Energy saving in atmospheric crude process using modified crude distillation units

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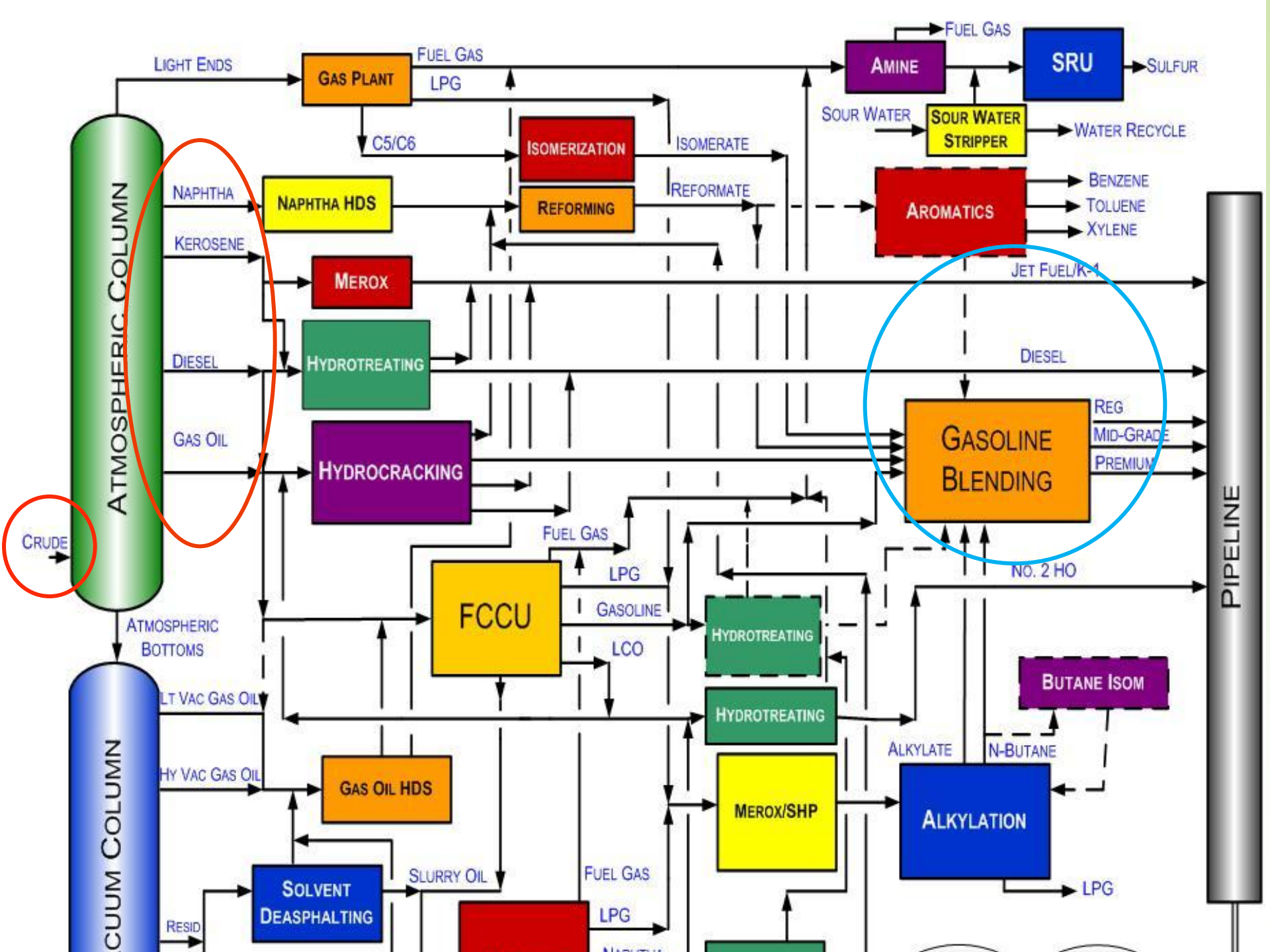
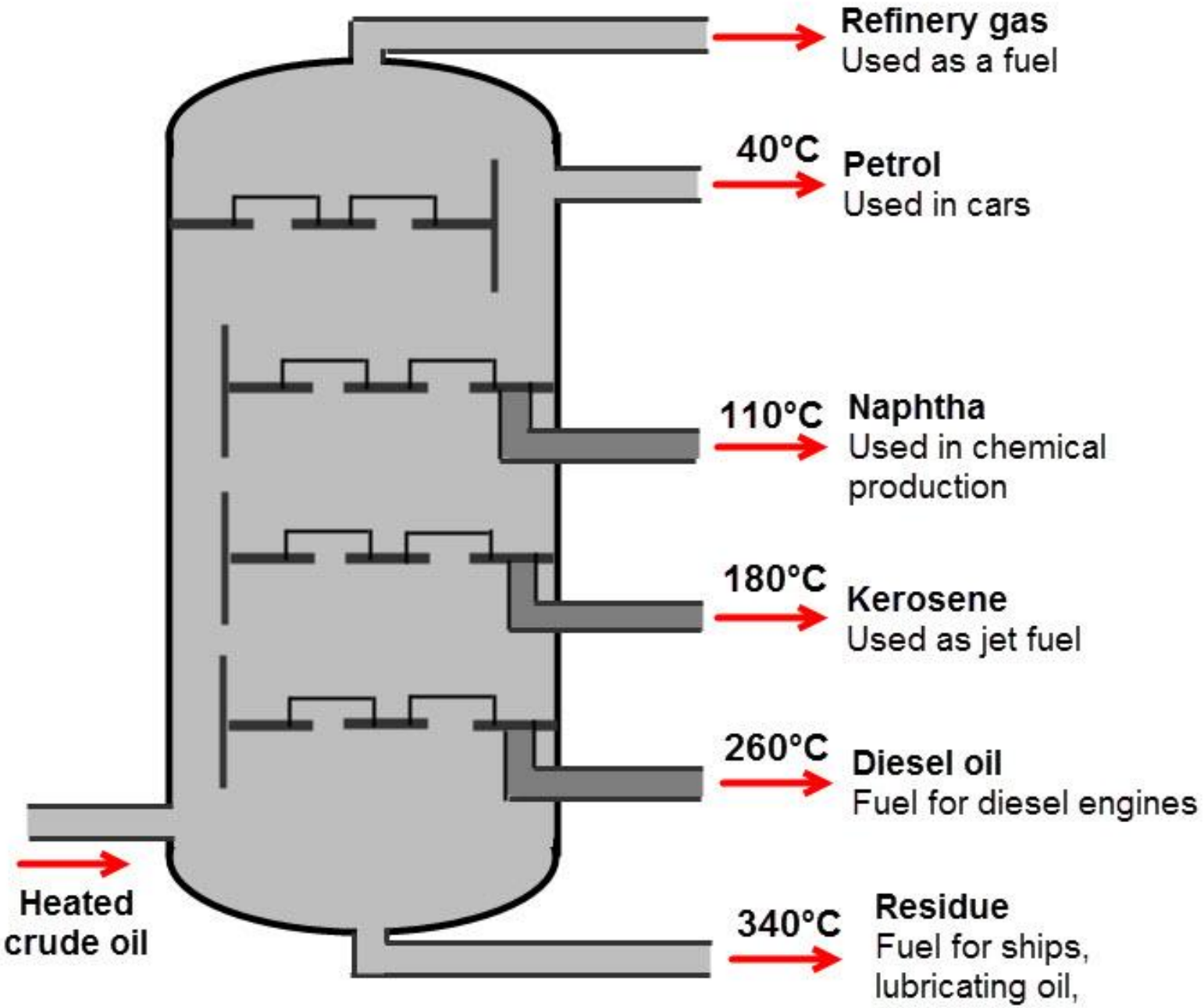

LIGHT ENDS
GAS PLANT
FUEL GAS
LPG
AMINE
FUEL GAS
SRU
SULFUR
SOUR WATER
SOUR WATER STRIPPER
WATER RECYCLE
C5/C6
ISOMERIZATION
ISOMERATE
REFORMATE
REFORMING
AROMATICS
BENZENE
TOLUENE
XYLENE
NAPHTHA
NAPHTHA HDS
KEROSENE
MEROX
JET FUEL/K-1
ATMOSPHERIC COLUMN
DIESEL
HYDROTREATING
DIESEL
GAS OIL
HYDROCRACKING
GASOLINE BLENDING
REG
MID-GRADE
PREMIUM
CRUDE
FUEL GAS
LPG
FCCU
GASOLINE
LCO
NO. 2 HO
PIPELINE
ATMOSPHERIC BOTTOMS
HYDROTREATING
BUTANE ISOM
LT VAC GAS OIL
HYDROTREATING
ALKYLATE
N-BUTANE
HY VAC GAS OIL
GAS OIL HDS
MEROX/SHP
ALKYLATION
LPG
SLURRY OIL
FUEL GAS
SOLVENT DEASPHALTING
LPG
RESID


Refinery gas
Used as a fuel
40°C
Petrol
Used in cars
110°C
Naphtha
Used in chemical production
180°C
Kerosene
Used as jet fuel
260°C
Diesel oil
Fuel for diesel engines
Heated crude oil
340°C
Residue
Fuel for ships, lubricating oil,

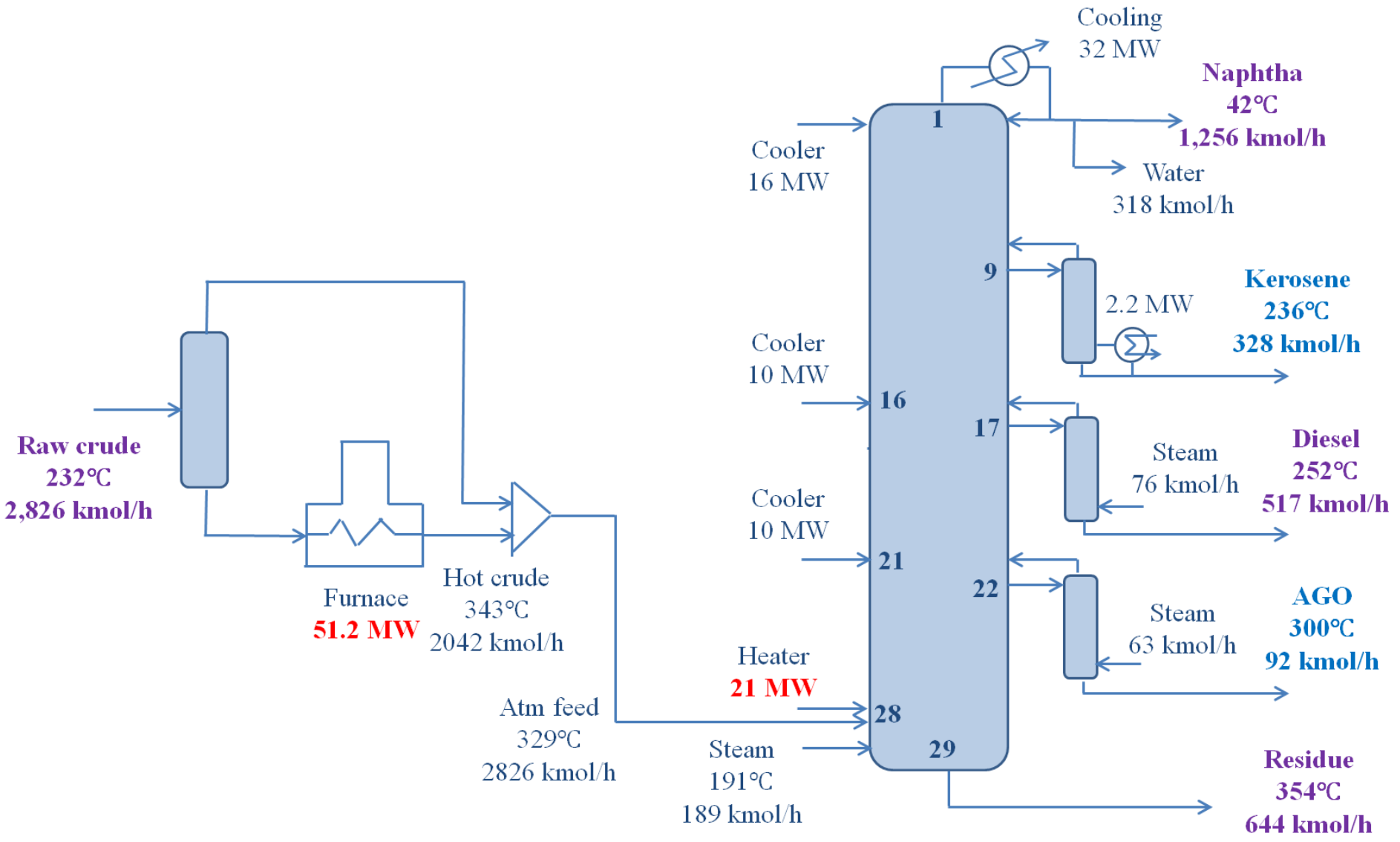
Petroleum refining: second largest consumer of energy in U.S. manufacturing,
3,555 TBtu (18%) of 19,237 TBtu of total primary manufacturing in 2010 (DOE 2014)

In Korea, 35 mil ton CO_2/year off from CDU
Required reduction in 2030 due to Paris Agrmt: 56 mil ton CO_2/year in manufacturing

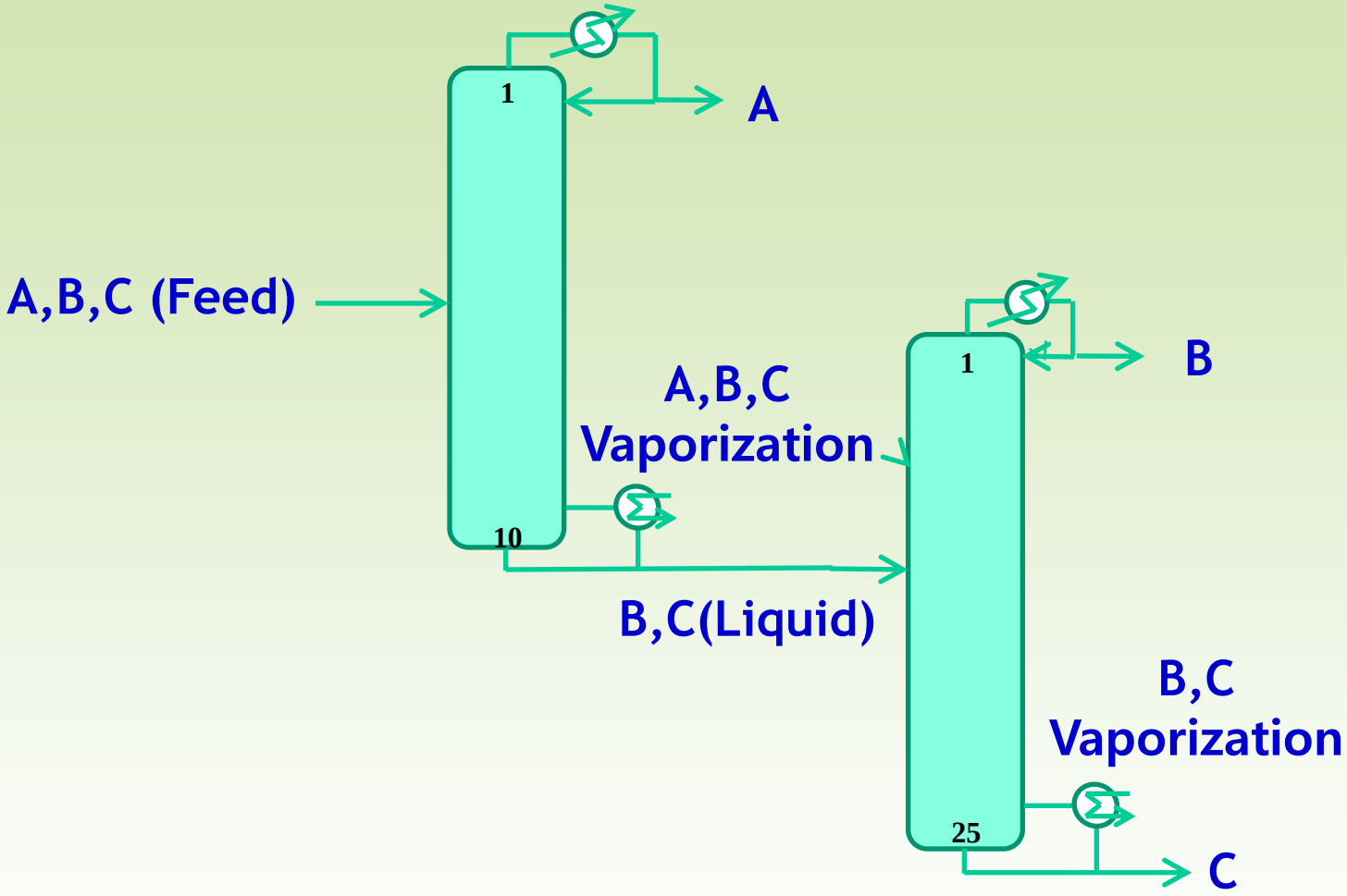
A 22% of required reduction can be achieved by saving 35% in CDU

Characteristic of CDU

Conventional CDU (100,000 bbl/d)



Ternary separation system



In case of B and C, twice vaporization consuming more energy

CDU Characteristics

1.Complex components in feed
2. Five products from a single column
3. Large throughput: 100 mil barrels per day
   large energy saving available
4. Close feed and product trays, feed mixing
5. 100 year operation, accumulated knowhow,
   sufficient operators' experience, license expired,
   no depreciation necessary, no urge to invest

No attempt to improve

CDU Characteristics- 2

6. Steam as heat supply- easy to separate
7. Side stripper used- increase tray number
8. Large b.p. difference between products
9. Product specification- mixture, viscosity

Proposed CDU

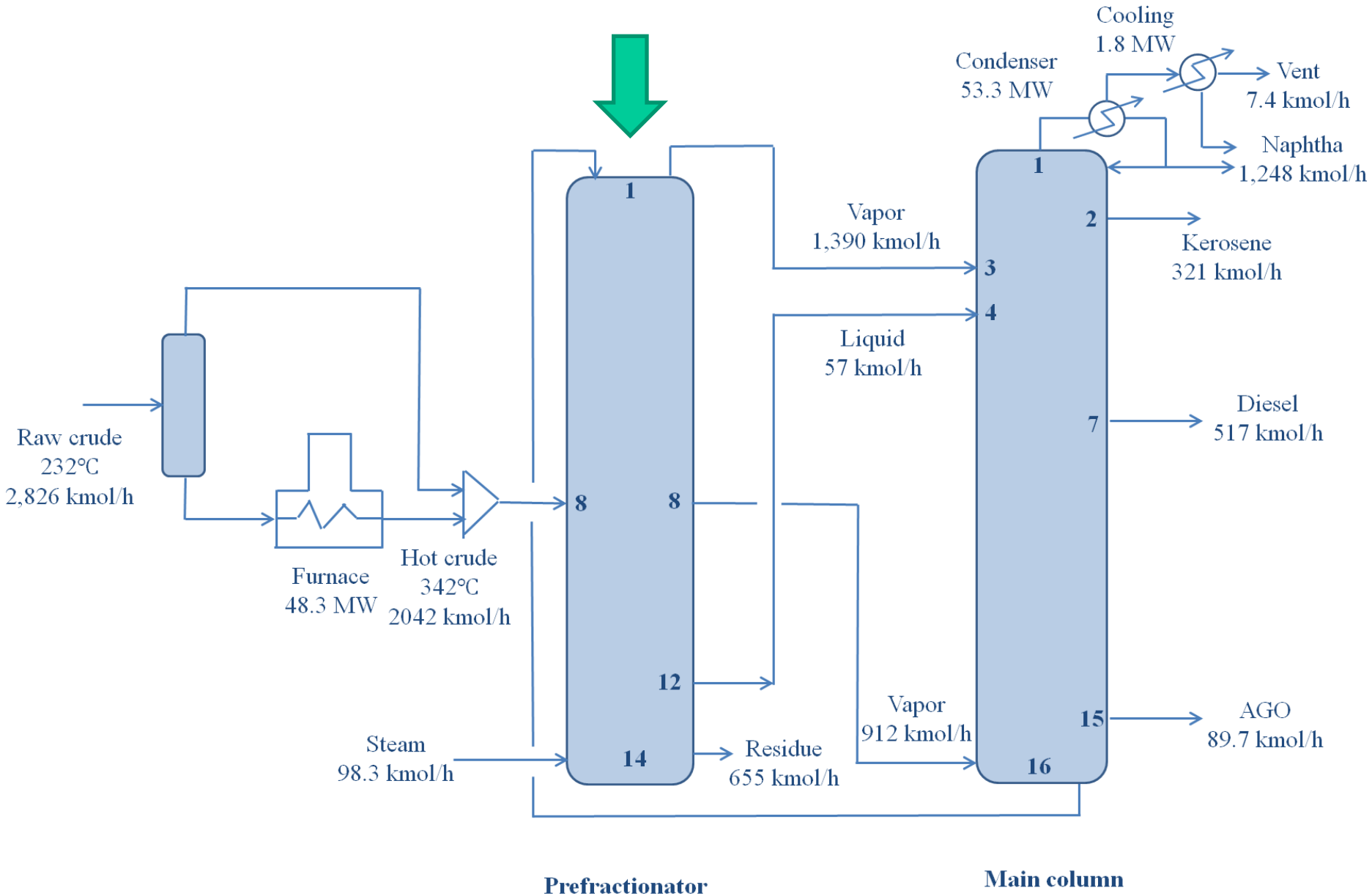
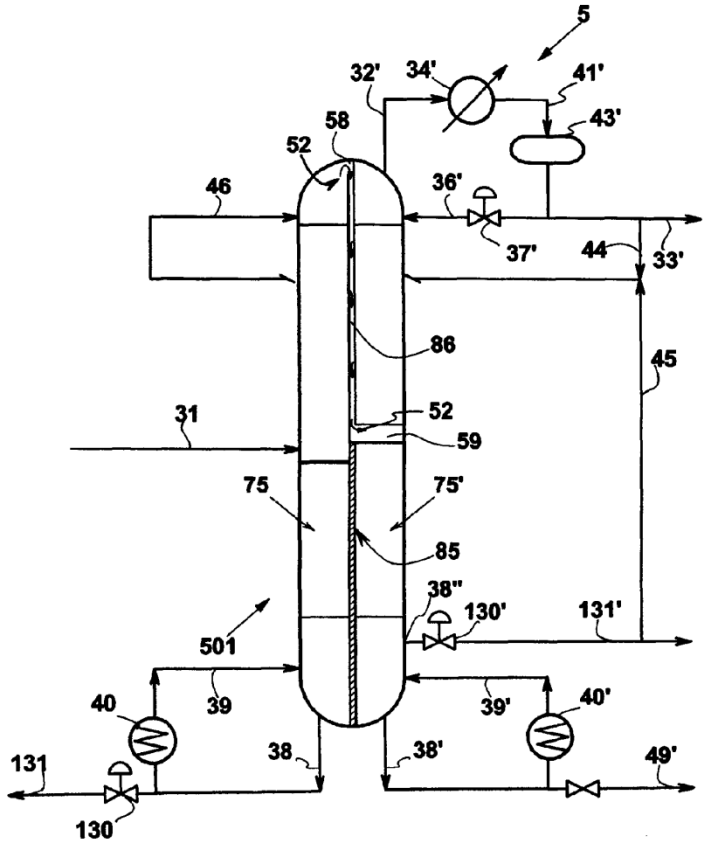


Fig. 5

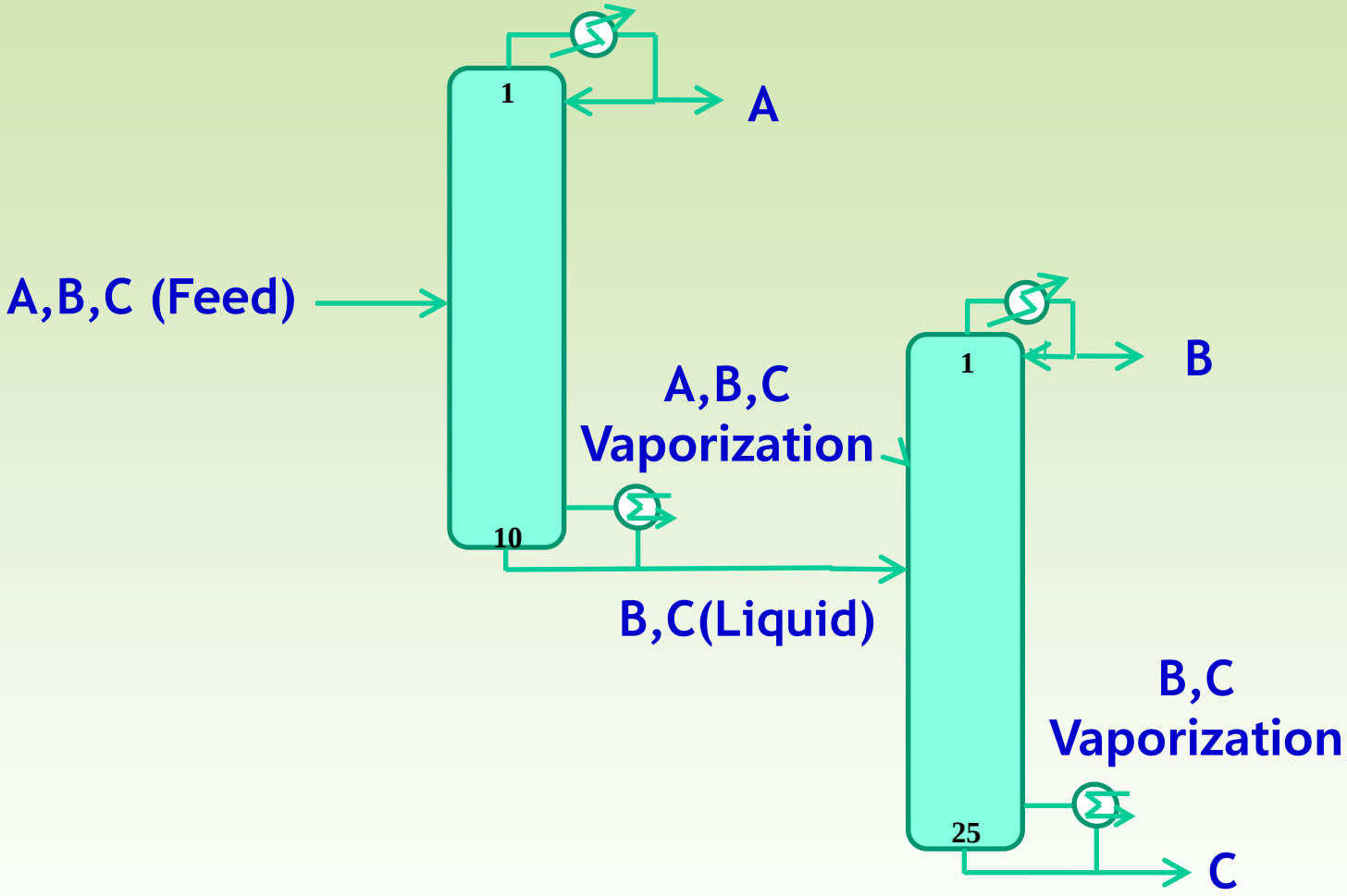

5
32'
34'
41'
43'
58
52
46
36'
37'
44
33'
86
45
31
52
59
75
75'
85
38"
130'
131'
501
40
39
39'
40'
38
38'
49'
131
130

- Motivation and Means
  - reduction of energy demand
  - follows design concept of DWC
  - lower feed tray mixing

    separates bottom section: prefractionator
  - provides ideal column profile

    interlinking between two columns

Ternary separation system



In case of B and C, twice vaporization consuming more energy

A company of ThyssenKrupp Technologies

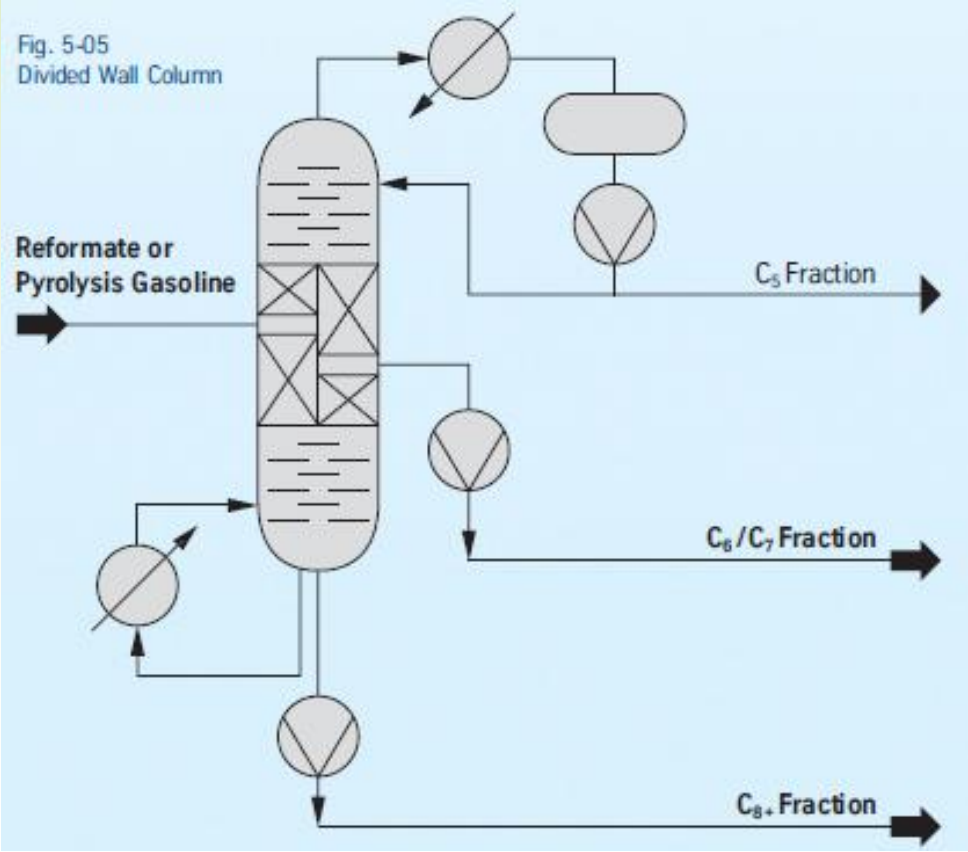
Uhde

5.2.2 Divided Wall Column Distillation

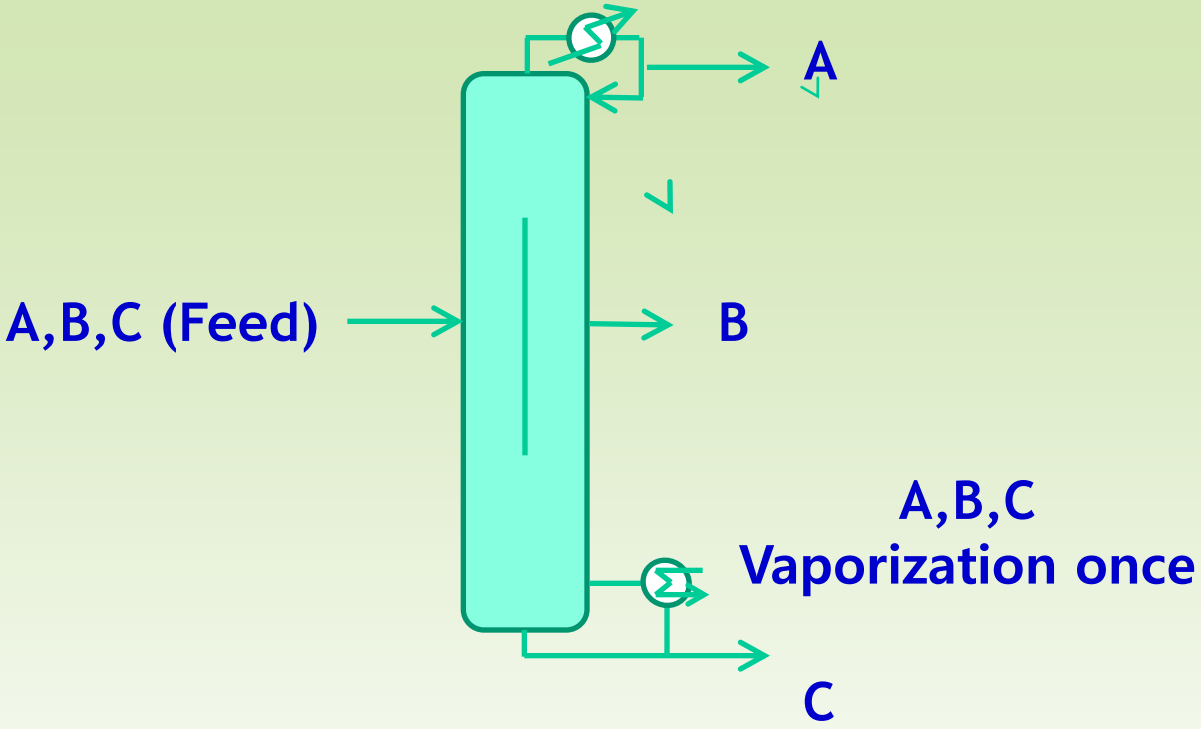
Whenever more than two fractions have to be separated by distillation, the question arises as to which is the most efficient configuration

These advantages are reflected in:

- up to 20% less investment costs
- up to 35% less energy costs
- up to 40% less plant space requirements



DWC, efficient distillation

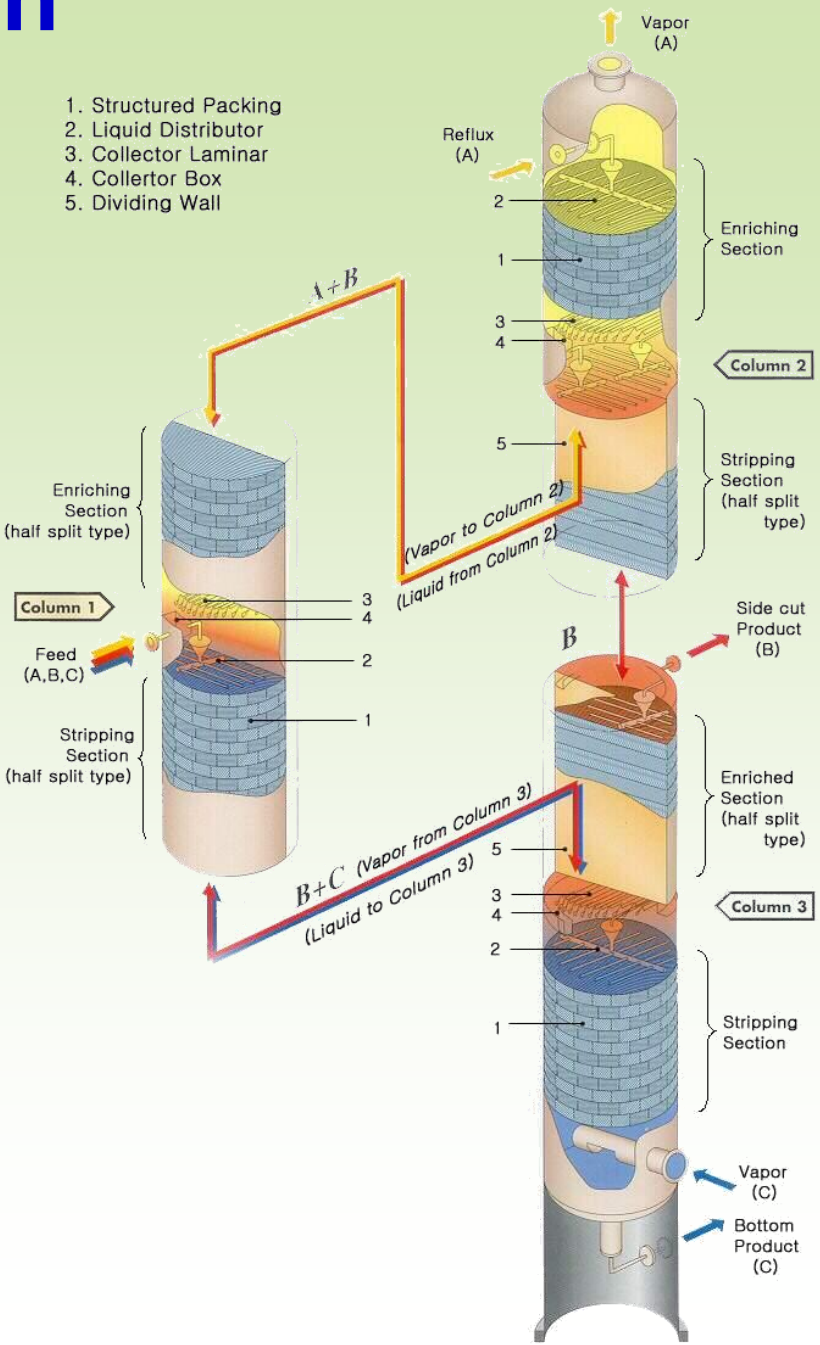


Economics, mil$/year

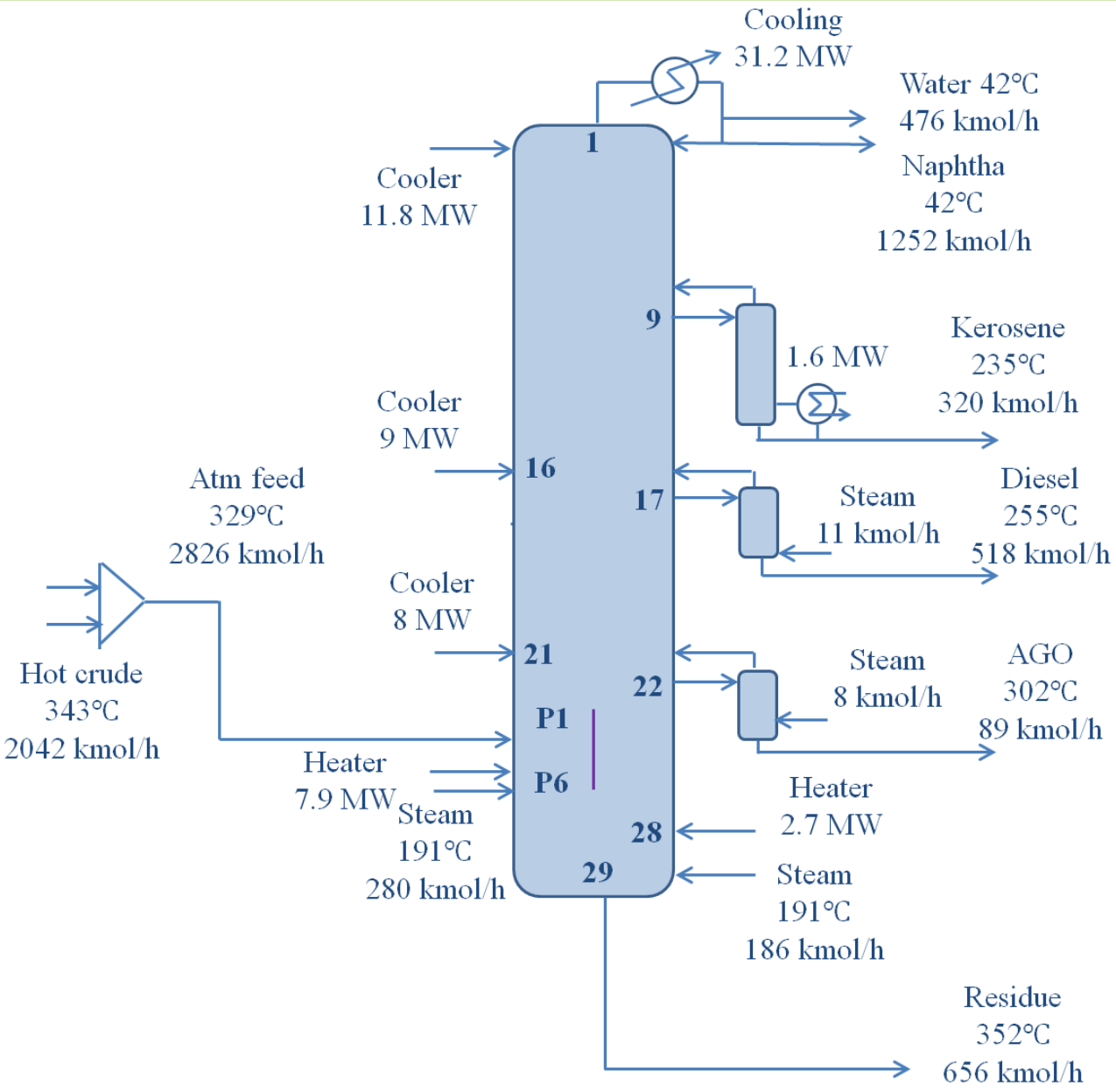
Variable	Conventional CDU				Proposed CDU	
	Main	Side 1	Side 2	Side 3	Col 1	Col 2
Investment						
Column	1.232	0.038	0.025	0.022	0.401	0.771
Tray	0.167	0.002	0.001	0.001	0.037	0.093
Heat Exch.	1.934	0.179				2.700
Furnace	5.545				5.277	
Pump Around	1.240/0.927/0.927					0.298
Total				12.24		9.577
Utility						
Furnace	9.701				9.152	
Steam	3.836/1.100	0.300	0.348	0.289	0.327	
Total				15.574		9.479

- Present status
  - single column operation
  - feed and product mixing at feed tray
  - large energy requirement
- Proposed
  - two-column operation
  - no mixing between feed and products
  - 35% less heating duty
  - 22% less investment, 51% less utility cost
  - column P adjusted for easy vapor flows
  - revamping, add a new column

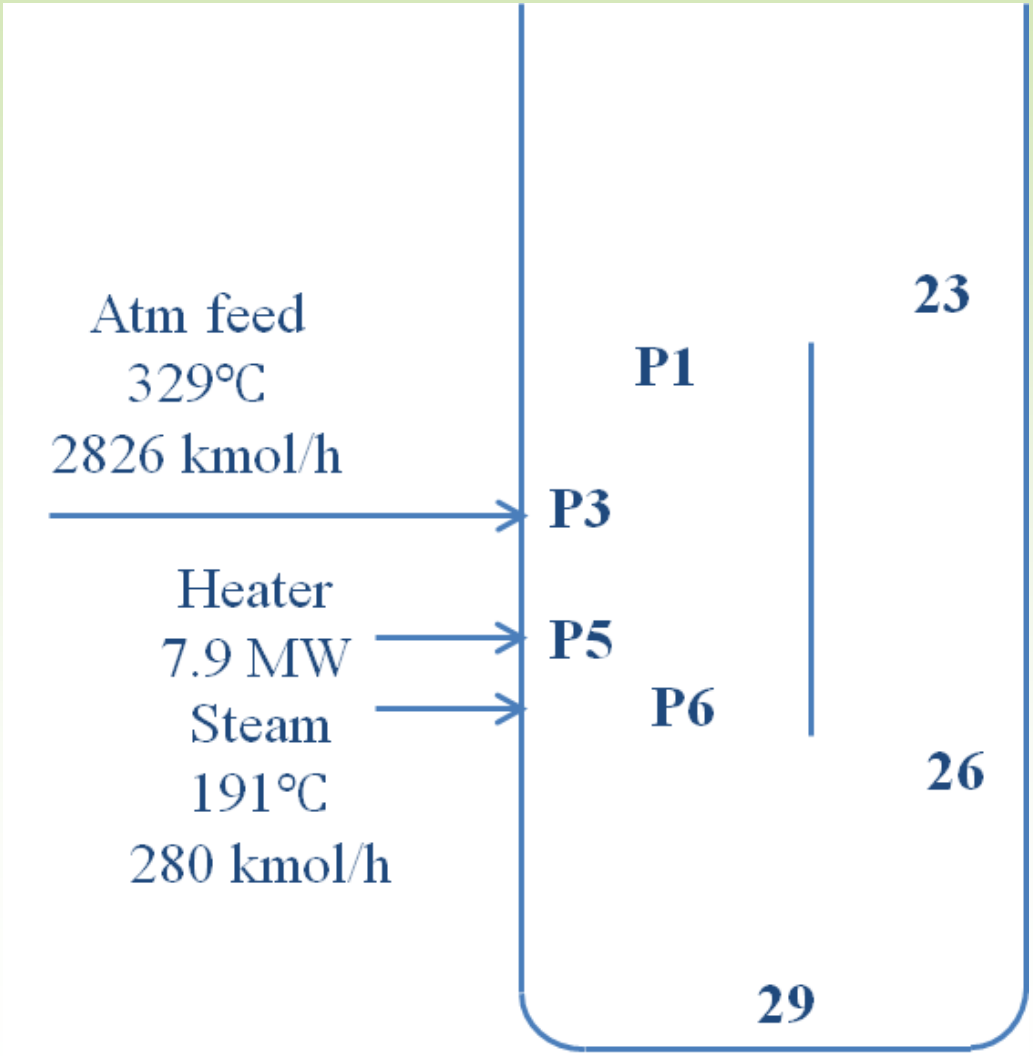
New modification
- DWC in CDU



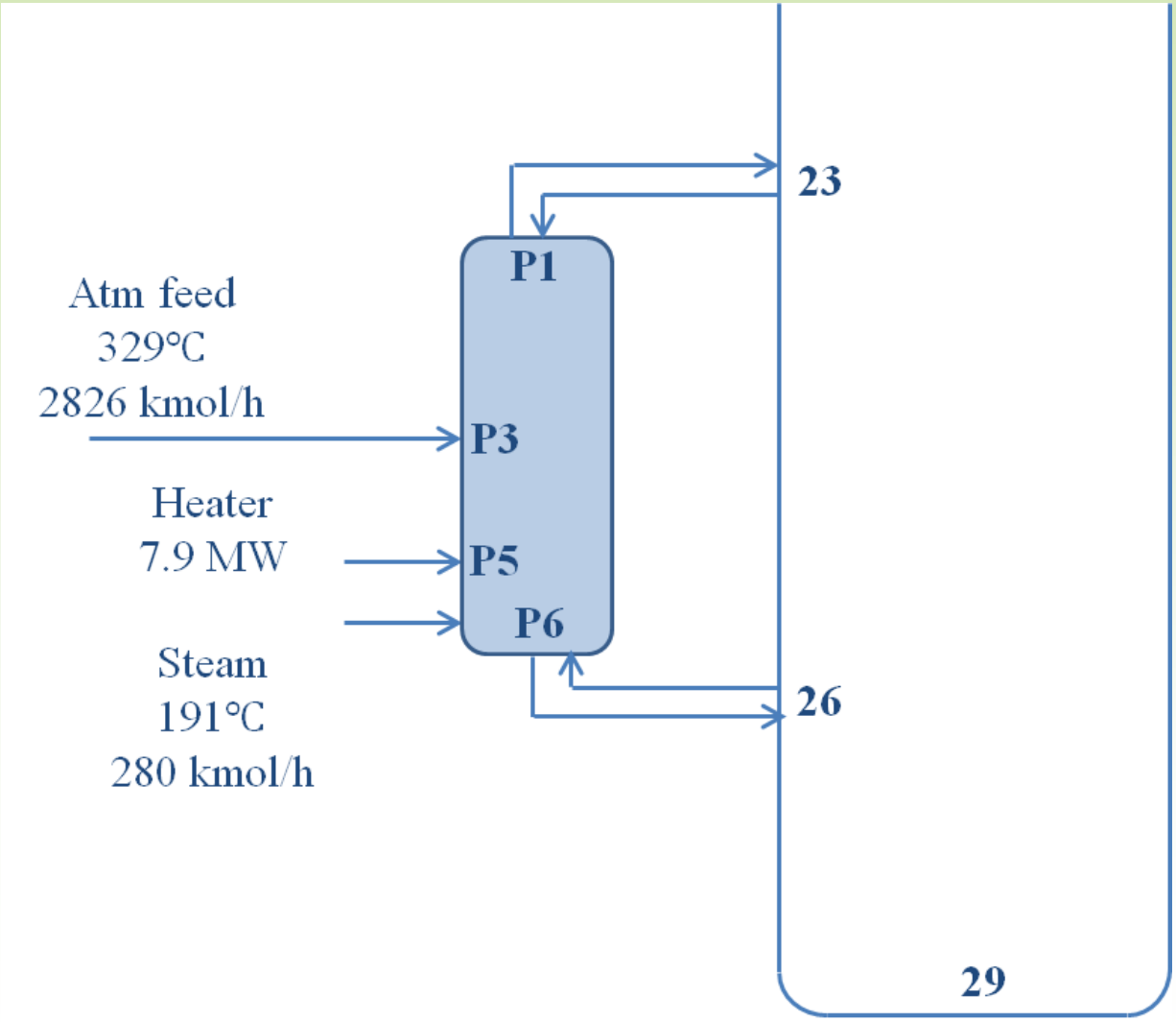
CDU with DWC


Cooling
31.2 MW
Water 42°C
476 kmol/h
1
Naphtha
42°C
1252 kmol/h
Cooler
11.8 MW
9
1.6 MW
Kerosene
235°C
320 kmol/h
Cooler
9 MW
16
Atm feed
329°C
2826 kmol/h
17
Steam
11 kmol/h
Diesel
255°C
518 kmol/h
Cooler
8 MW
21
Steam
8 kmol/h
AGO
302°C
89 kmol/h
22
Hot crude
343°C
2042 kmol/h
P1
P6
Heater
7.9 MW
Steam
191°C
280 kmol/h
Heater
2.7 MW
28
29
Steam
191°C
186 kmol/h
Residue
352°C
656 kmol/h

Enlarged bottom section



Separate prefractionator



- Features
  - separate sections for feed and product
  - size of prefractionator
  - interlinking stages
  - flow distribution

Economics, mil$/year

Variable	Conventional CDU				Proposed CDU	
	Main	Side 1	Side 2	Side 3	Prefract.	Main
Investment						
Column	1.232	0.038	0.025	0.022	0.254	1.306
Tray	0.167	0.002	0.001	0.001	0.022	0.171
Heat Exch.	2.704	0.179			0.539	1.915
Pump Around	3.094					2.616
Total				7.475		6.823
Utility						
Cooling	0.531					0.422
Steam	3.836/ 1.100	0.300	0.348	0.289	2.239/ 0.116	0.996/ 0.990
Total				6.404		4.765

- Proposed
  - DWC applied
  - no mixing between feed and products
  - 37% less heating duty excluding furnace
  - 9% less investment, 26% less utility cost
  - easy revamping