Steam Crackers at MPC

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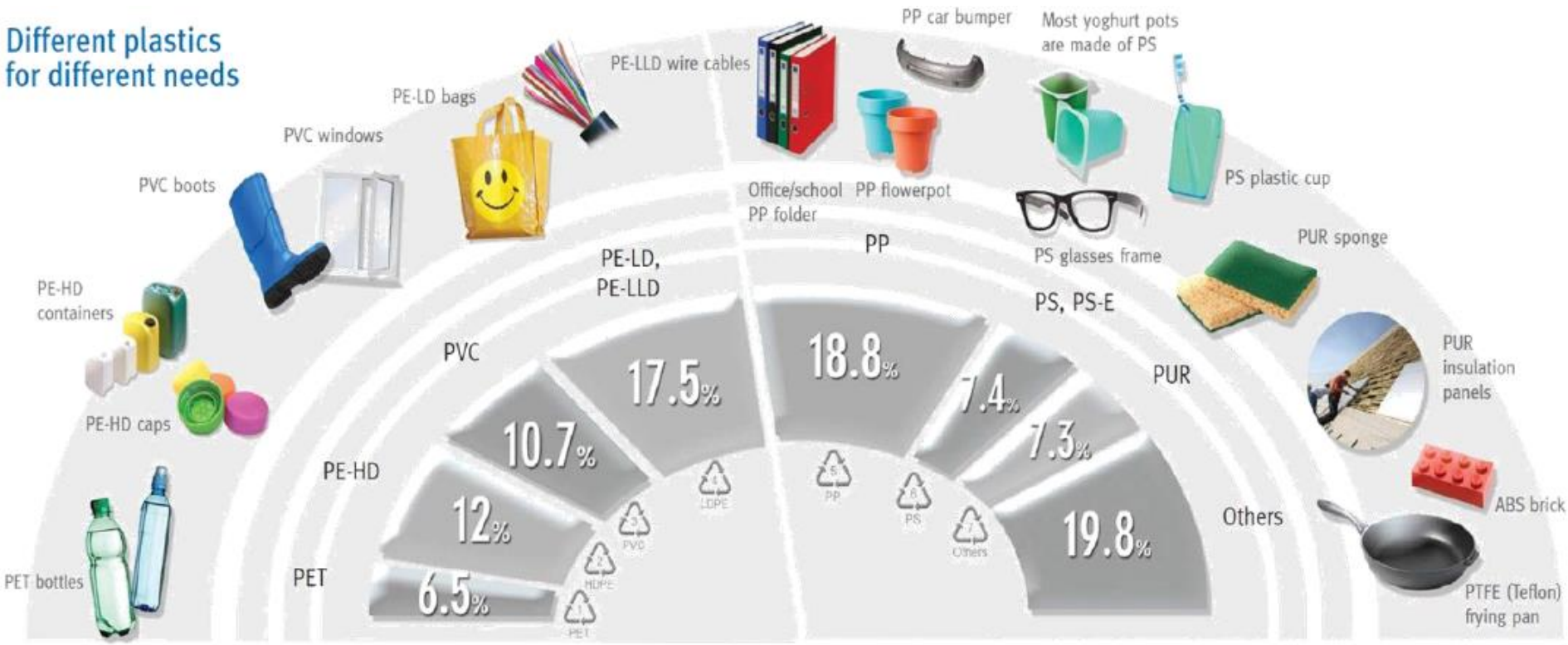
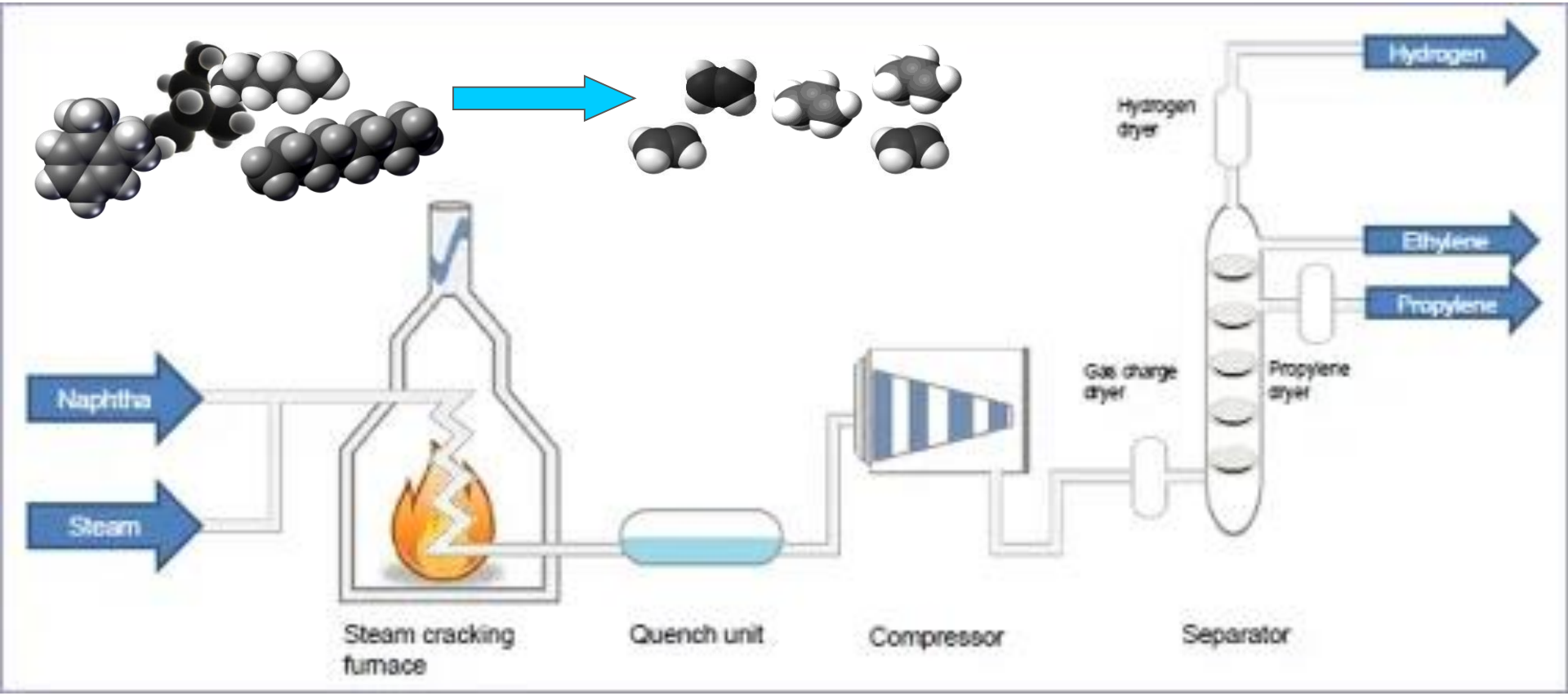
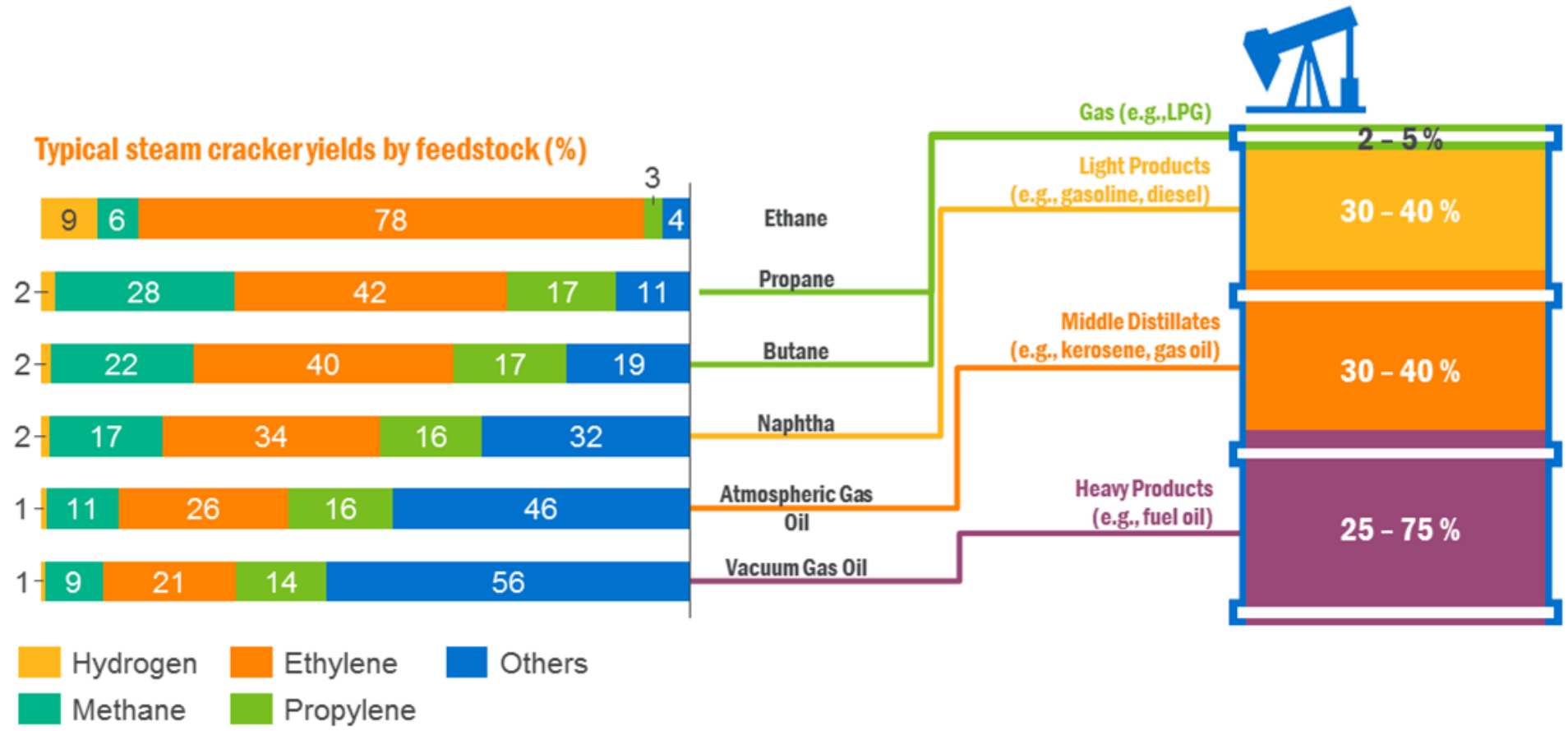
The world of plastics



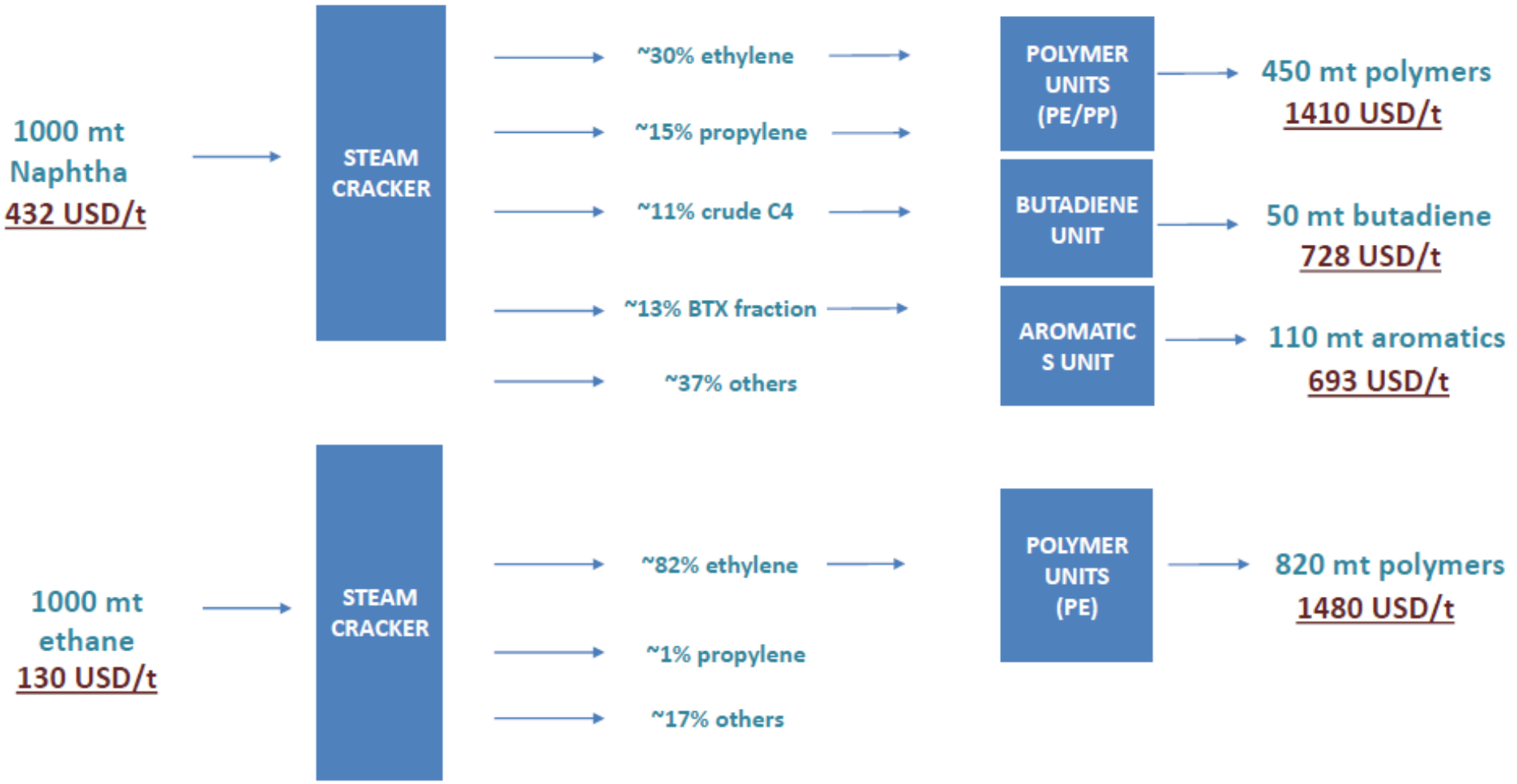
What is steamcracking?



SC feeds and yields



Economy of different feeds

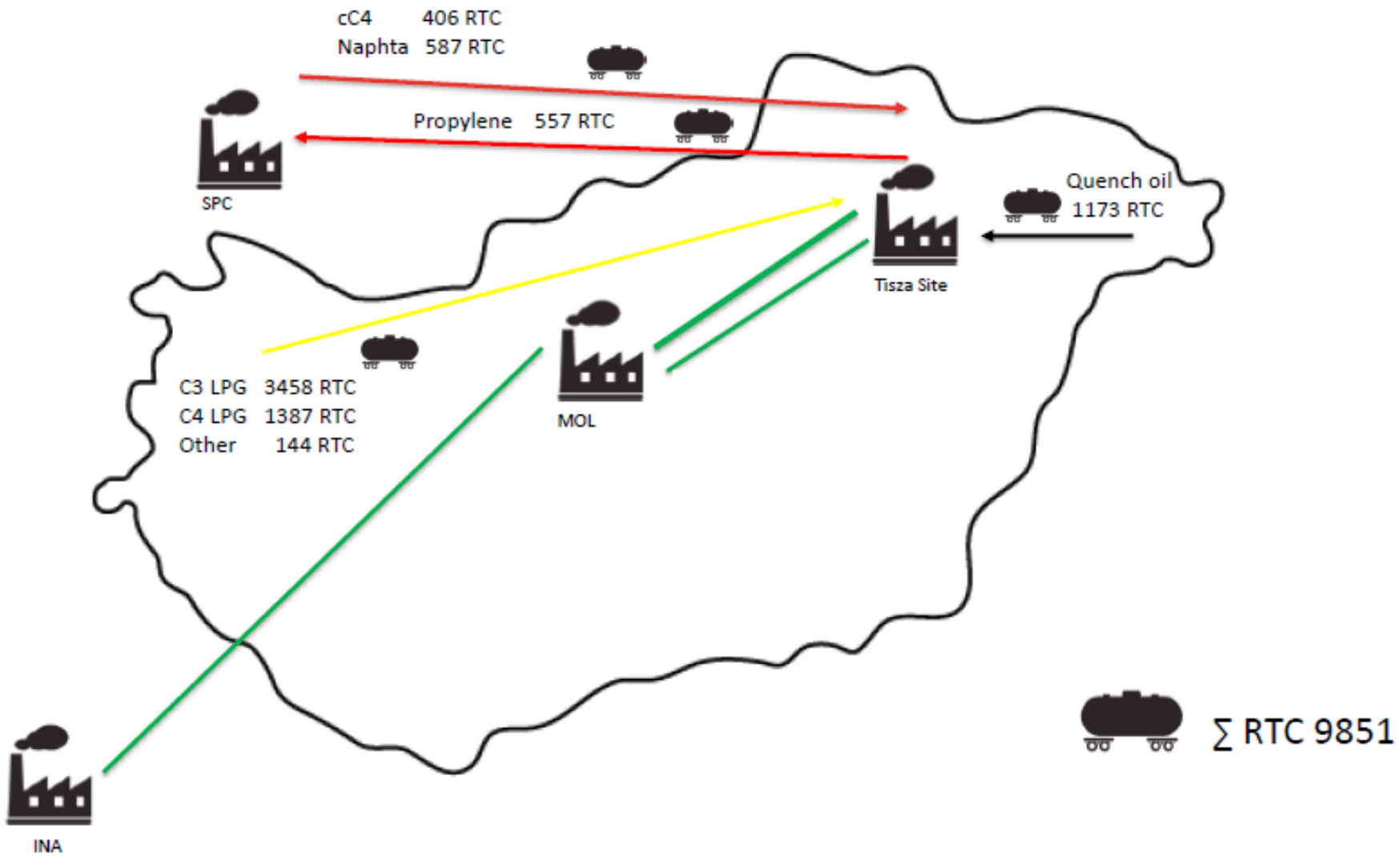


MOL Group

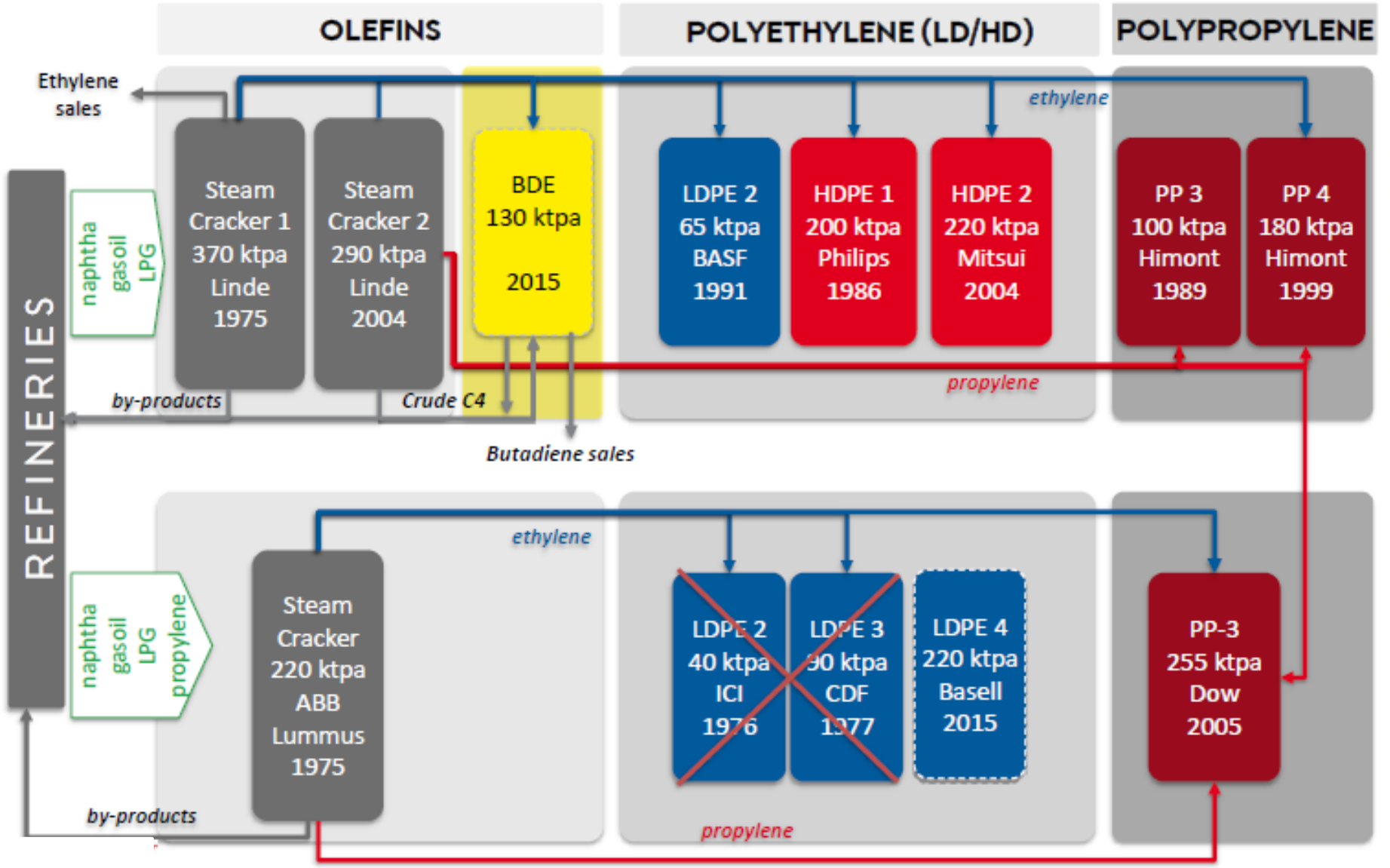

SPC
BRATISLAVA REFINERY
DANUBE REFINERY
MPC
RIJEKA REFINERY
Refinery
Petrochemical plant
Domestic and core markets
Ethylene pipeline
Oil pipeline
Petchem pipeline
Product depot

? m^3 ; ? kg / m^3

Railway connections



Petchem units of MOL



The Olefin Asset at MPC

Feeds : PCN, AGO, LPG

Cryogenic ethylene and propylene storage

SC-1 unit (Linde – 1975), 370 kta ethylene

SC-2 unit (Linde – 2004), 290 kta ethylene

Tank Yard

raw C4

BDEU

Ethylene
Propylene

LDPE-2, HDPE-1 & 2, PP-3 & 4, BorsodChem

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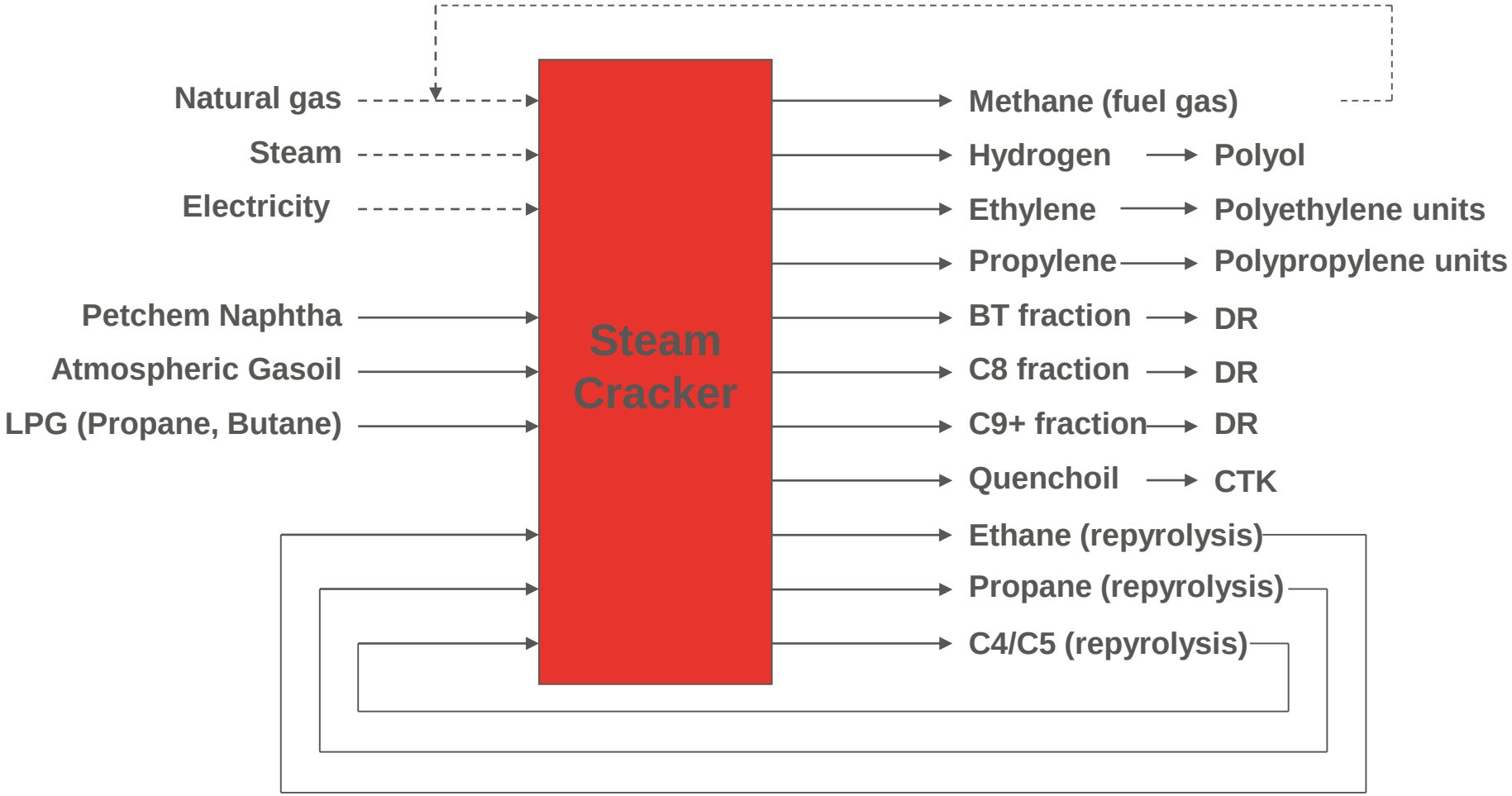
Analogy

Steam Crackers

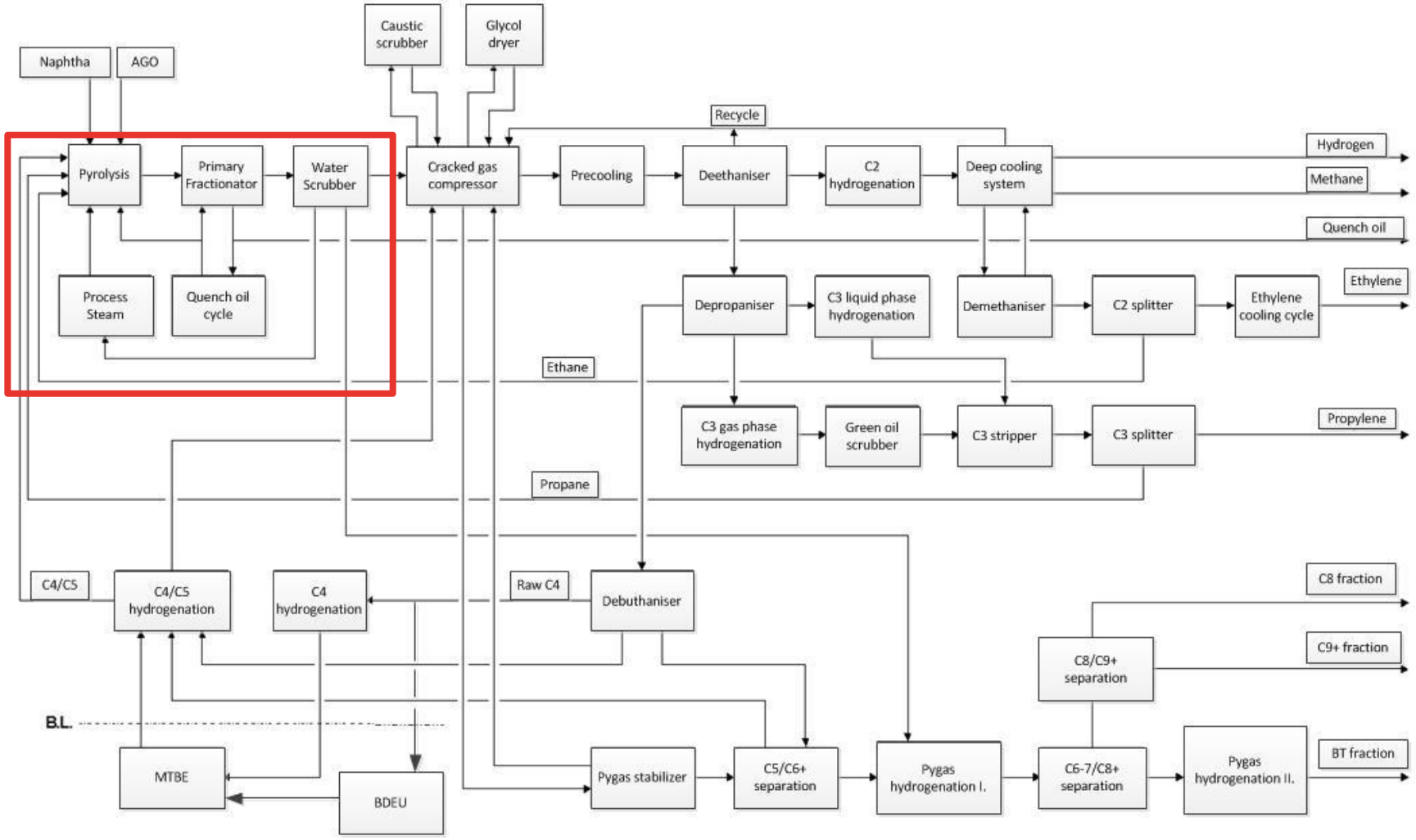
Polymer units

Material and energy streams of a Steam cracker



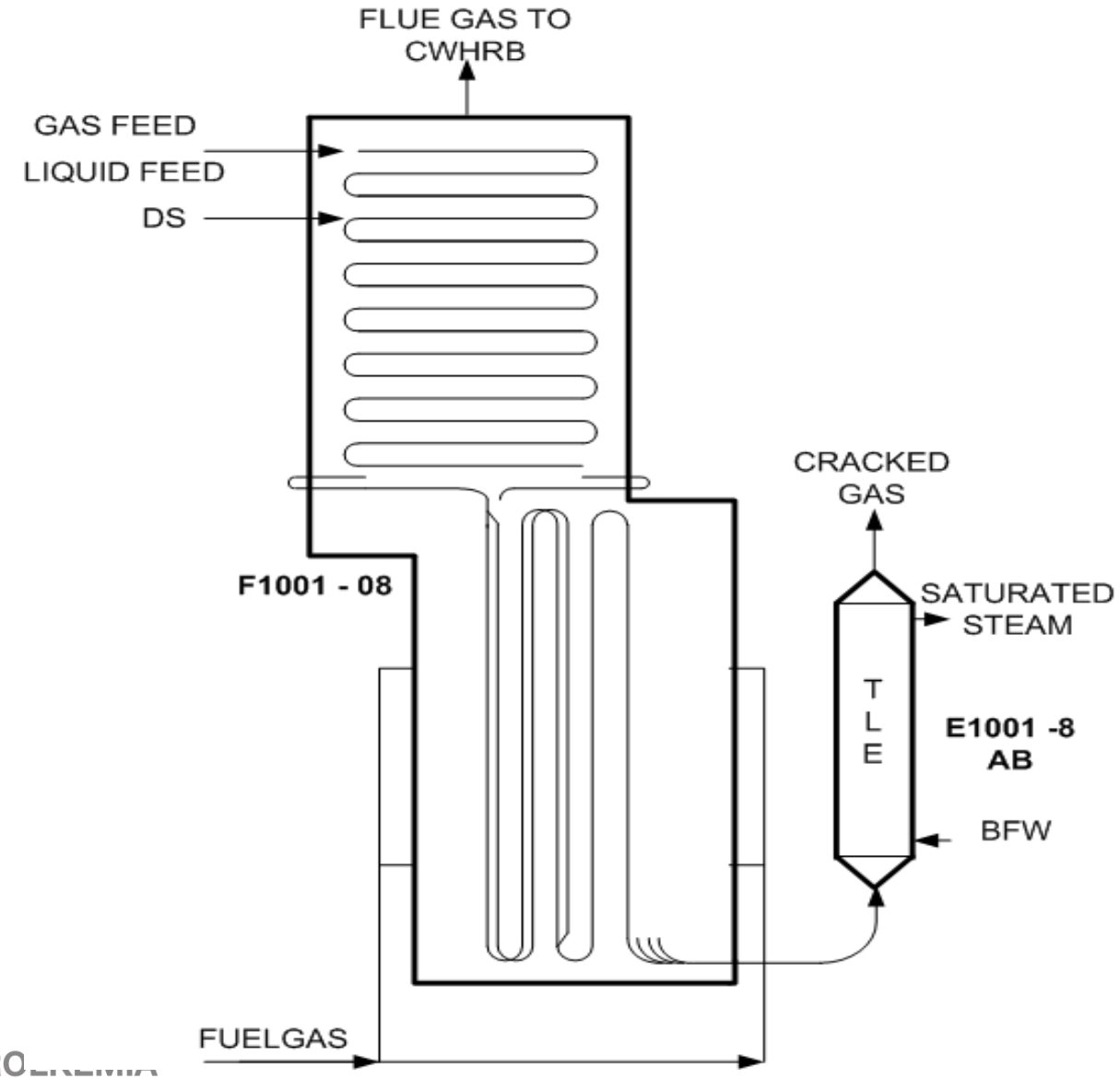
Steam Cracker-1

Block Scheme of SC-1
Hot section



SteamCracker-2 furnaces

StreamCracker-1 furnace scheme (F1001-8)



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Radiation section

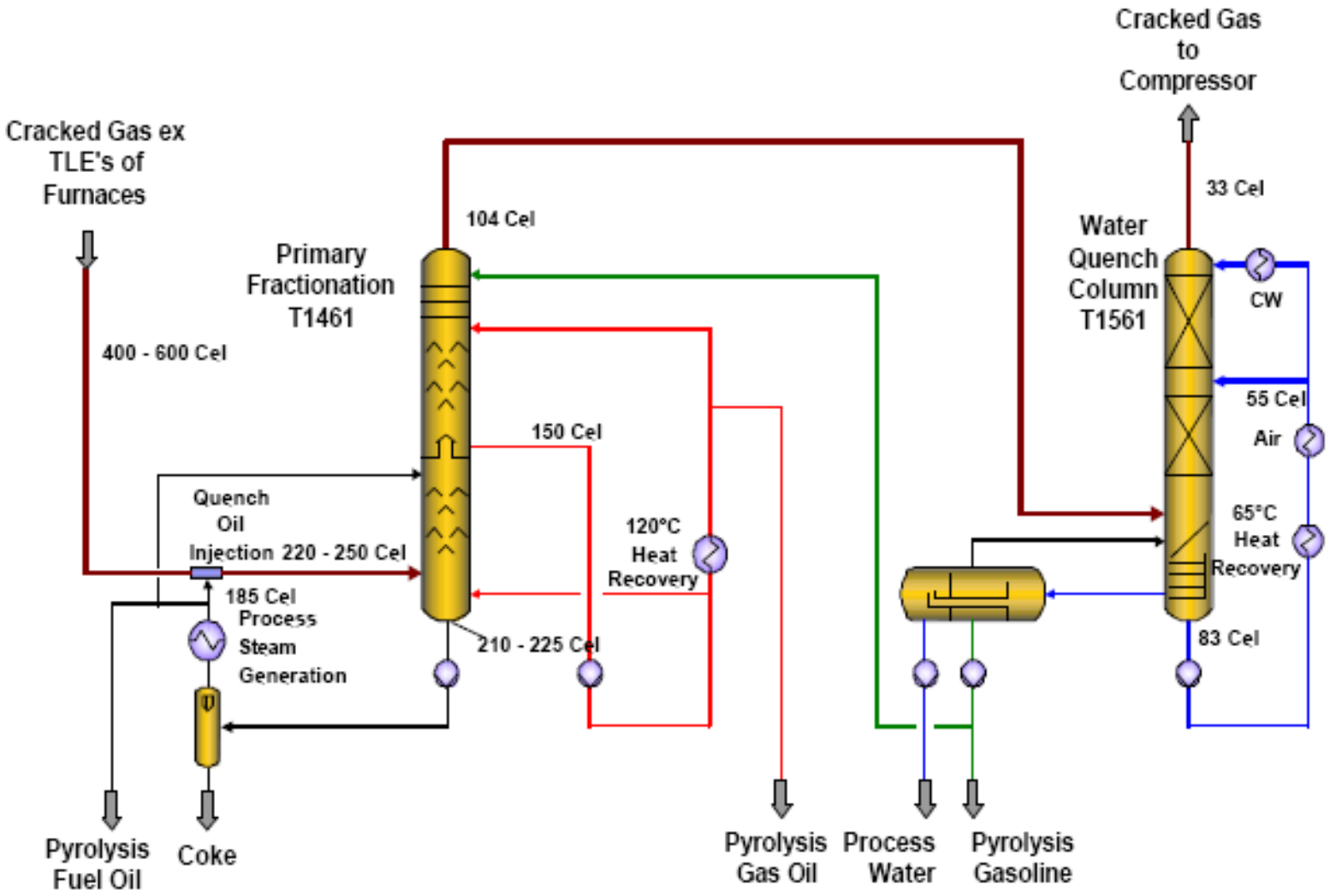
Pyrolitic parameters

- COT Temperature: 800 – 860 °C
- Outlet pressure: 0,3-0,6 barg
- Propylene/ethylene ratio= 0,45 – 0,6
- Steam/hydrocarbon ratio= 0,4 – 0,8
- Residence time: 0,1 – 0,5 sec
- Furnace runlength (between decokings): 30-80 days
- For SC-2 max load 4oo3 furnaces are needed
- For SC-1 max load 9oo11 furnaces are needed

The problem of coking

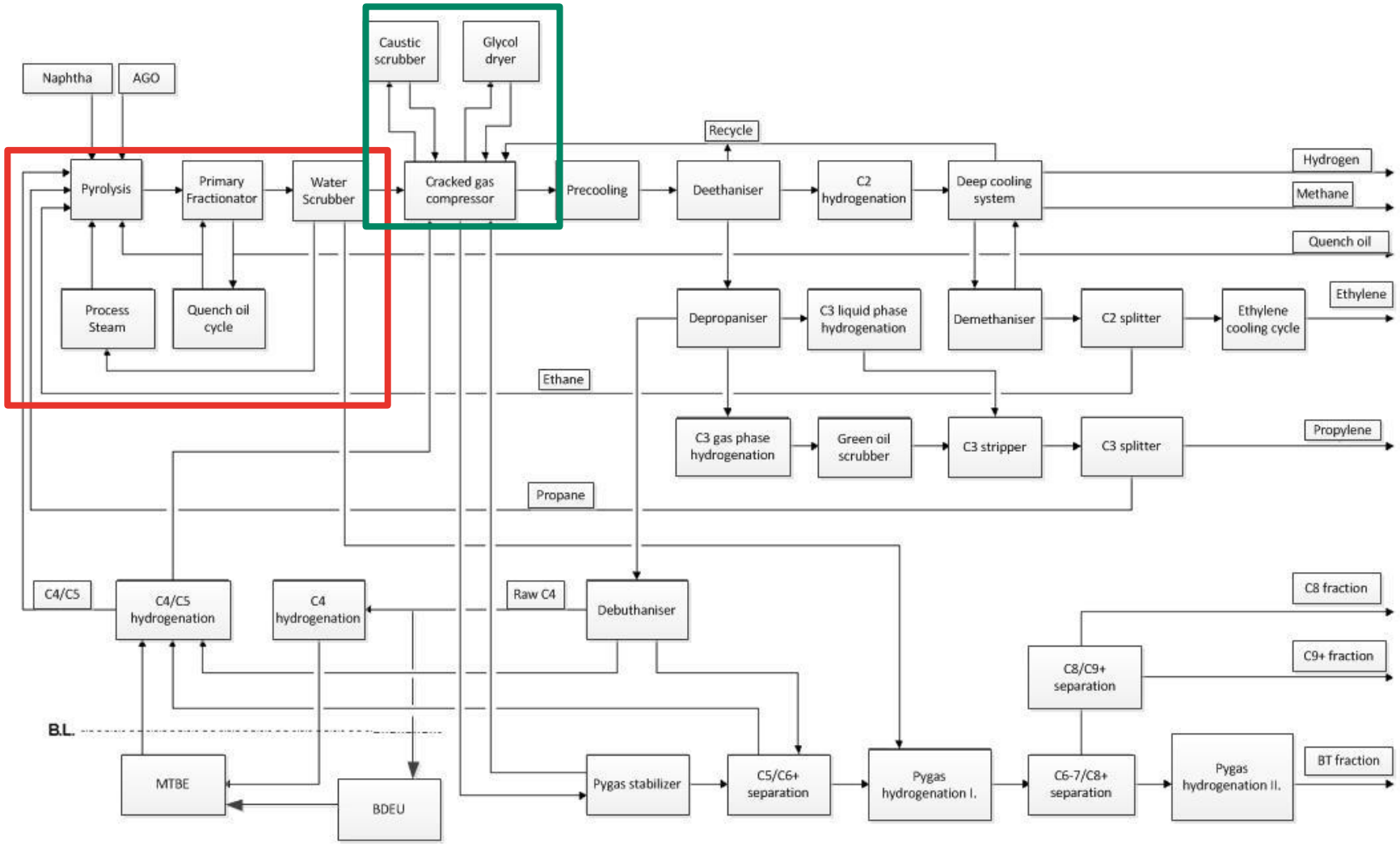
- During operation a coke layer formed in the radiant tubes
- At a given Tube Metal Temperature (TMT) the radiant tubes and has to be decoked
- Coke formation is catalysed by the Ni present in tube metal
- Sulfur is used to deactivate the Ni and retard coke formation
- Sulfur is dosed in form of DMDS that is decompose in the radiant zone and connect to the Ni, forms NiS

Oil and water quenching



SteamCracker-2

Block Scheme of SC-1 Compression

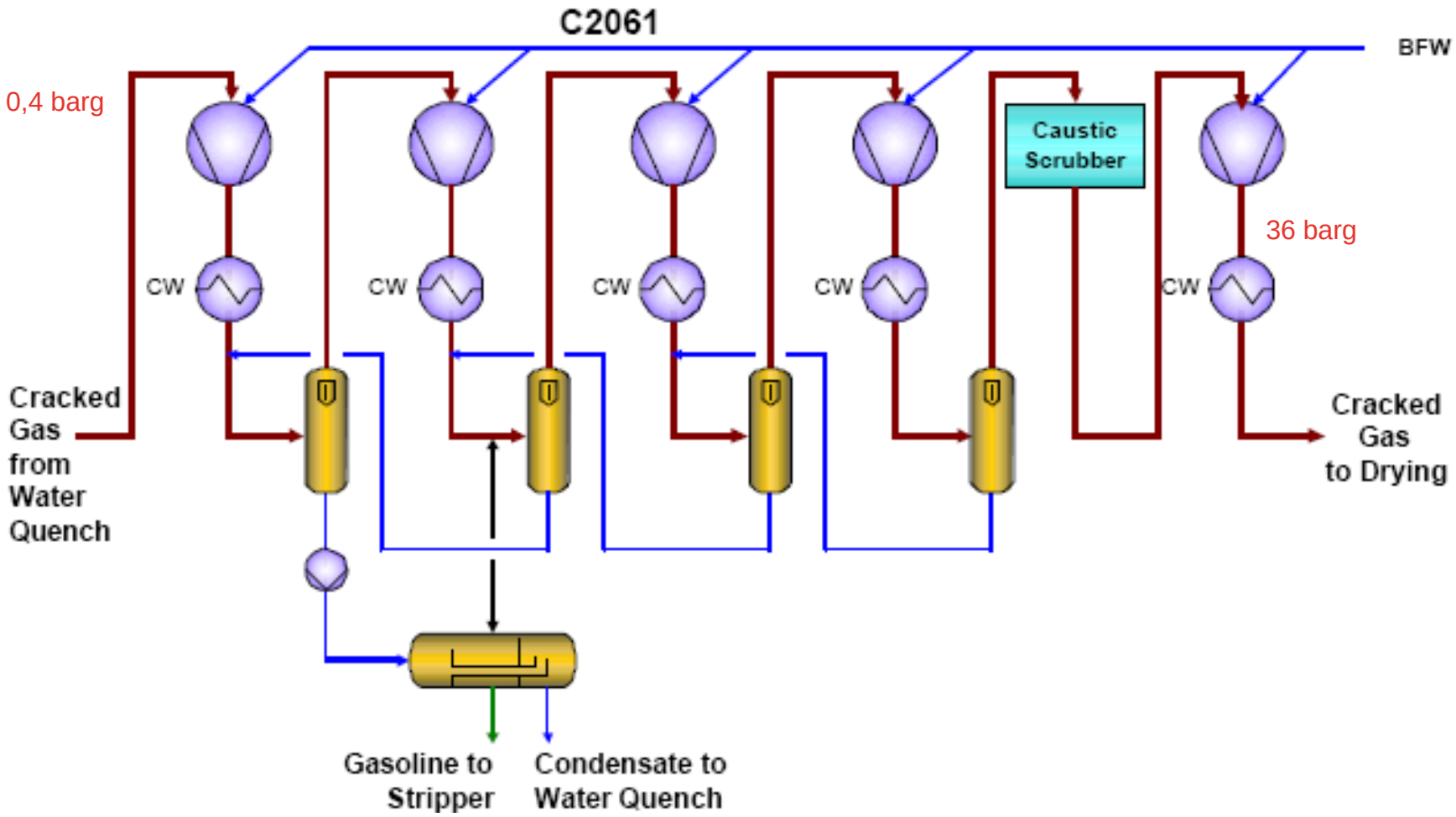


Cracked gas compression

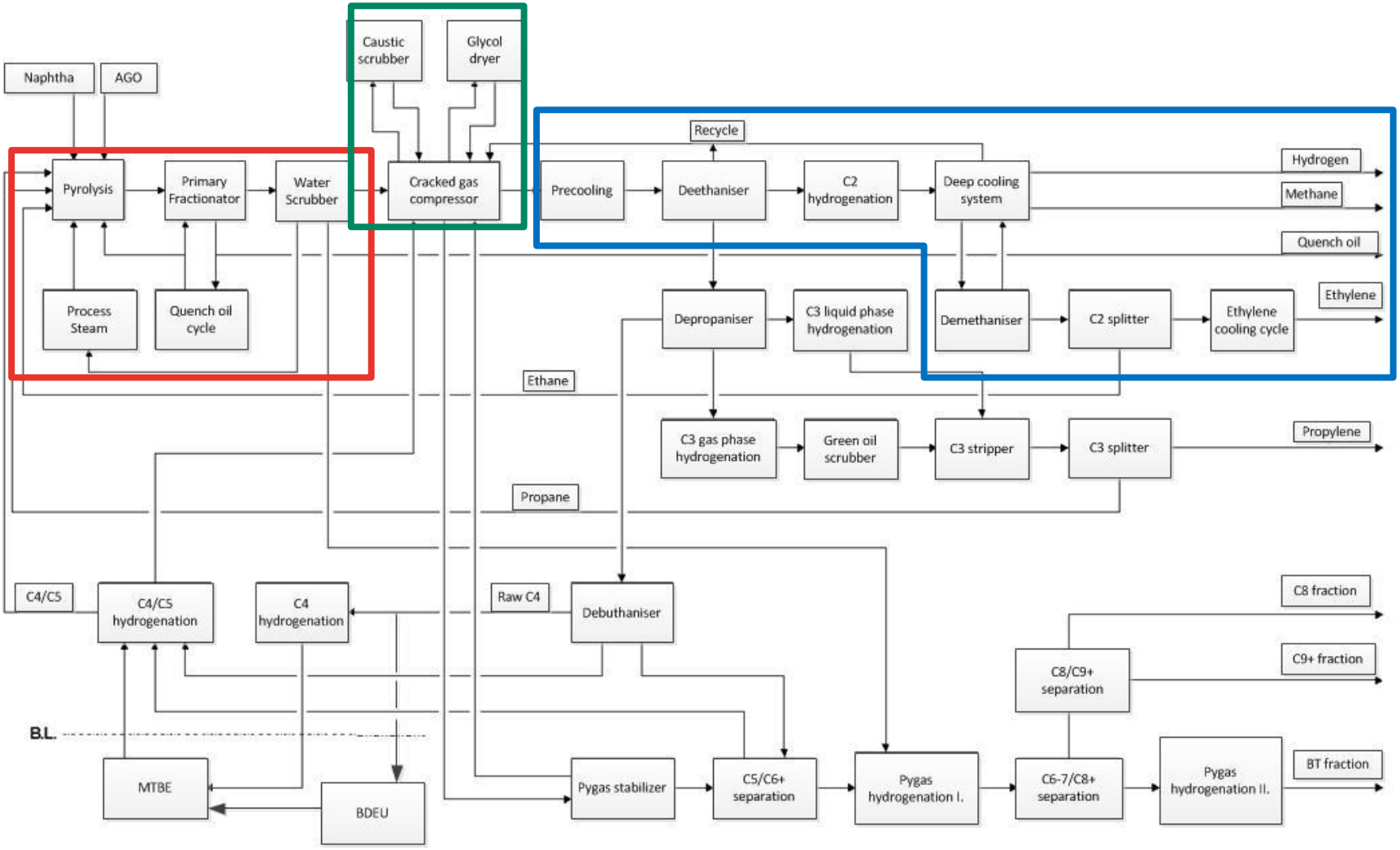
- The compression of cracked gas takes place in a five stage centrifugal turbo compressor
- Steam turbine driven
- The water and the higher hydrocarbons are condensed in the interstage coolers and collected separately in the knockout drums
- Caustic scrubber, Glycol (SC1)/molecular sieve (SC2)
- Suction pressure: 0,5 bar(g)
- Discharge pressure:
  - SC-1: 32 bar(g)
  - SC-2: 36 bar(g)

Cracked gas compressor – Steamcracker-2

Cracked gas compressor – Steamcracker-2



Block Scheme of SC-1
Cold section



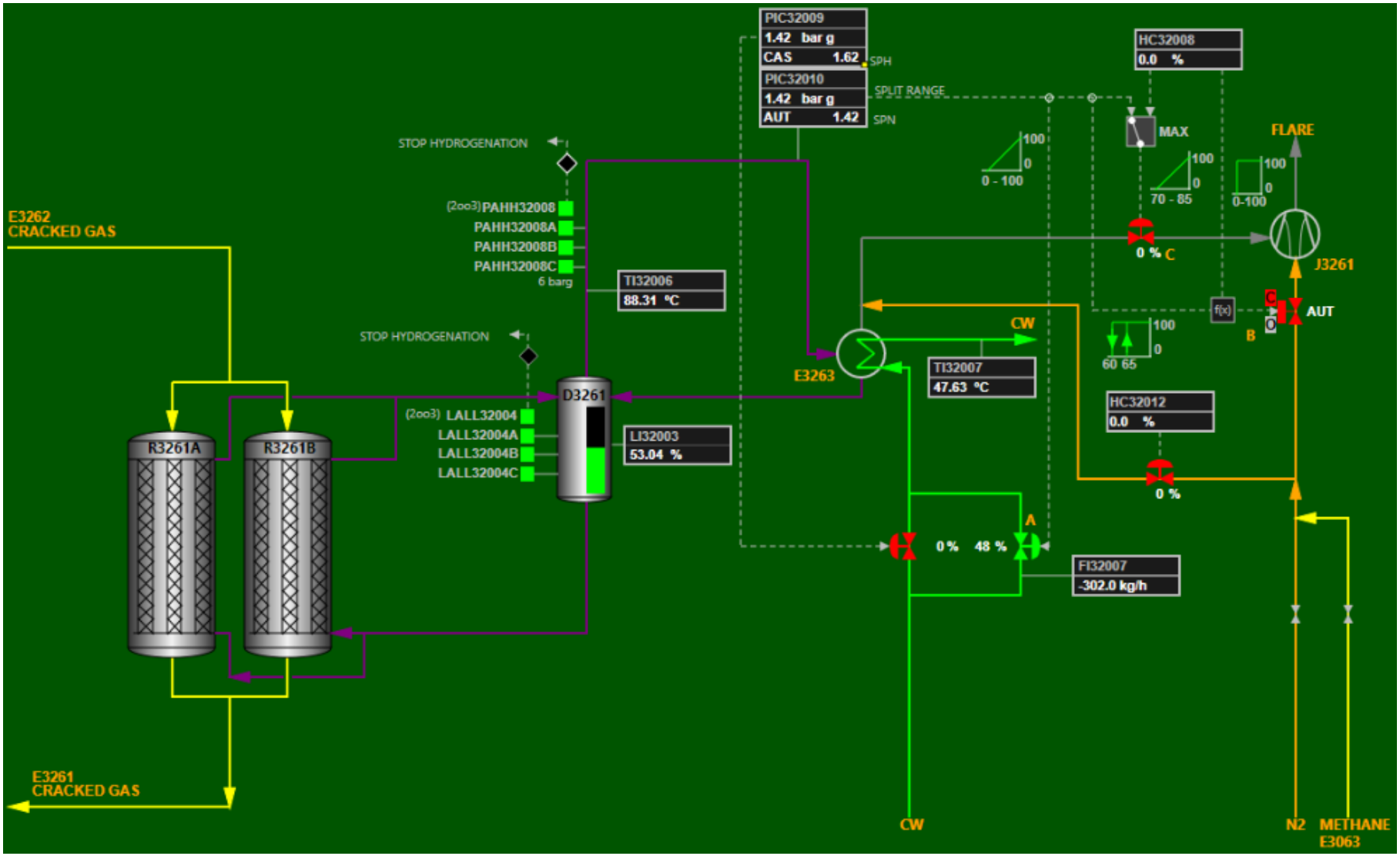
Precooling and drying

- The cracked gas from the CGC (~40°C) is cooled down to ~15°C
- Cooling with:
  - Recirculated streams coming from cold section,
  - Cooling with propylene heatexchangers.
- Condensate and gas separation in knock out drums
- Drying with molecular sieve in SC2
  - Separate liquid and gas drying
  - Dryer regeneration with warm methane stream
- C_{2-}/C_{3+} separation (deethanizer columns)

Acethylene isotherm hydrogenation

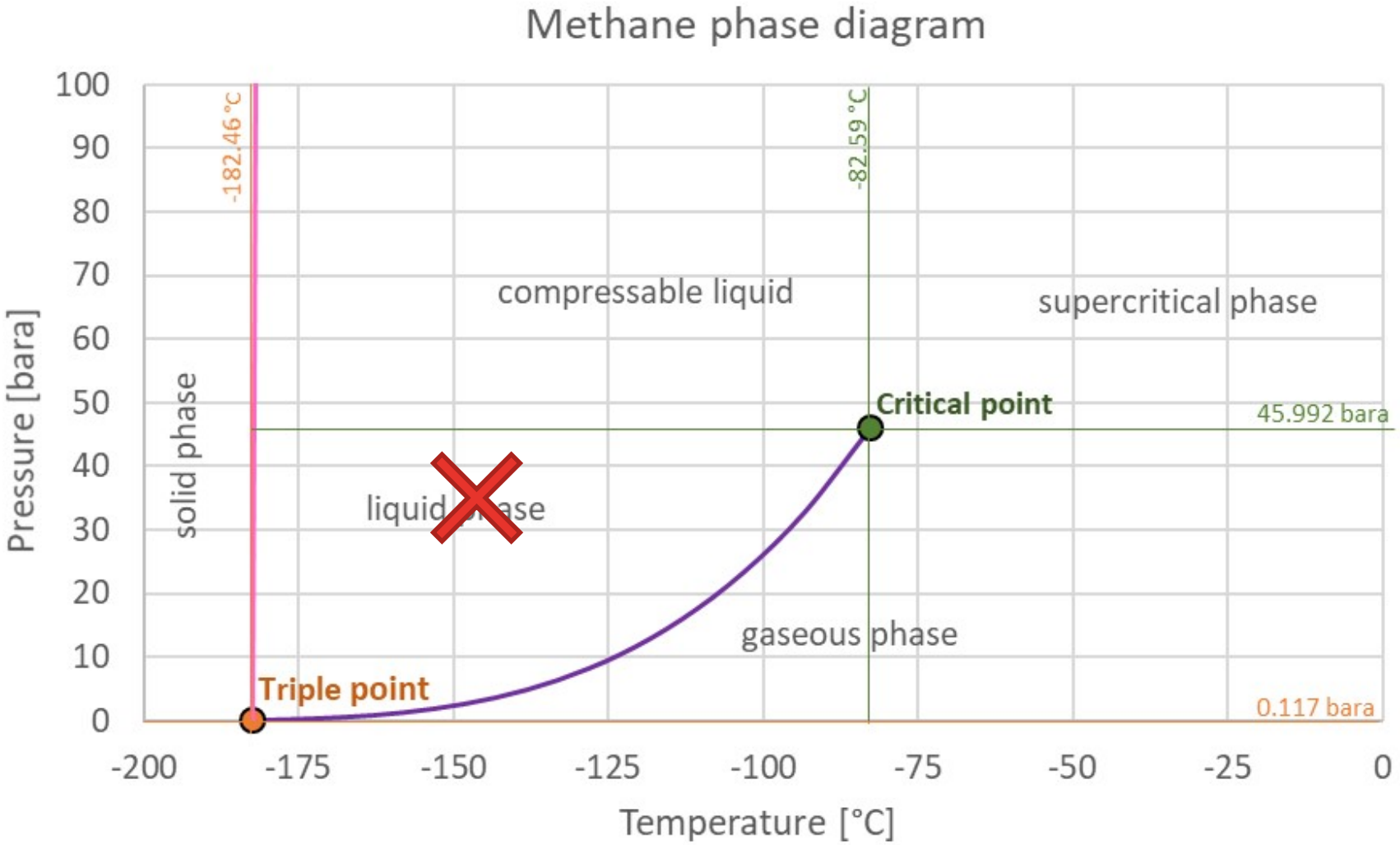
- Front-end design – hydrogen is in the feed
- Isotherm reactor – temperature is set with a closed methanol cycle
- Reaction controlled with inlet temperature and CO content
- Selectivity is ~70%; acethylene is reduced from 7000 ppm to 1 ppm
  - Ethylene product specification is <4 ppm acethylene
  - The run length of the Palladium catalyst is >5 years
  - Tubular reactor with 1210 tubes
  - Two parallel reactor, change is only possible during a SD

Acethylene isotherm hydrogenation

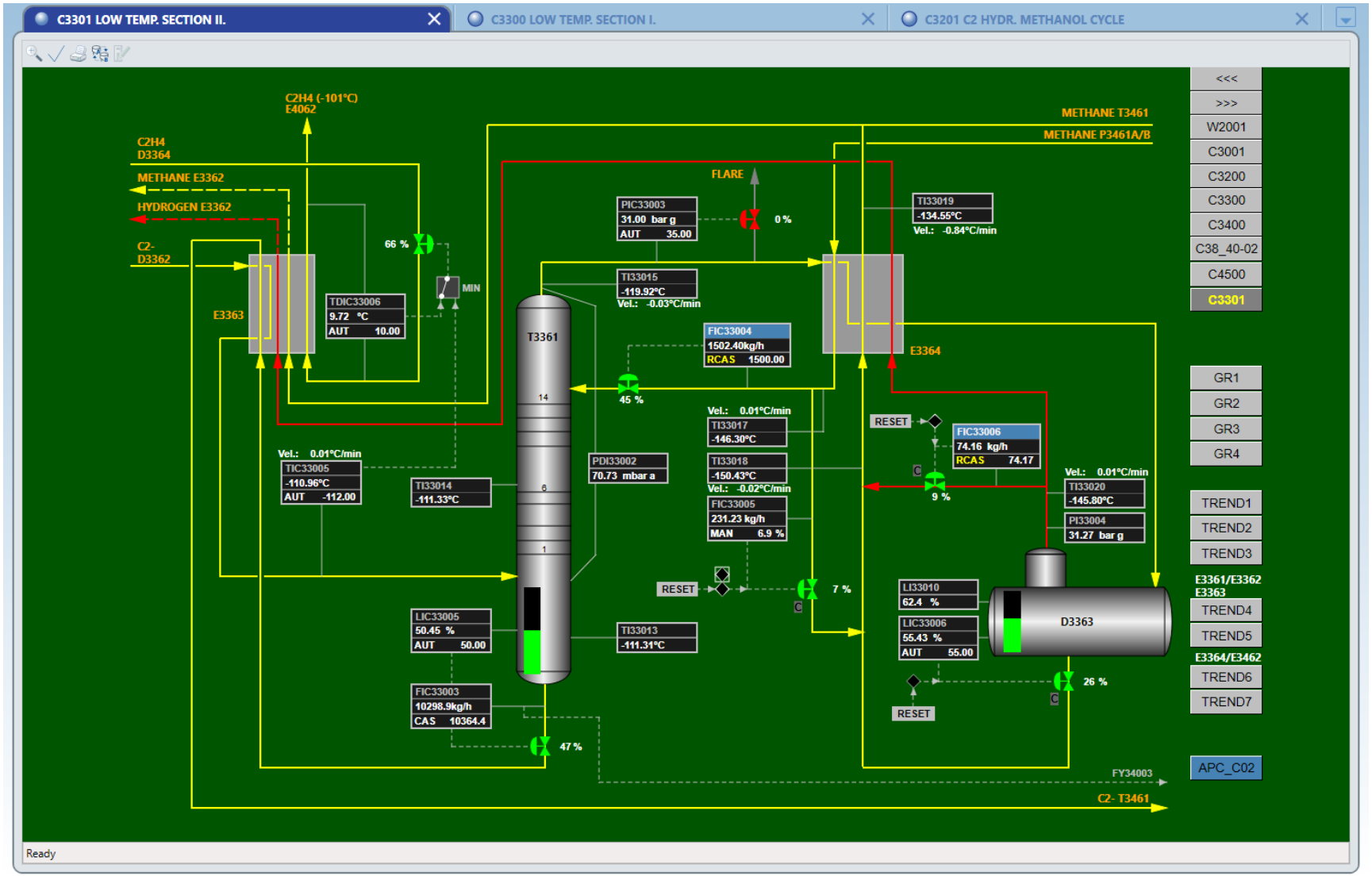


Cold section - C1/C2 separation (demethanizer)

- Cooling in several heat exchangers where part of the ethane, ethylene and methane are condensing
- Cooling with ethylene cycle and recirculated cold streams from the very end of the cold section
- At the end of the process the stream reach -146°C where only the hydrogen and small part of the methane remains in gas phase
- Condensates are routed to the demethanizer column for C_1/C_2 separation


Methane phase diagram
Pressure [bara]
Temperature [°C]
100
90
80
70
60
50
40
30
20
10
0
-200
-175
-150
-125
-100
-75
-50
-25
0
-182.46 °C
-82.59 °C
compressable liquid
supercritical phase
solid phase
Critical point
45.992 bara
gaseous phase
Triple point
0.117 bara

C1/C2 separation

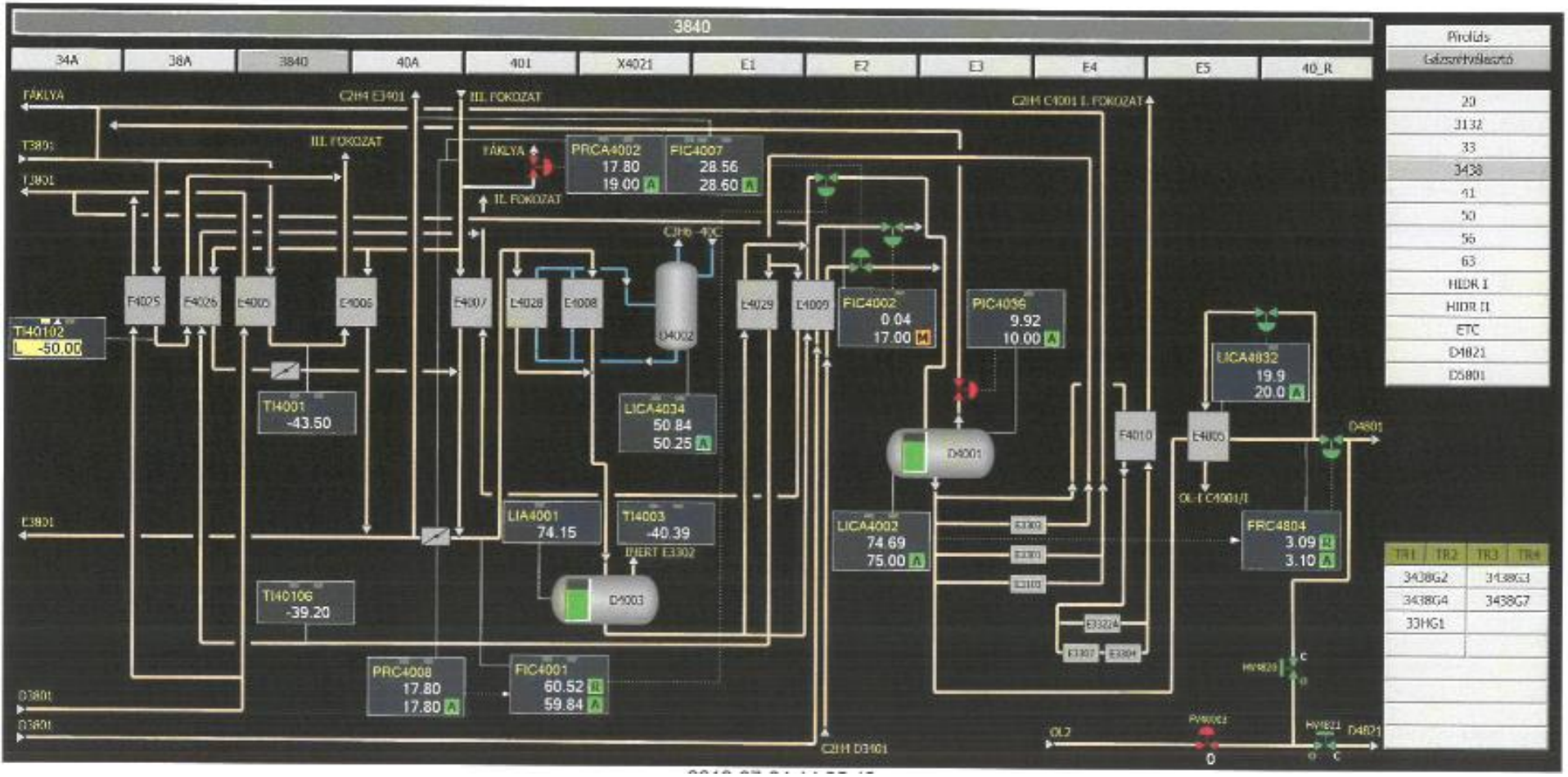


Ethylene cooling cycle

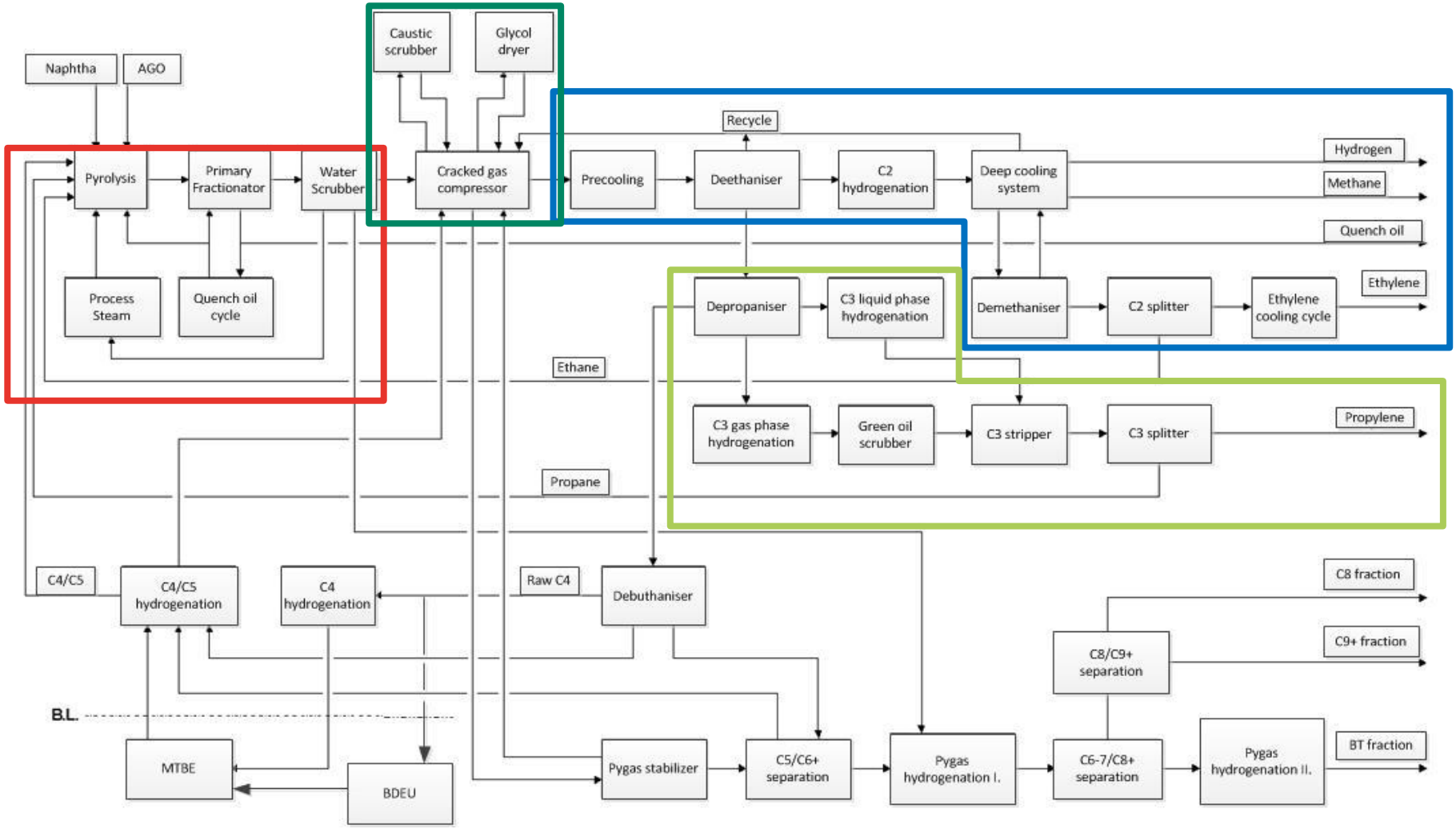
- Four stage centrifugal compressor
- Powered by steam turbine
- Open cycle:
  - The compressor produces the reflux of the column
  - Supply the ethylene heat exchangers with liquid ethylene,
  - Supply the polyethylene plants.

Ethylene compressor

Ethylene cycle



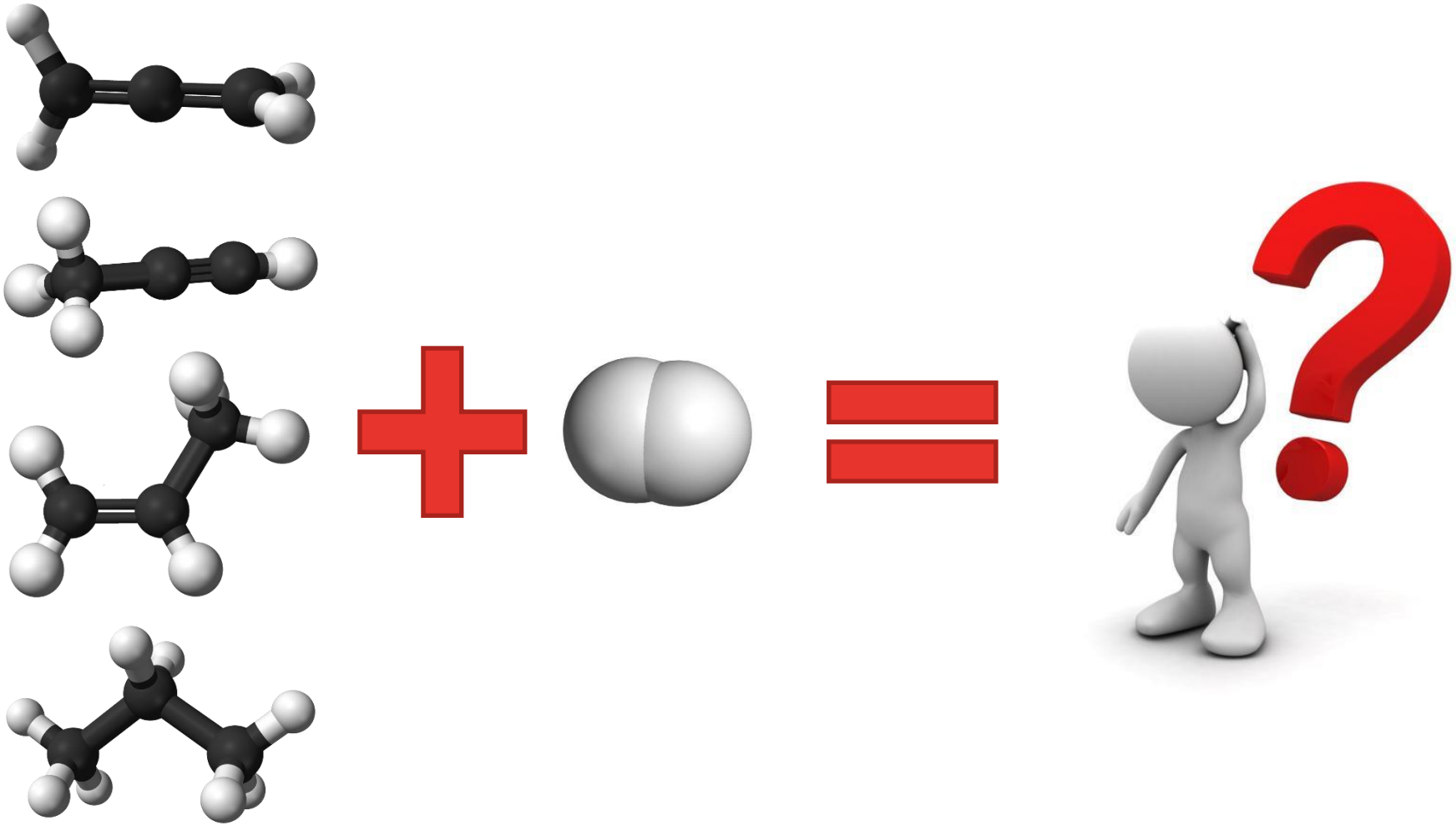
Block Scheme of SC-1
Propylene line



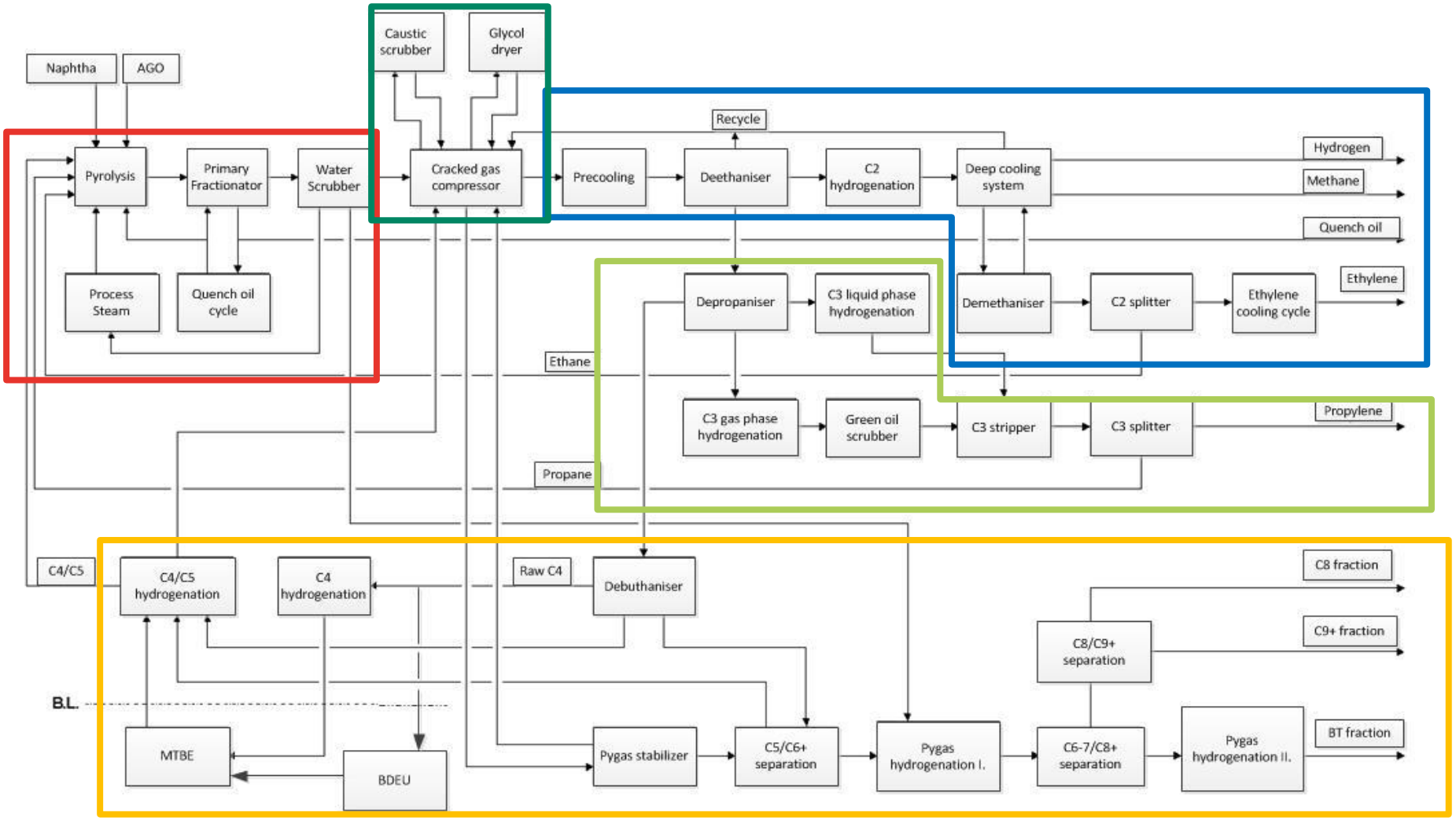
Propylene production

- Deethanizer column
- Depropanizer column
- Methylacetylene and propadiene selective hydrogenation
  - Gas and liquid phase reactors
  - Platina catalyst
  - High selectivity (>80%)
- C_3 stripper – remove hydrogen and methane from C_3 stream
- Propane/propylene splitter
  (boiling points = 42 vs. 47,6°C → ~2*100m, ∑ 350 tray)

C_3 hydrogenation



Block Scheme of SC-1
C_4 and pygas section

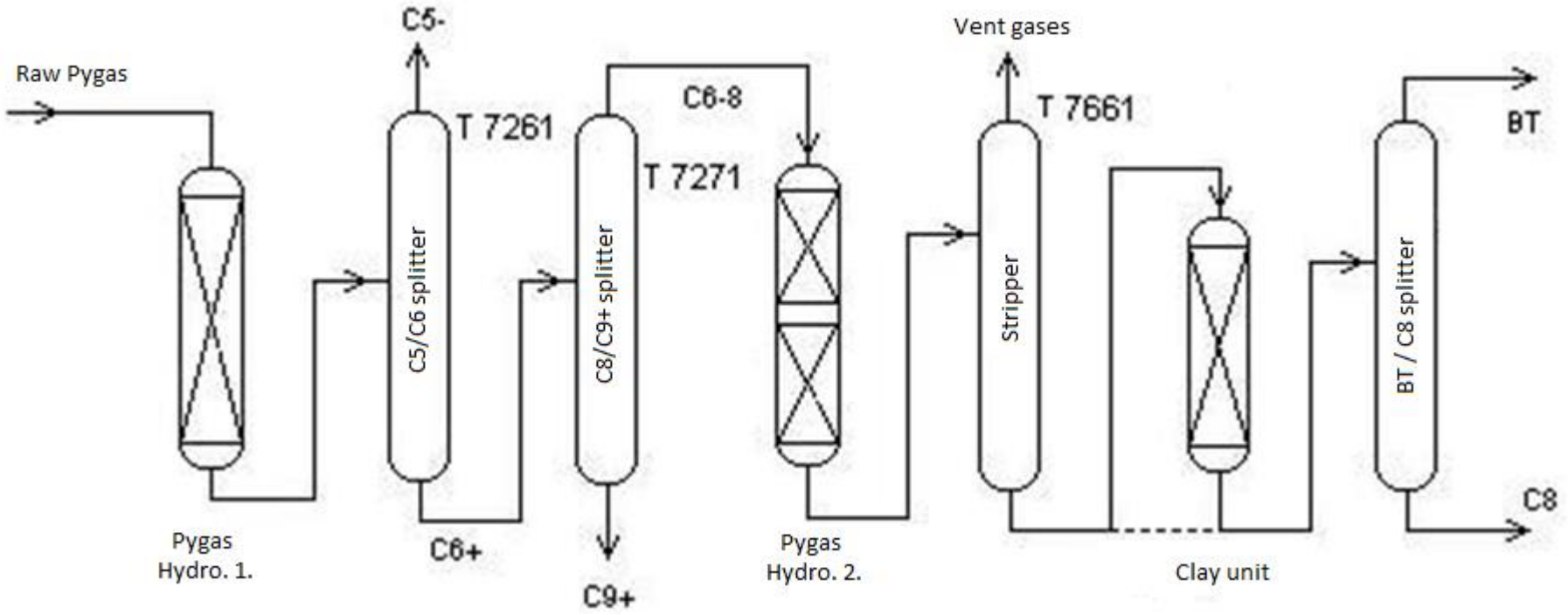


C_4/C_5 and pygas hydrogenation

- C_3/C_{4+} separation (depropanizer)
- C_4/C_{5+} separation (debuthanizer) — RawC_4 to BDEU
- C_5/C_{6+} separation (depenthanizer)
- C4 selective hydrogenation — MTBE feed
- C_4/C_5 total hydrogenation — Repyrolysis
- Pygas 1st stage hydrogenation
- C_6-C_7/C_{8+} separation
- Pygas 2nd stage hydrogenation — BT product
- C_8/C_{9+} separation — C_8, C_{9+} product

Pygas hydrogenation

- Remove of unsaturated molecules of the Pygas stream and separation for marketable products:
  - BT fraction — aromatic unit feed
  - C8 fraction — Gasoline mixing component
  - C9+ fraction — Bunker mixing component or cutter stock



Utility systems

- Steam and condensate
- Boiler
- Boiler feed water preparation
- Fuel gas
- Catalyst regeneration
- Waste eater treatment
- Flare
- Cooling water

Thank you for your attention!