Where energies make tomorrow

SPYRO® Suite 7

The ethylene furnace simulation standard

T.EN TECHNIP ENERGIES

Rigourous simulation of steam cracking

SPYRO® is Technip Energies' proprietary software for steam cracking yield prediction and complete furnace simulation of gas or liquid feedstocks. Since its introduction in 1979, SPYRO® has been adopted by 80% of ethylene producers worldwide. The tool simulates the performance of any type of pyrolysis furnace to improve:

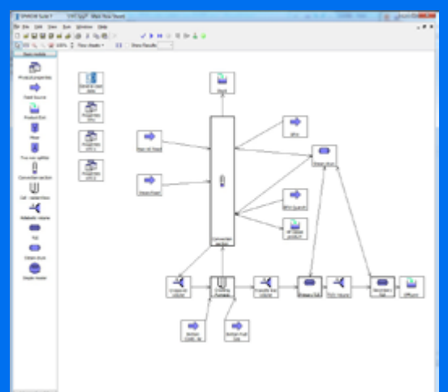
- Profitability of existing plants
- Furnace operation
- Production planning and scheduling
- Feedstock selection
- Performance evaluation

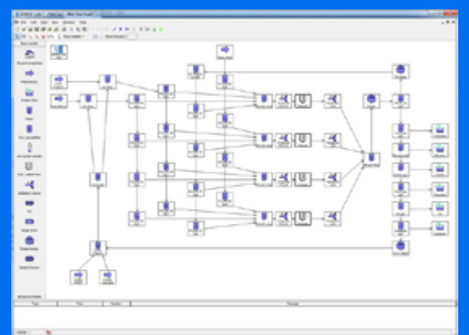
A continuously upgraded software tool, SPYRO® provides multiple benefits to end users. As a complete furnace model, it simulates:

- Cracking kinetics in radiant coils
- Firebox radiant heat transfer
- Convection section
- Quench system (Transfer Line Exchange system and steam drum)

SPYRO® performs yield simulations of multiple furnaces with recycle streams. Using a dedicated Excel interface, customers can import results directly into spreadsheets and run simulations.

GRAPHICAL USER INTERFACE
SPYRO® operates on a Windows platform. Its flowsheet-oriented graphical user interface allows end users to view models, submit input parameters and review simulation results.



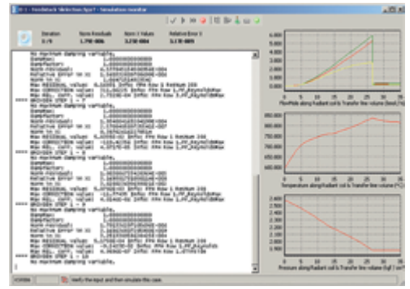


SPYRO® SIMULATION OPTIONS
The tool can be tailored to fit users' needs such as:

- Radiant coils and TLE for yield prediction
- Full furnace model performance review
- Multiple furnace models, including recycle streams allowing overall material balance

SPYRO® Suite 7 is an equation-based, flowsheet-oriented program

TYPICAL BENEFITS
- Easy access of input and output
- Can easily specify the boundary condition at any position in the coil
- Open equations
  - f (y,x) = 0
- More flexible model setup
  - Model connections
  - Fix/estimate variables
- Hot start is possible to minimize calculation time



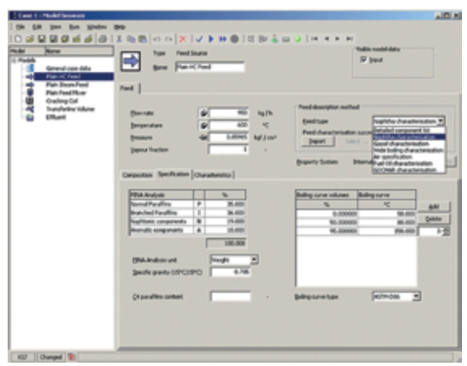
OPTIONS FOR DIFFERENT FEED SPECIFICATION METHODS FROM GAS TO HEAVY FEEDSTOCK
SPYRO® provides detailed composition of liquid feedstocks using the following input parameters:

- Specific gravity
- Boiling curves
- PINA composition and other properties, depending on the type of characterization

Direct input of individual components is also available (typically used for gaseous feeds).

- Generic feed model
- Flow rate, composition, T, P, vapor fraction
- Feed characteristics
- Detailed component selection
  - Gaseous feedstock
  - Fuel
- Instant feed characterization for liquid feedstocks
  - Naphtha
  - Gasoil
  - Wide boiling cuts
- Distillation curves
  - ASTM-D86
  - ASTM-D2887
  - TBP

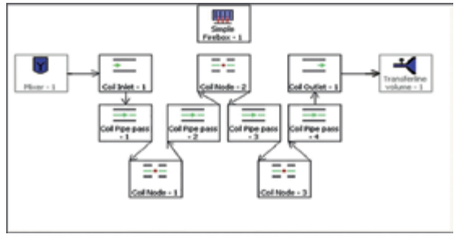
KINETIC SCHEME
The core technology of the SPYRO® model is in its kinetic scheme, which has progressed over the years and been used by the majority of olefin producers. The current kinetic scheme defines more than 3,000 reactions involving 128 molecular and 20 radical components. It ensures accurate simulation of the steam cracking process for the whole range of possible hydrocarbon feedstocks.



Cracking yields

The cracking coil and transfer line exchanger are divided into sub-models that focus on conversion of feed to products and coking simulation.

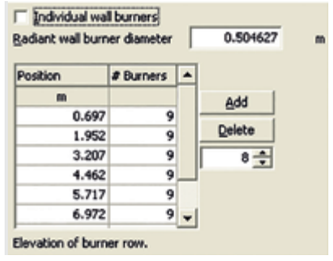
CRACKING COIL
SPYRO® is preconfigured software that allows definition of all commercially available radiant coils. The model also includes adiabatic zones in shielded or trough areas.

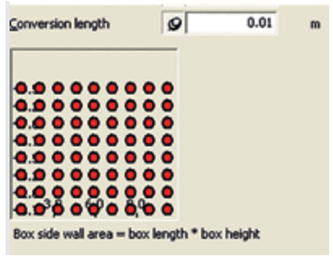


FIREBOX®
The performance of combustion chambers in ethylene furnaces can be simulated using the FIREBOX component of SPYRO. FIREBOX provides accurate tube skin temperature profile and flue-gas properties flowing to the convection section.

This provides accurate predictions for the tube skin temperature profile, fuel/air consumption and properties of the flue gas flowing to the convection section. Other features include:

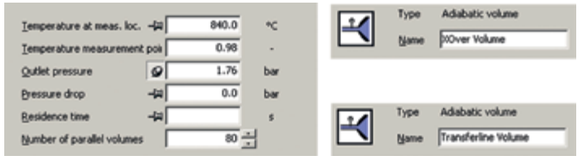
- Flexible cell distribution
- Discrete ordinate method
- Modeling heat transfer
- Radiant wall burners
- Flame burners
  - Burners at one, two, or more levels
  - Individual burner specification
- Emissivity calculation
  - Leckner
- Heat release pattern
  - Fuel conversion functions
  - Shape parameters





ADIABATIC VOLUME
The adiabatic volume represents a reaction volume where, if the temperature level is high enough, chemical reactions are calculated. This model is used mainly for the transfer line volume between the radiant coil and TLE. It also can be used for any other reaction volume, such as the crossover piping between the convection section and the radiant coil, or piping between TLEs.

SPYRO® output contains decomposition, concentration, and process temperature data. This allows the user to achieve a better comparison with plant data.

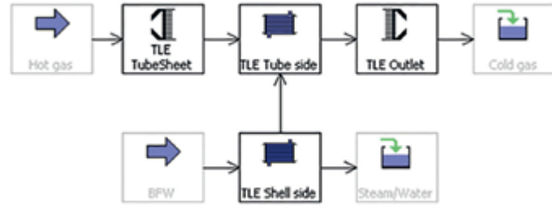


Transfer line exchanger

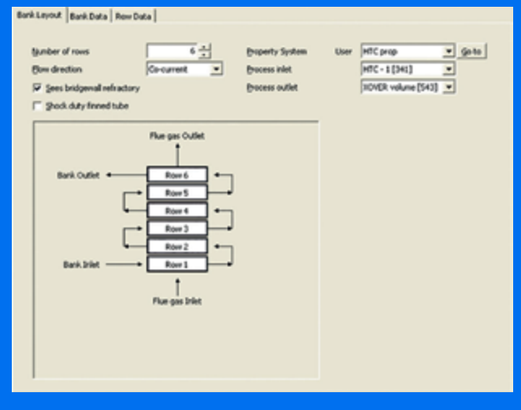
SPYRO® Suite 7 simulates the transfer line exchanger with the capability to simulate any type of commercial TLE design.

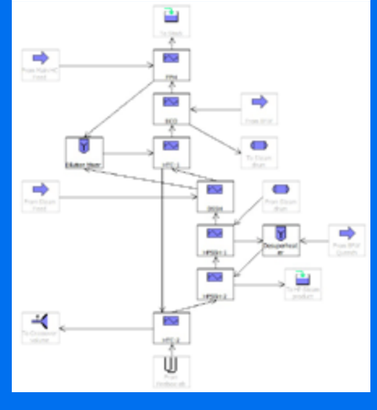
Steam generation, heating, and vaporization of boiler feed water are generic models of TLE simulations. Other heating applications also are possible.

- Generic model for shell side
  - Boiling/heating the water
  - Any other process fluid
  - Custom connections
- Tube model
  - TLE coking
  - Full property system for process fluid
  - Updated Nusselt relations
  - Cracking reactions
- Tube sheet and outlet
  - Inlet/outlet pressure/friction losses
  - Tubesheet coking



CONVECTION SECTION MODEL CALCULATES HEAT TRANSFER BETWEEN HOT FLUE GAS AND COLDER PROCESS FLUID
Any type of stream can be heated or vaporized, including HPS, HC, and DS. SPYRO® simulates the process side and flue-gas side simultaneously using the layout of the convection bank, bank operating data, and row geometries as input.





What's new in SPYRO® Suite 7?

IN BRIEF

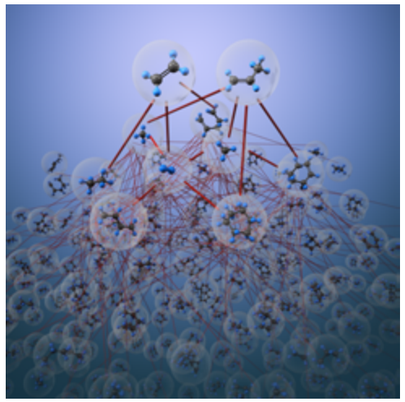
- Complete furnace simulation
- Flowsheet- and equation-oriented flexible case setup
- Freedom in fixing variables
- Adiabatic cracking model (also in radiant coil)
- Flexibility in kinetic scheme selection
- Multiple furnace simulations
- Unit of measure choice by user
- Reactions for hydrogenation
- Component splitting
- CO/CO_2 modeled from water shift reaction
- FIREBOX® model
- TLE cold side modeling with any fluid
- Import of keyword and visual EFPS files
- Ability to model venturi as separate simulation block

APPLICATIONS

- Optimization of furnace operations
- Feedstock selection
- Furnace operability studies
- Furnace performance evaluation

BENEFITS

- Optimized cracking severity
- Maximized production of desired products
- Reduced maintenance costs through optimized run lengths
- Deeper insight into plant operations
- Accurate production planning



Schematic of a thermal cracking reaction network

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