16th STS-AIChE Southwest Process Technology Conference

- Cracking Technology – Past, Present & Future
- John Murphey III
- Technip Energies

Sept 22-23, 2025, University of Houston

TechnipEnergies | General | Anyone - No Protection

Speaker Bio

John has more than 40 years of process engineering experience in the process and petrochemical industries, including 37 years specializing in the design of cracking furnaces. He is experienced in the design of both grassroots and revamp cracking furnaces and related ancillary equipment; cracking yield prediction for gas and liquid hydrocarbon feedstocks; development and presentation of licensor training materials for licensee engineers and operators; furnace startup and operation.

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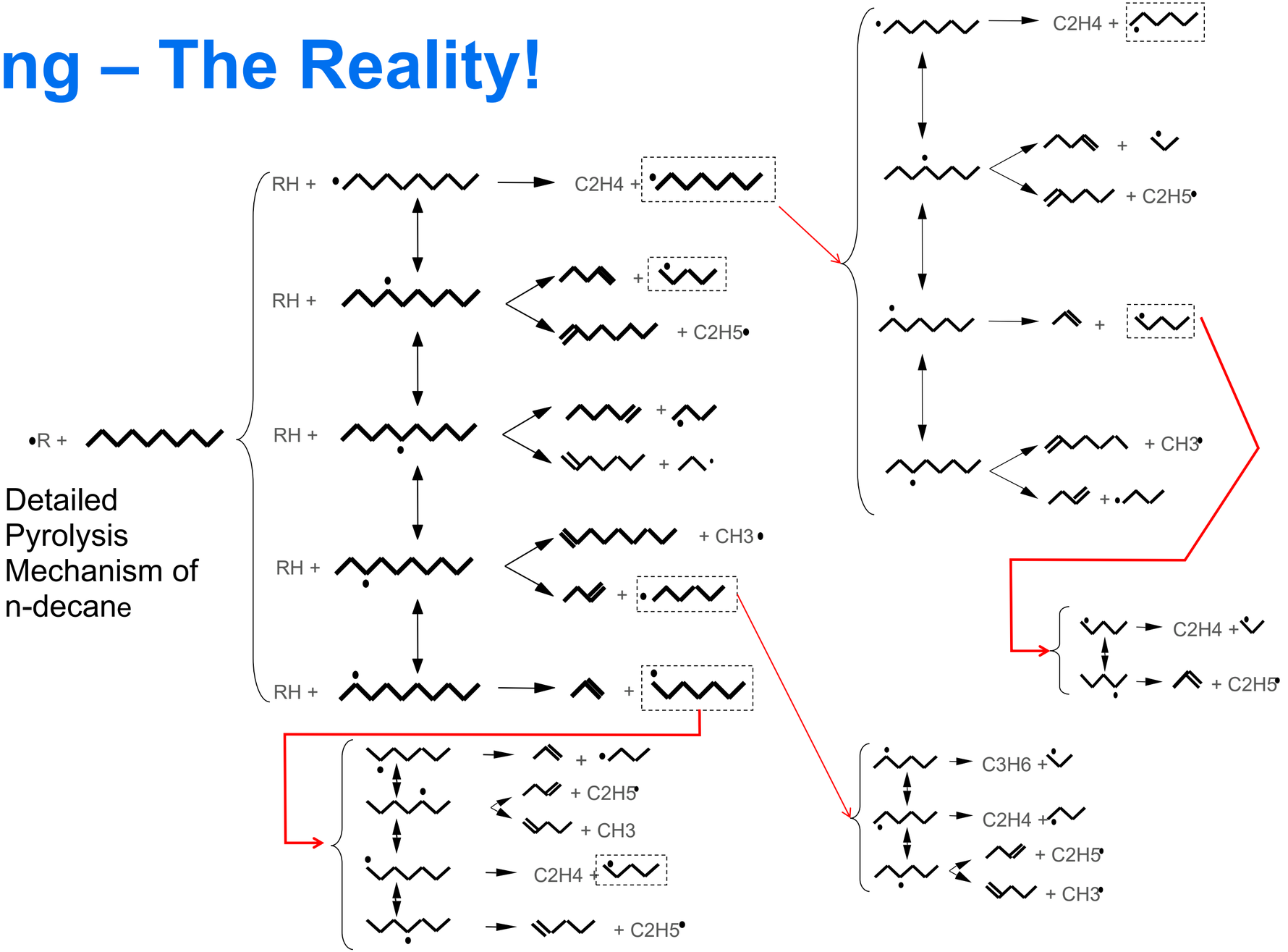
What is Cracking? Simplistic – “Spaghetti”

- Steam cracking is a petrochemical process in which saturated hydrocarbons are heated until they crack into smaller, often unsaturated, hydrocarbons
- Breaking a long piece of dried spaghetti is very easy

- Breaking a short piece of spaghetti is very difficult

The shorter the hydrocarbon molecule, the more difficult it is to crack (more heat / energy required)

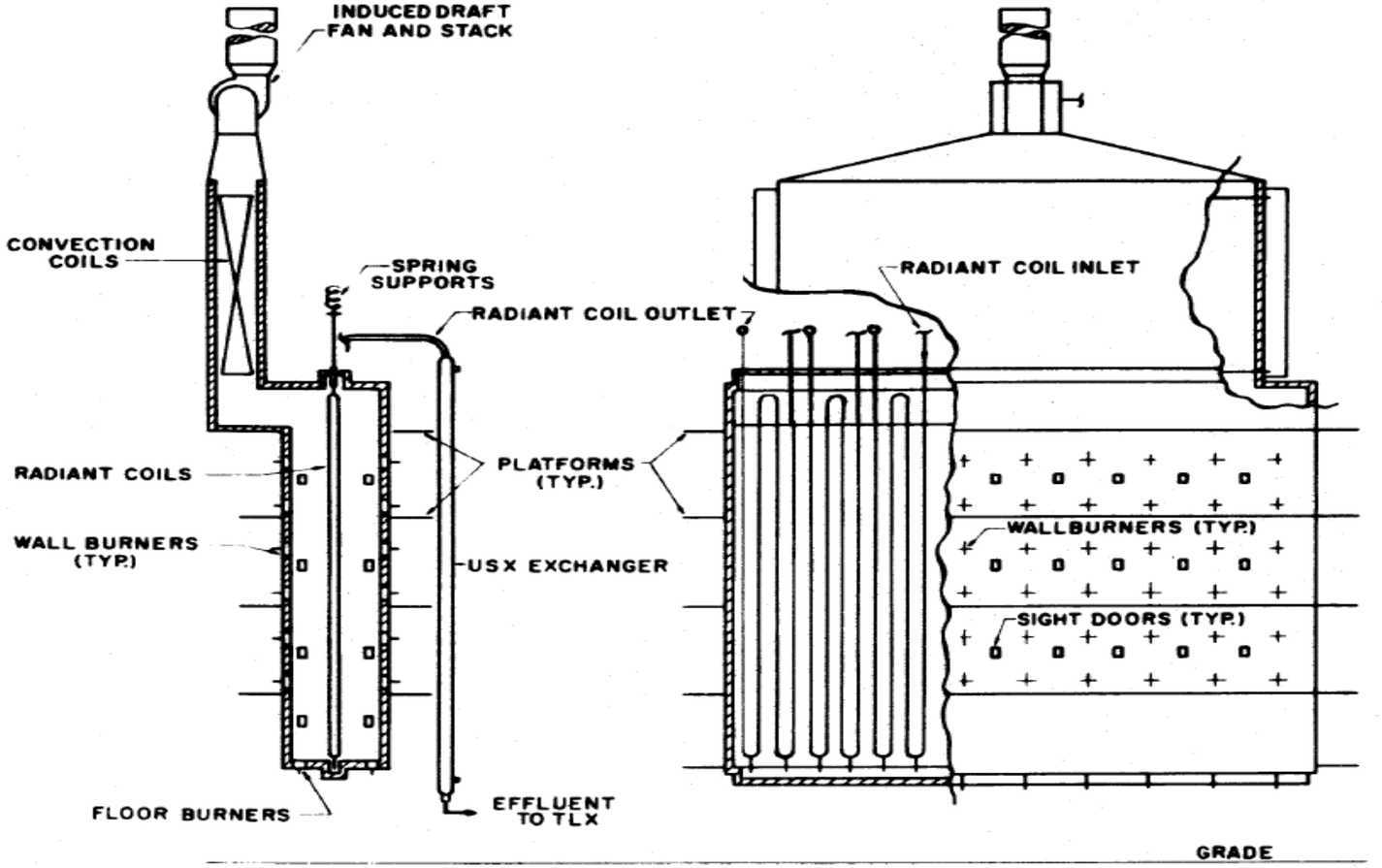
Cracking – The Reality!



Detailed Pyrolysis Mechanism of n-decane

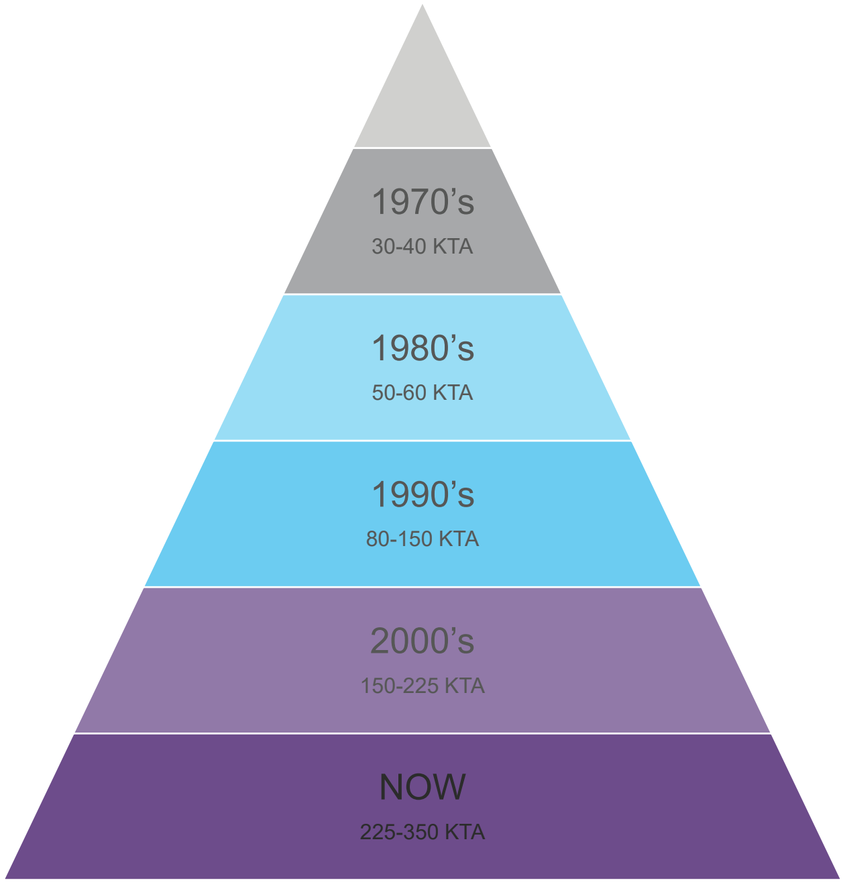
1St Ethylene Forum – 30 September 1975 New York City

STONE & WEBSTER USC TYPE CRACKING FURNACE



Furnace Capacity Trends

Ethylene production is normally measured in KTA (thousand tonnes per annum)



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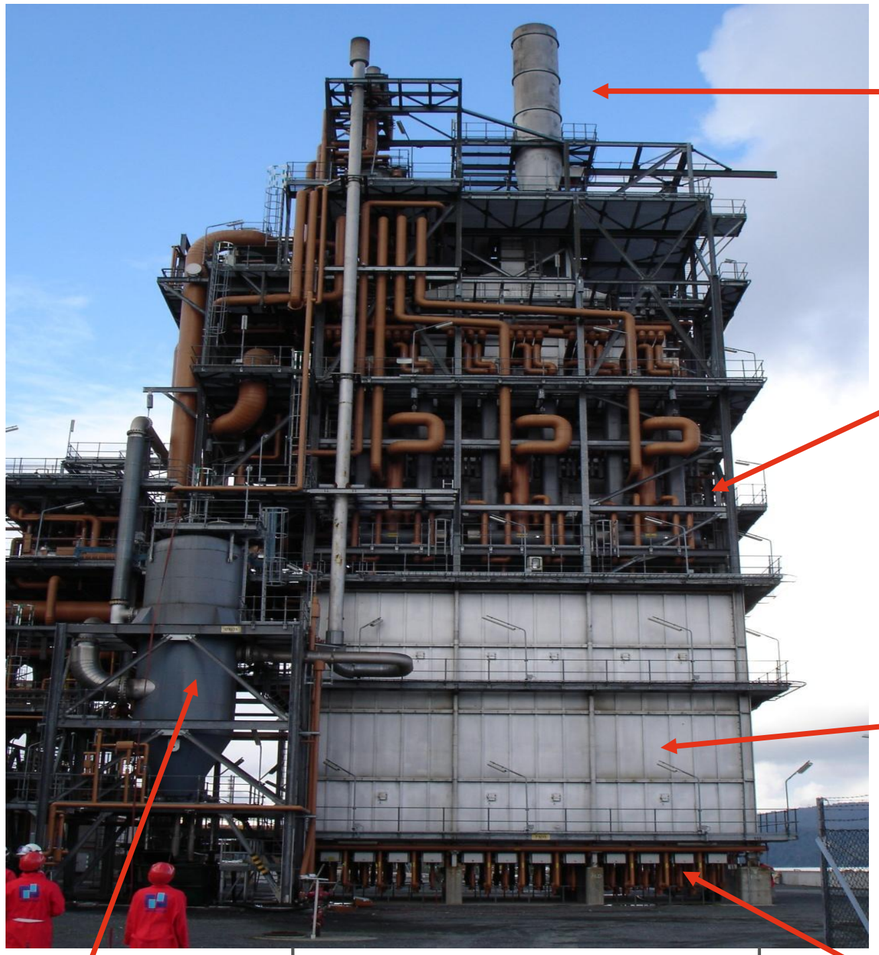
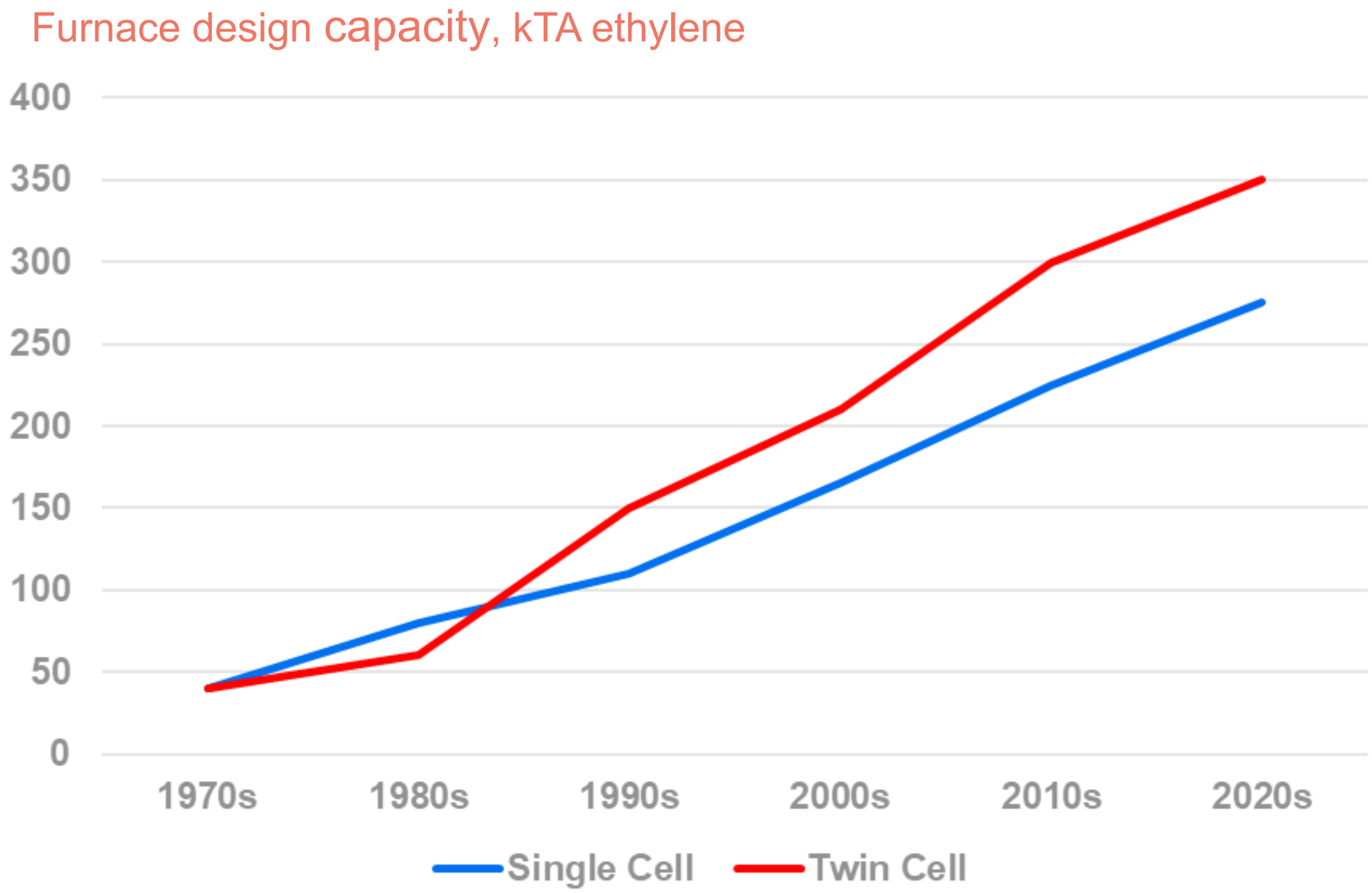
What does a Furnace actually look like?



Furnace capacities have increased



Technip Energies has designed the world's highest capacity operating furnace: 224 kTA Ethylene Liquid Feed/ 350 kTA Ethylene Gas Feed

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Radiant Box: Footprint

Operating (1997)

- 30.1 m length

Operating (2017)

- 32.6 m length

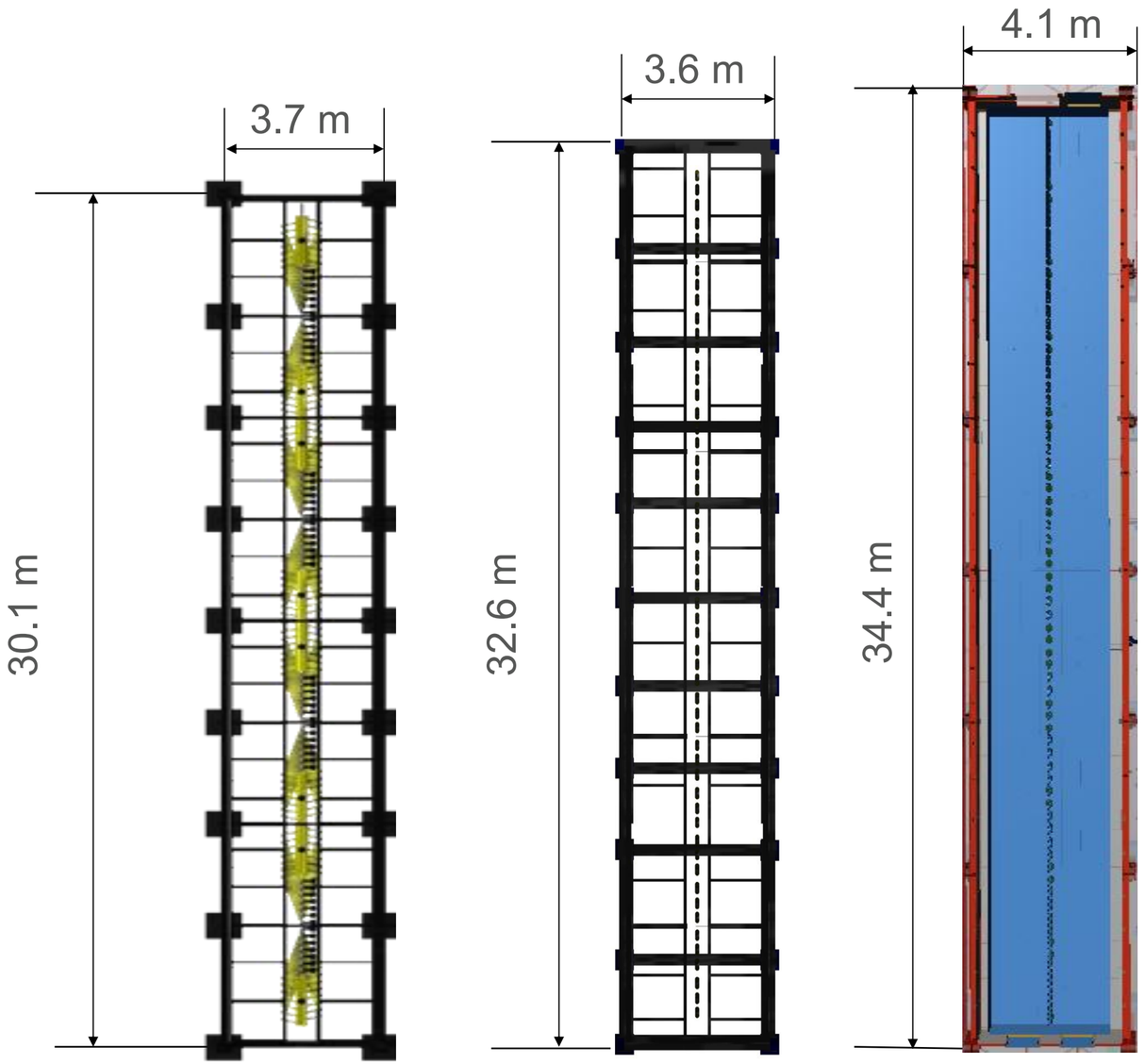
Operating (2024)

- 34.4 m length

Future

- Under evaluation

Double Capacity with Twin Cell



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“It’s not rocket science”…or is it?

AI Overview

The Saturn V's first stage (S-IC) released approximately 7.3 terajoules (TJ) of total energy, equivalent to the power of about 190 gigawatts for its 168-second burn time, by consuming RP-1 (kerosene) and liquid oxygen. This enormous energy output, though difficult to quantify exactly due to atmospheric conditions and inefficiencies, was primarily transformed into the rocket's kinetic and potential energy.

Technip Energies Low-emission cracking furnace
A first step towards a decarbonized ethylene plant

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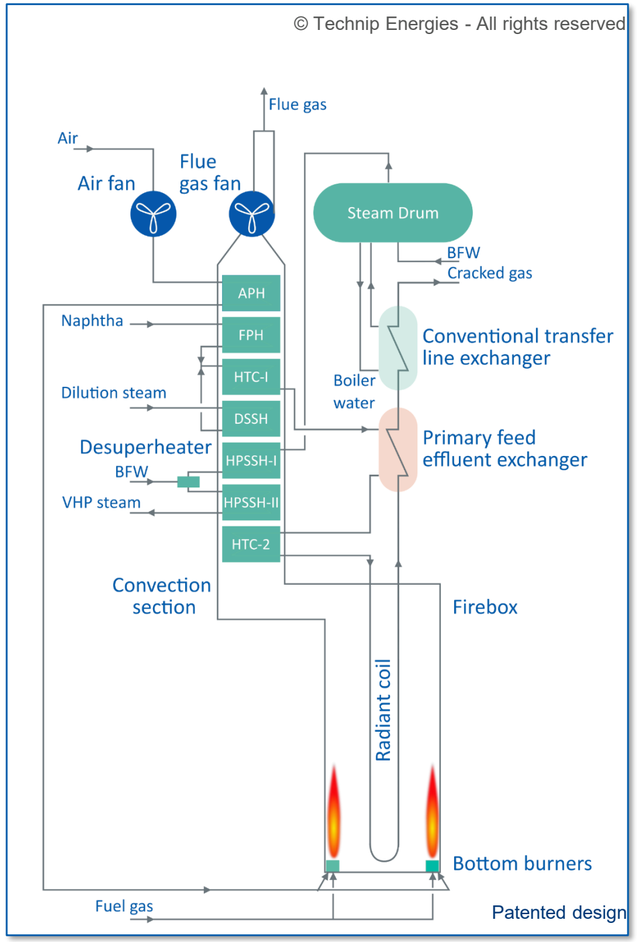
Low-emission cracking furnace

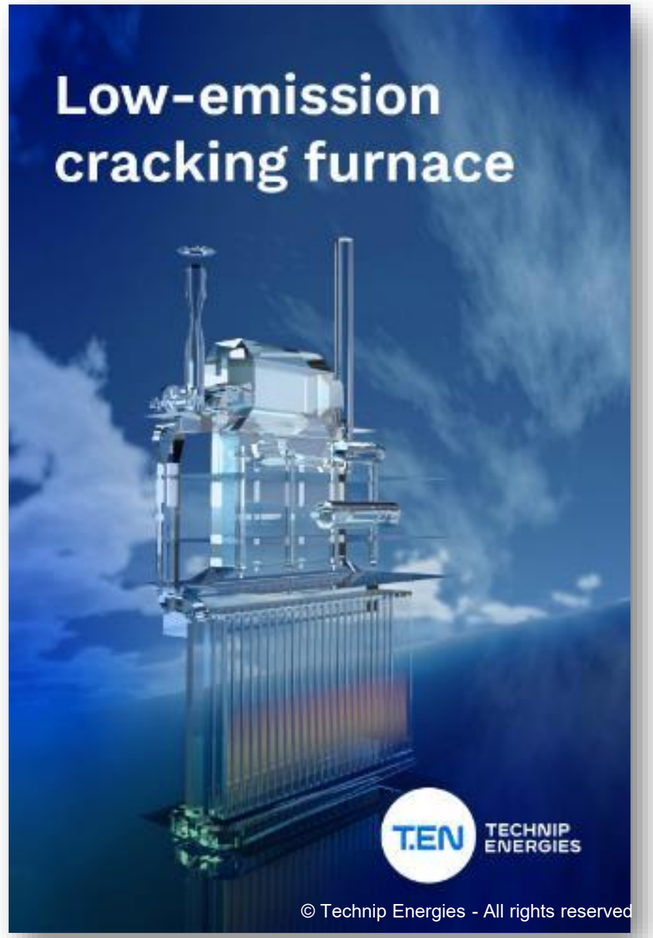
Key technology towards Net Zero ambition



Reduces fuel consumption and CO_2 emissions by 30%

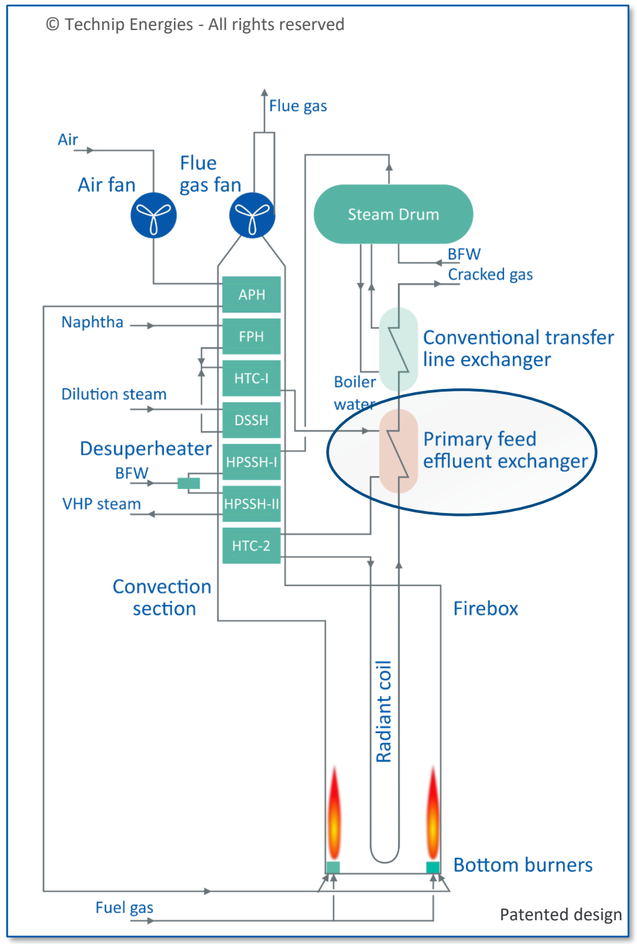
Higher fuel efficiency makes firing hydrogen more economically attractive

Cost-effective design with short pay-back time



Low emission furnace – PFEE required

Testing program arranged for dedicated designs



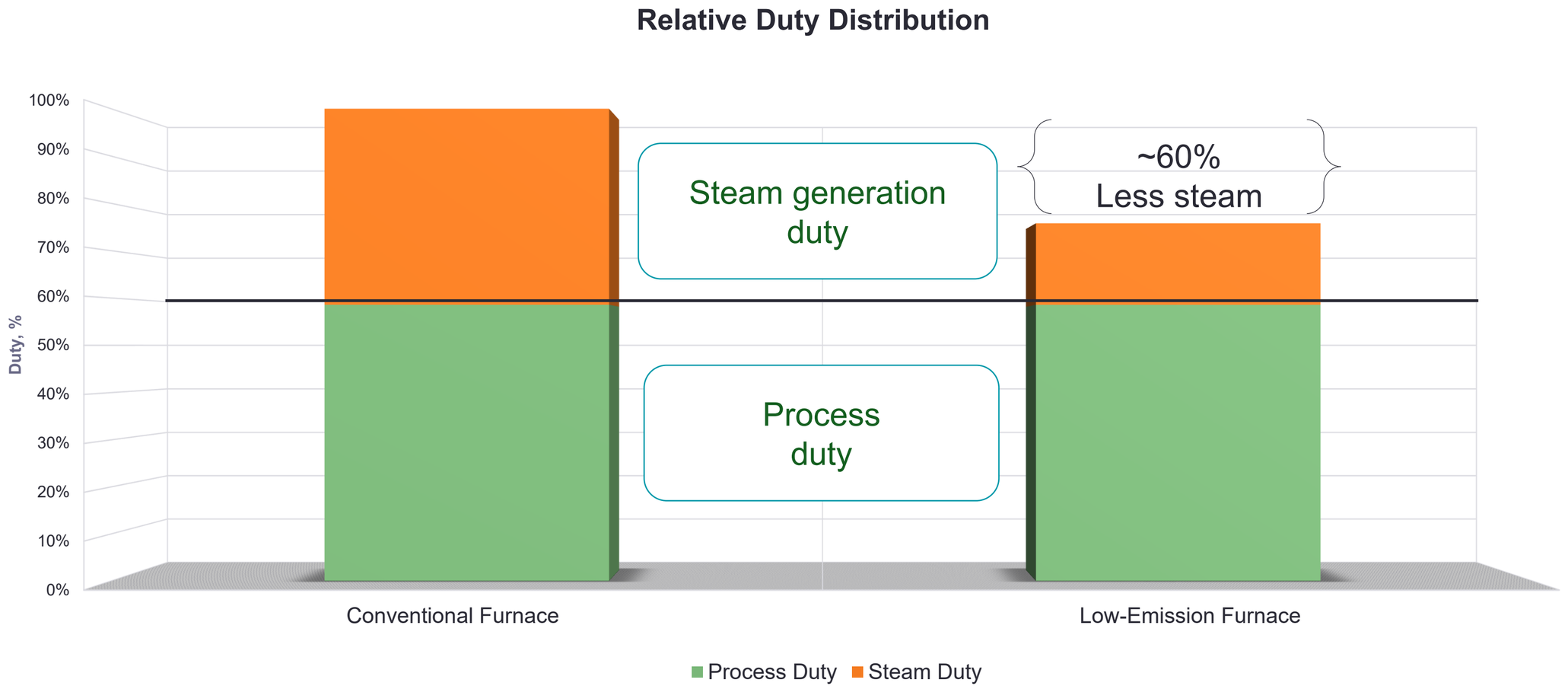
Most components have a high maturity level

New Primary Feed Effluent Exchanger (PFEE)

PFEE testing program arranged

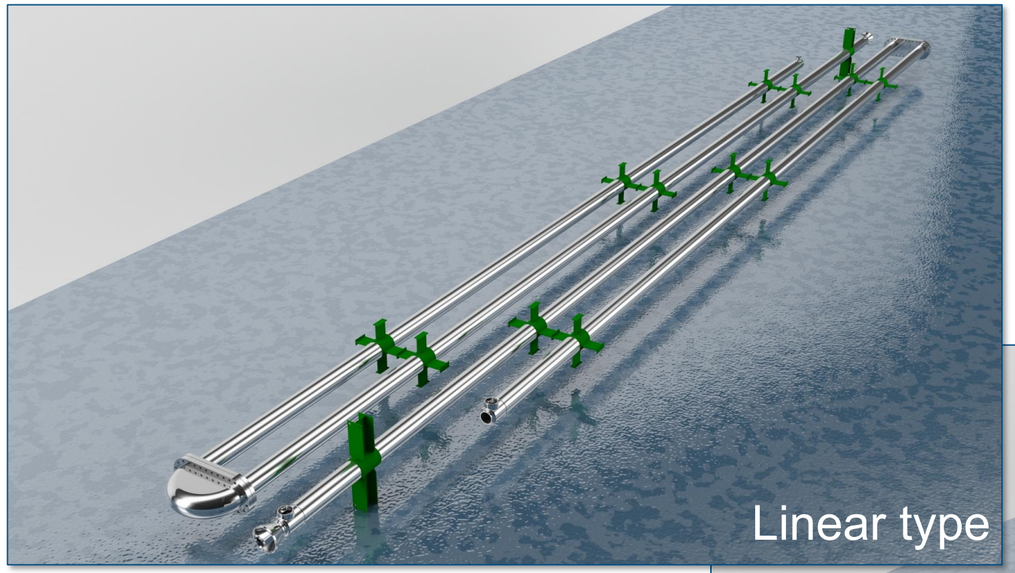
Duties redistributed in favor of process duty

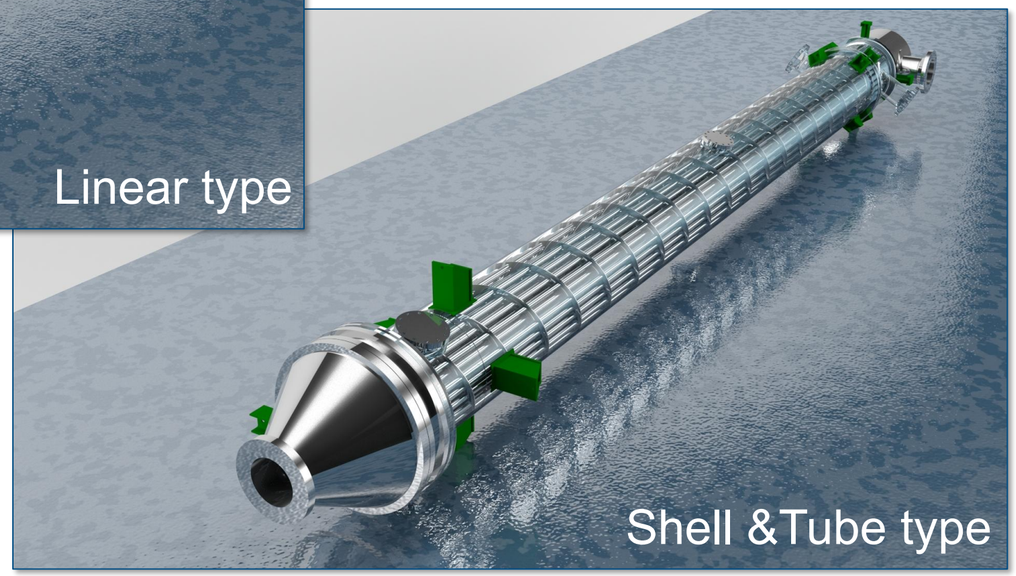
As less fuel is fired, flue gas emissions are reduced as well as recovered steam



Two Primary Feed Effluent TLE designs

Suitable for various low emission cracking technologies





Required for all future low emission cracking technologies

TWO PRIMARY FEED EFFLUENT TLE DESIGNS

Linear type

- Cracking furnace
- Electric furnace

Shell & Tube type

- Cracking furnace
- Electric furnace
- Rotating olefins cracker

Development of Shock Wave Heating

Rotating Olefins Cracker (ROC) is a Joint Development of Siemens Energy & Technip Energies

- Fundamental concept
  - Increase working fluid temperature with a shock wave
  - Steam/ hydrocarbon mix enters machine, is accelerated by impulse type stages to supersonic velocity, then decelerated in the diffuser section which hosts the shock wave
- Important characteristics of a turbomachine
  - **Driver agnostic** – decarbonize via electrification (motor drive) or H_2 fuels (GT drive)
  - **Scalable** – larger heat capacity requires only modest increase in machine size
  - **Direct application** of heat to working fluid

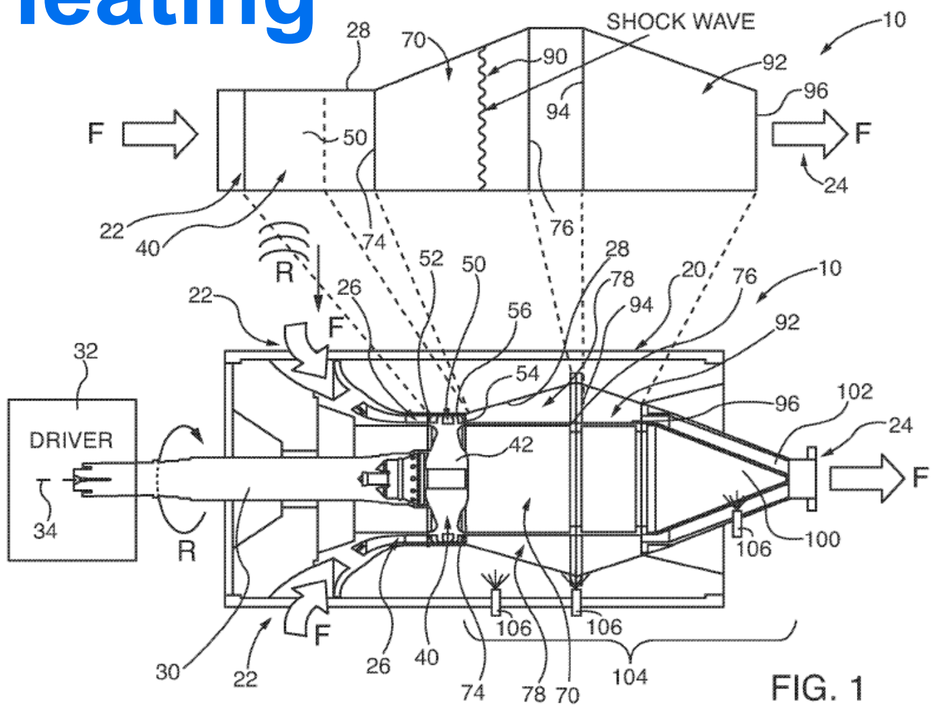
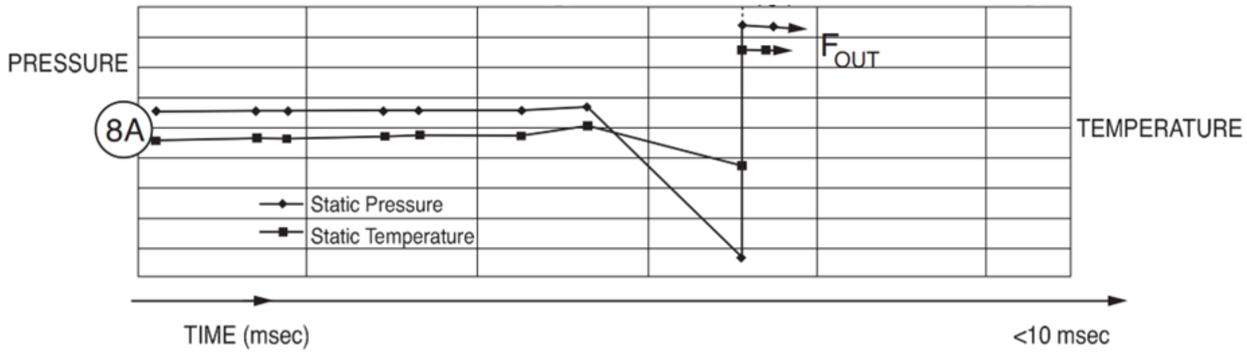
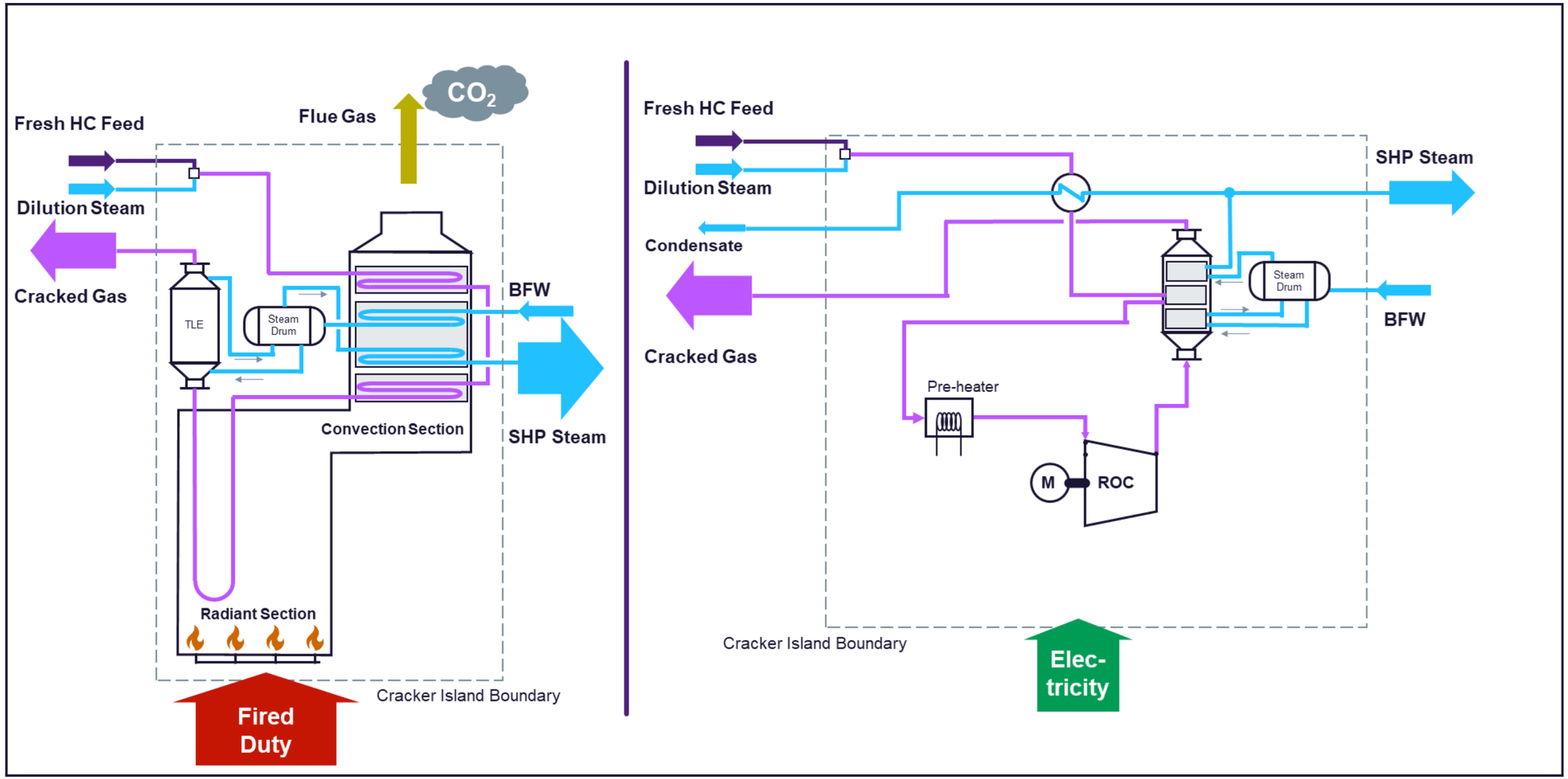


FIG. 1



Olefin Process, before and after ROC



Motor driven ROC with electric pre-heater eliminates all CO_2 emissions from the furnace with substantial improvement in specific energy consumption

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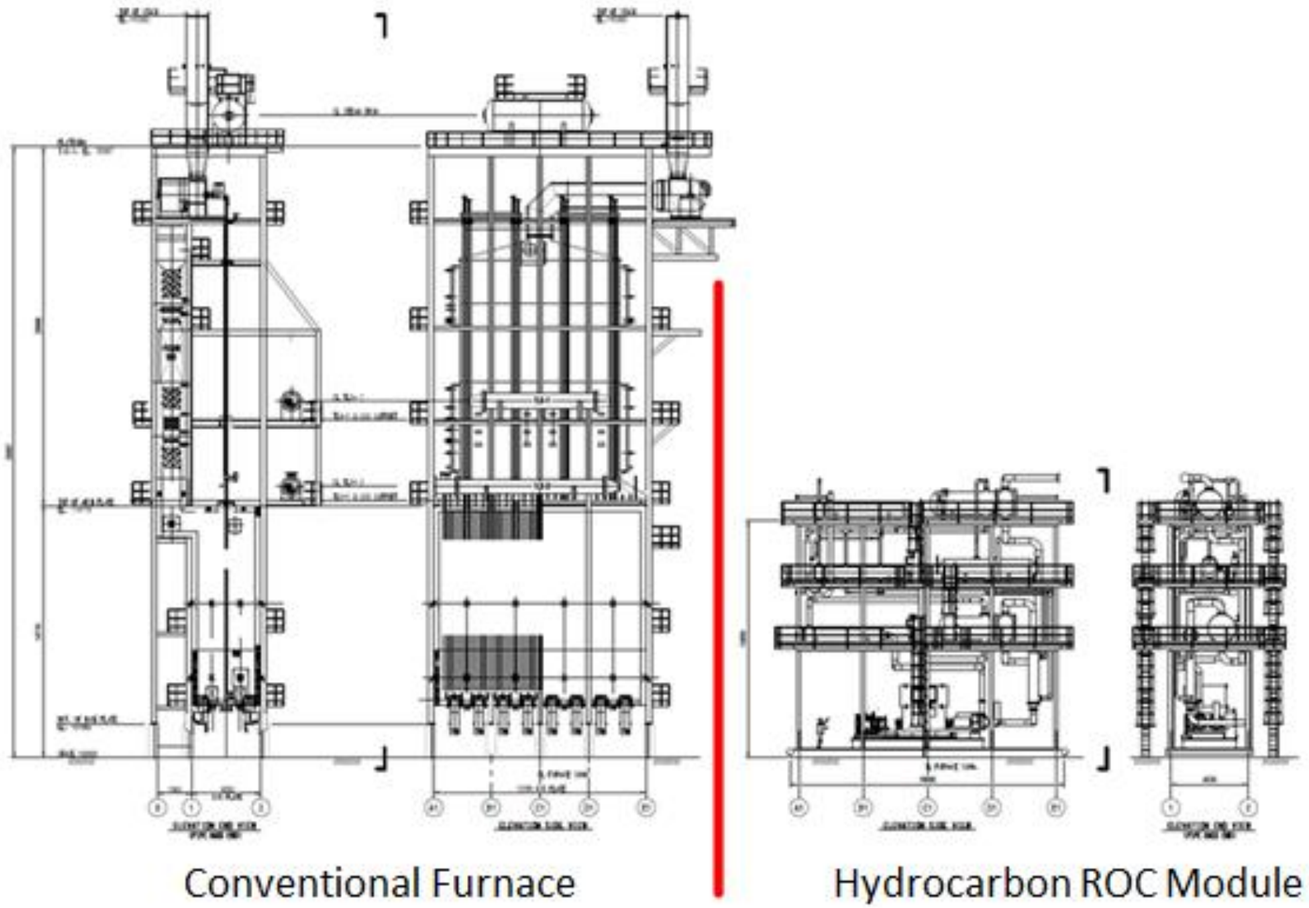
EUROPEAN ETHYLENE PRODUCERS COMMITTEE

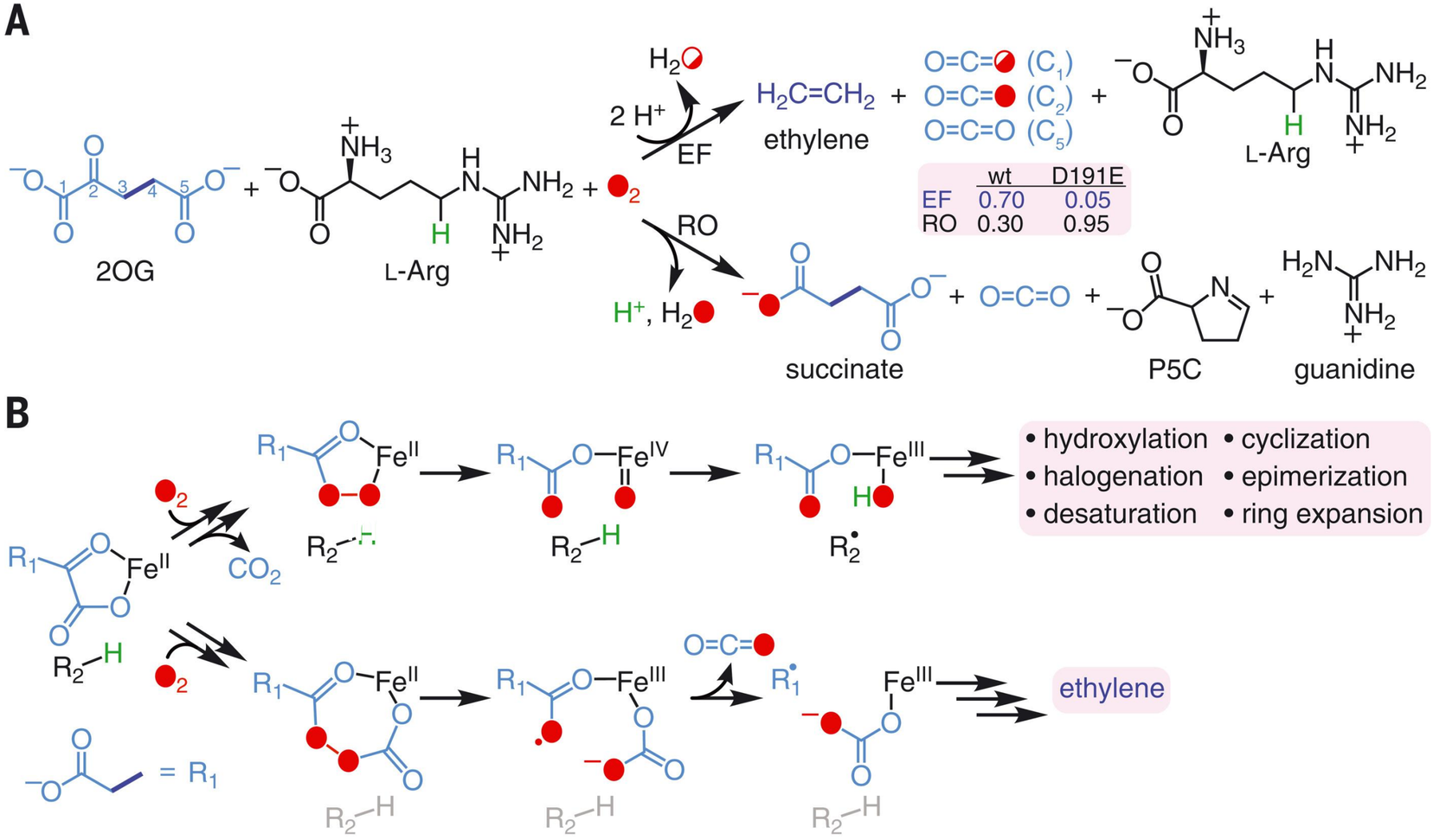
ROC Technology Unlocks CapEx and OpEx Benefits



- Significant footprint reduction due to compact method of imparting heat to the feedstock
- Turbomachinery based solution scales up well, doubling output for much less than double the equipment size
- Near instantaneous heating leads to smaller/ optimized reaction volumes – improved yield
- No surface heat exchange, minimizing potential to form carbon deposits which reduce capacity of system

The Future – Low energy

Microbial ethylene-forming enzyme (EFE)



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Thank You!

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