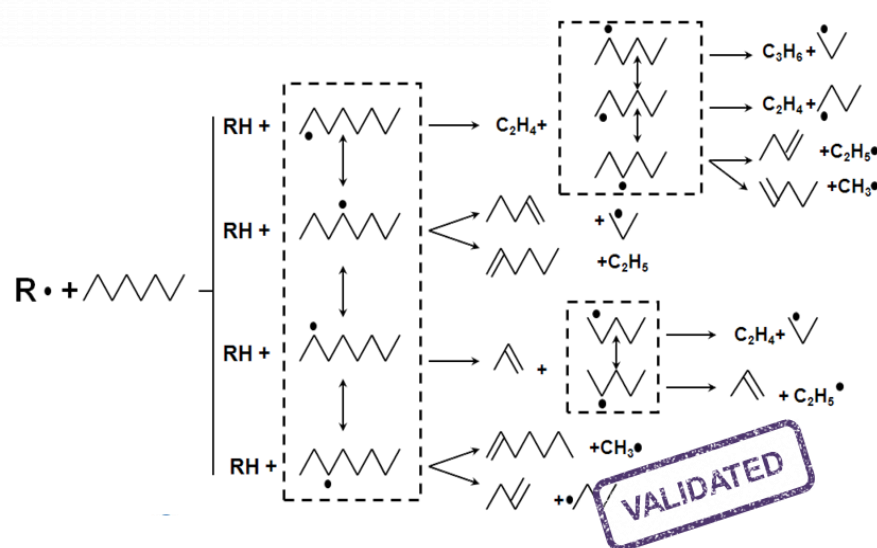
- Coke formation

- 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
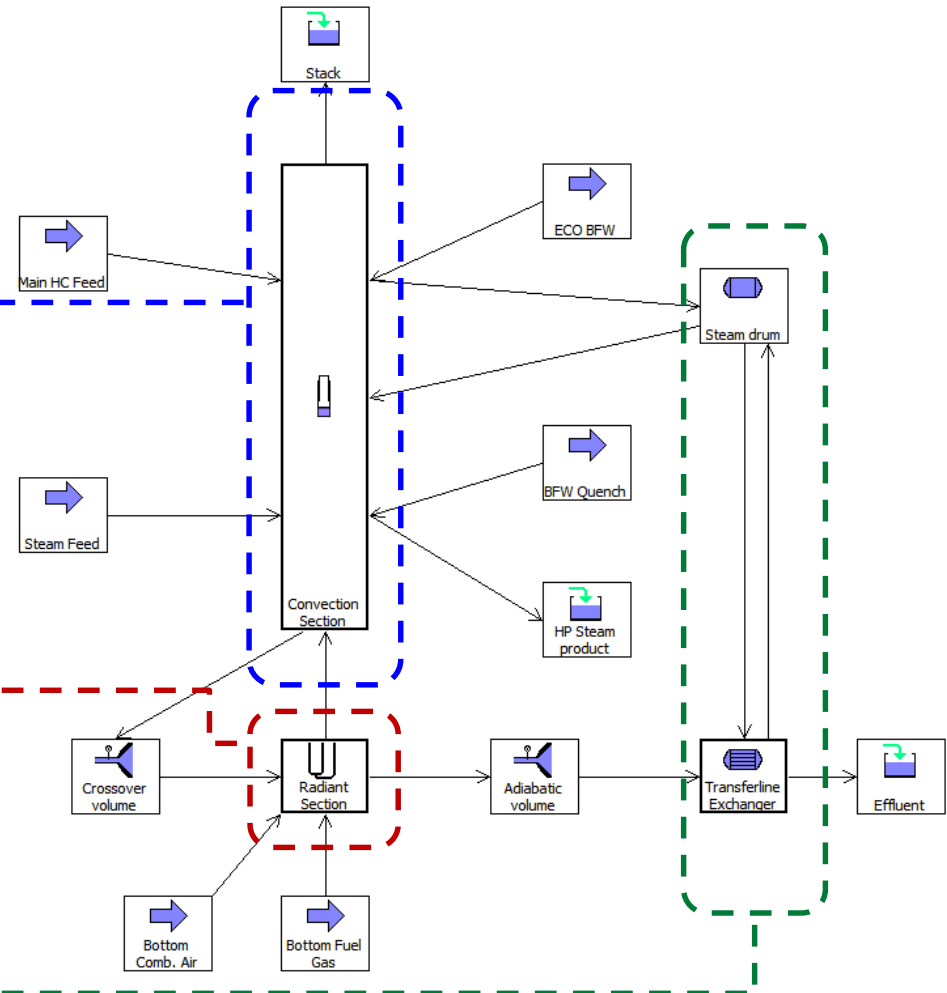
Most detailed models of ethylene furnaces

- **Convection section**
  - FPH
  - ECO
  - DSSH
  - HPSSH
  - HTC
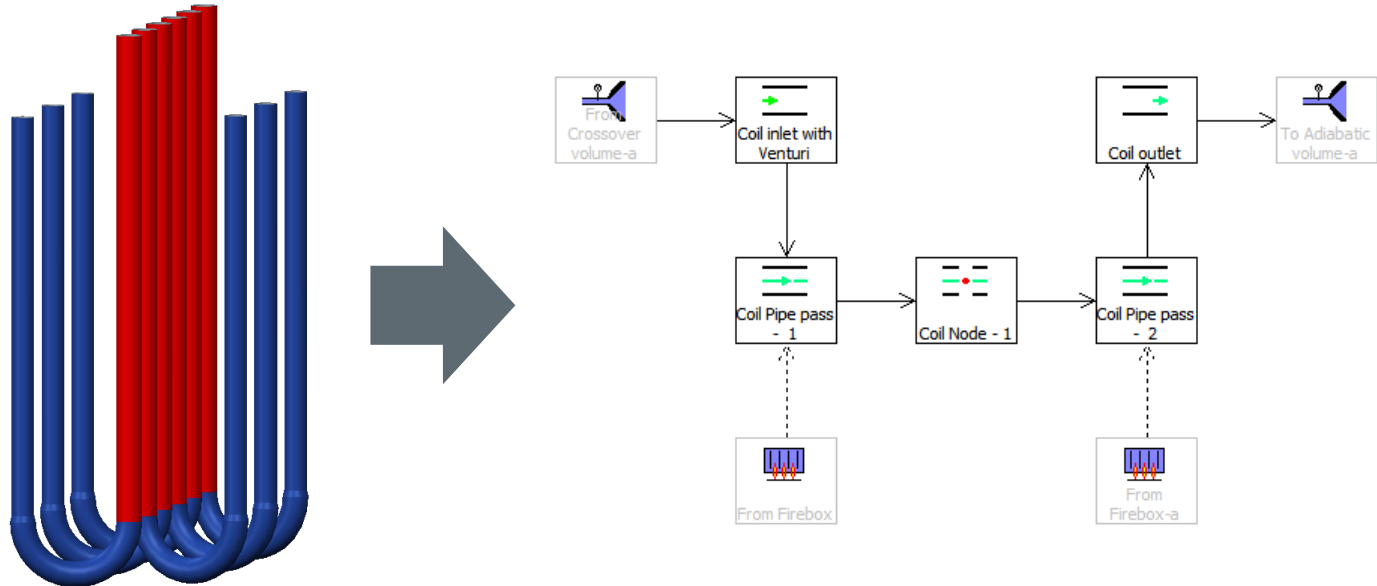
- **Radiant section**
  - Radiant Coil
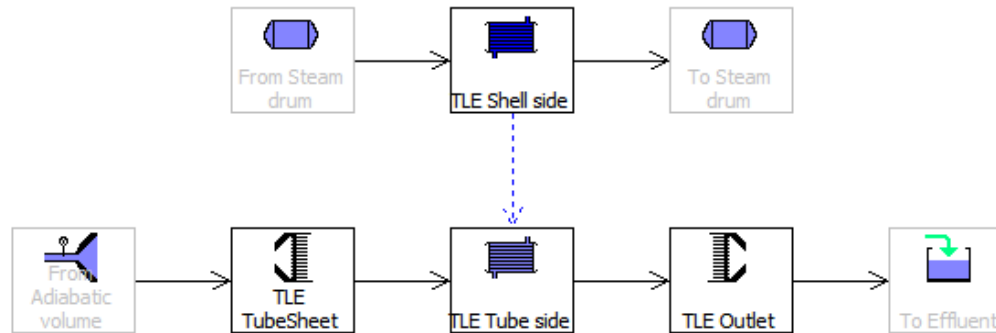 - Firebox

- **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
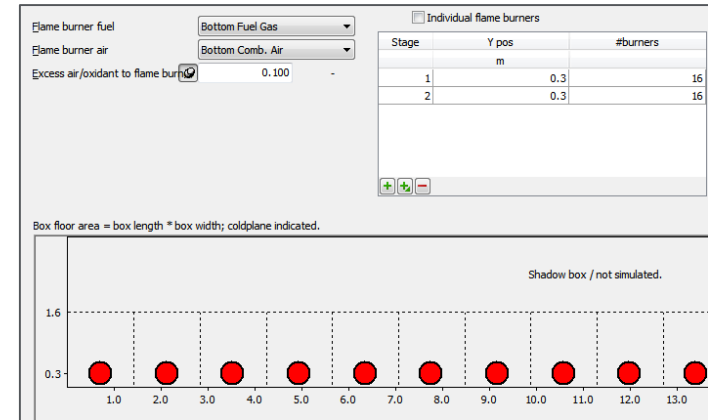
Transfer Line Exchanger

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
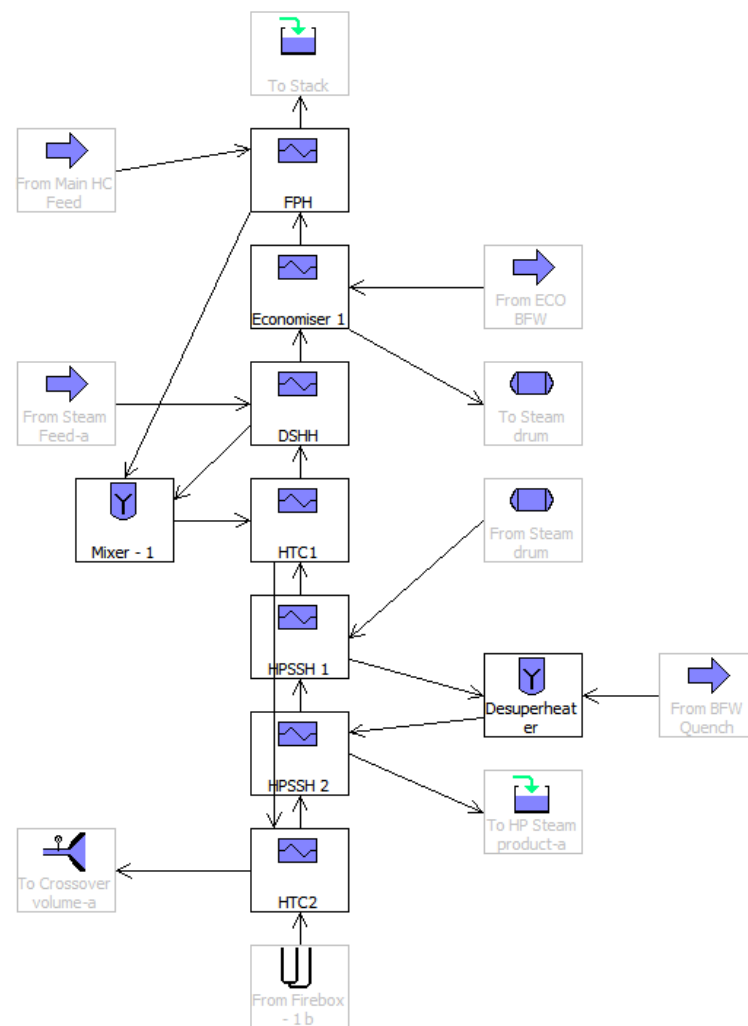
SPYRO® in Dynamic Modeling

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
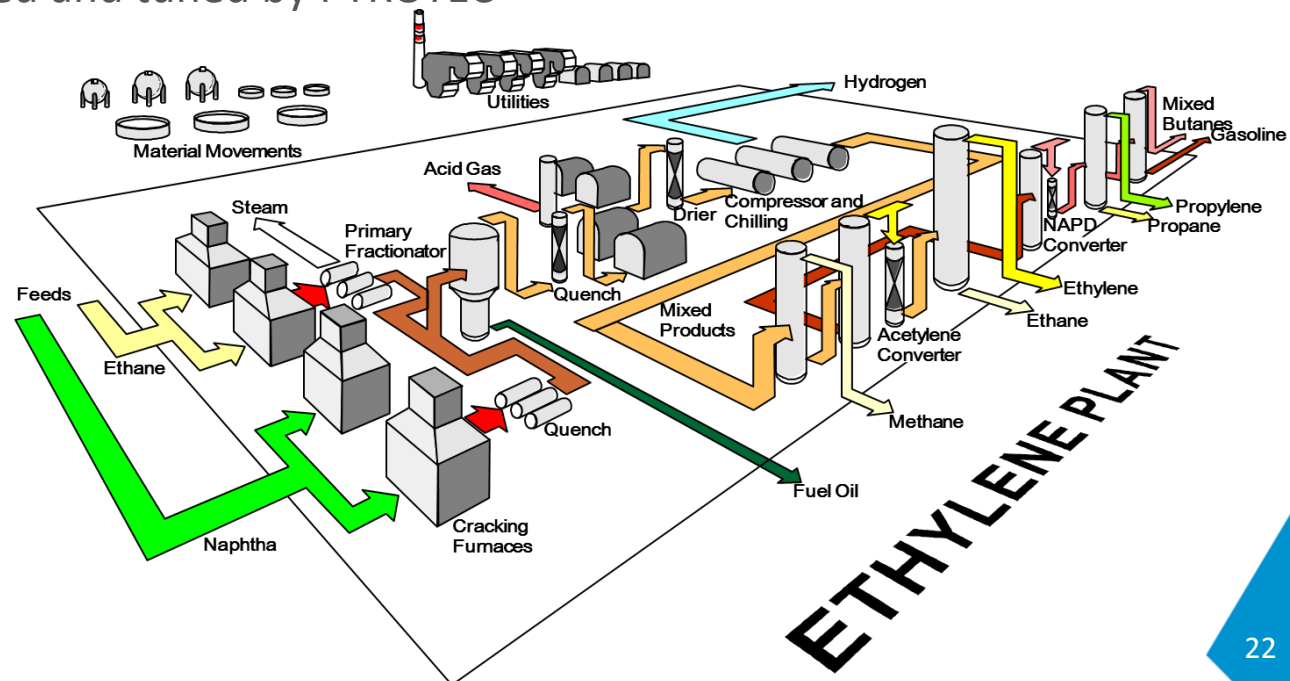
Graphical Flowsheet
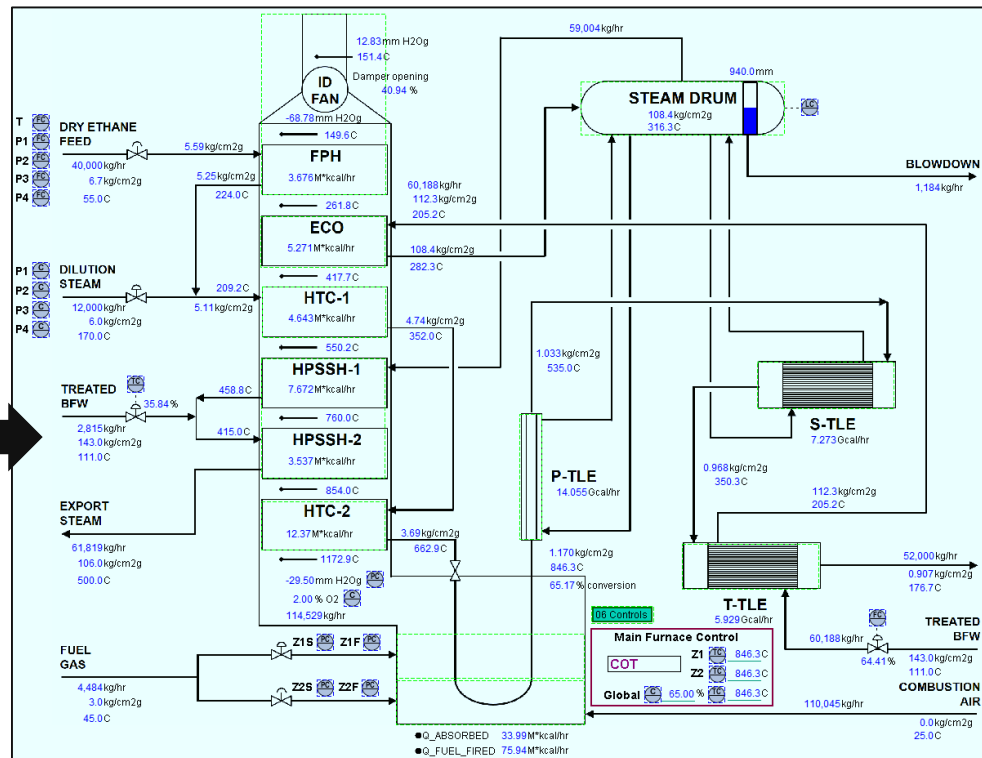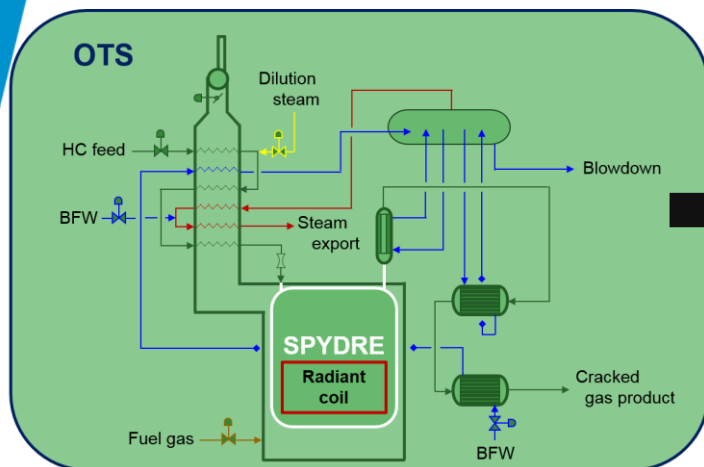
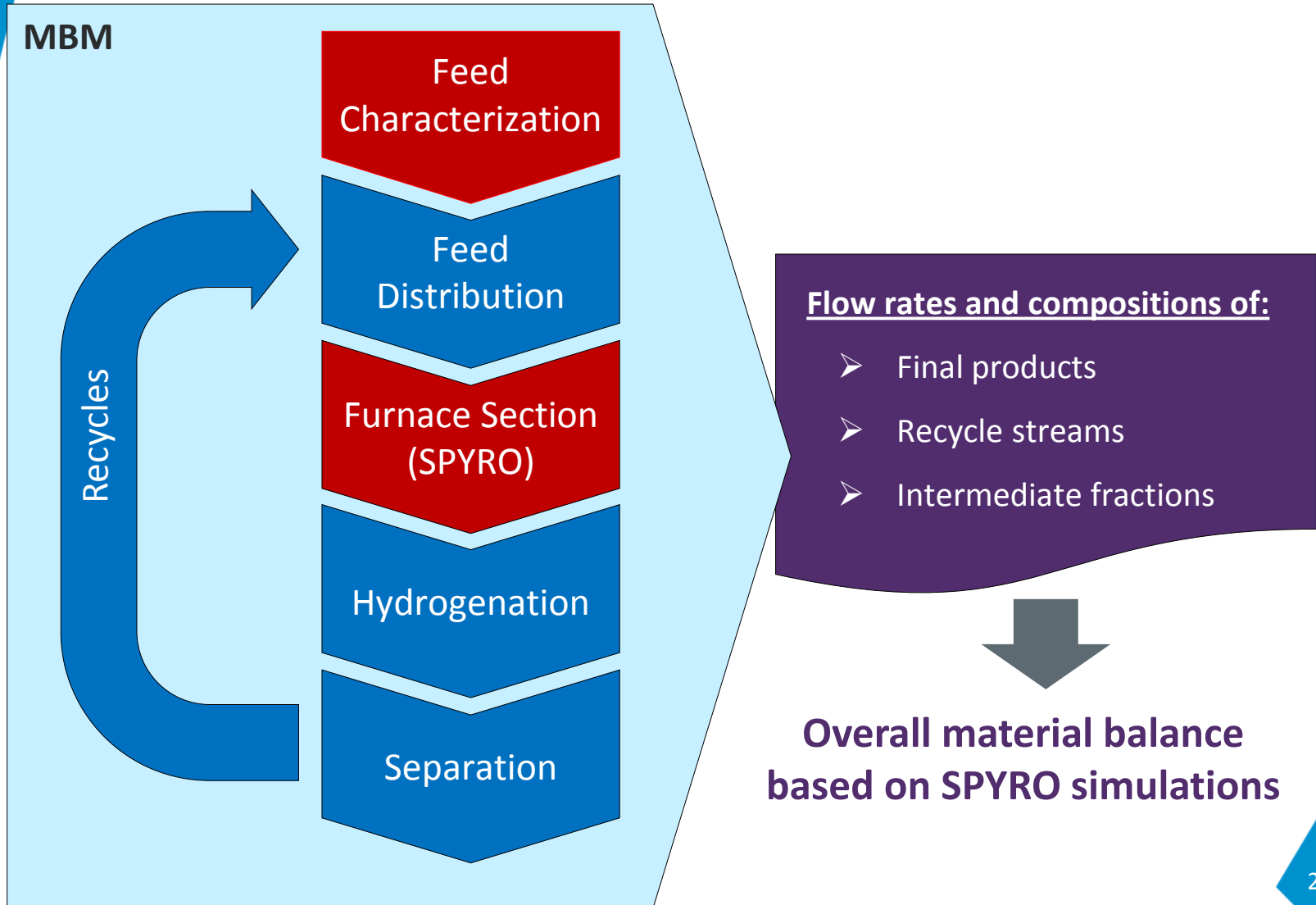# Material Balance Module (MBM)

Material Balance Module (1/2)

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

Material Balance Module (2/2)

MBM

Feed Characterization

Feed Distribution

Furnace Section (SPYRO)

Hydrogenation

Separation

Recycles

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 !

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