Design Development of a Novel Sour Water Stripper

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Contents

Introduction

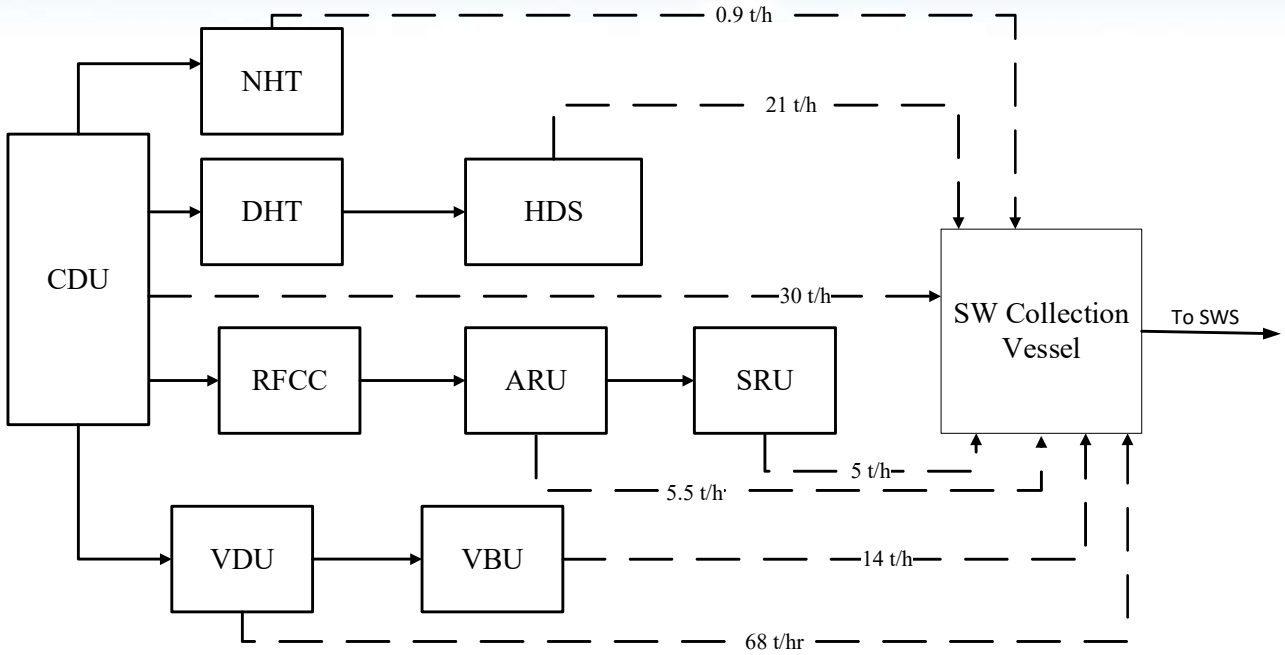
- *What is Sour Water?*
  - H_2S
  - NH_3
  - CO_2

  } in aqueous phase

- Sour water units are referred as "**Toilets of the Refinery**"
- 60 – 90 barrels of water are consumed per barrel of crude oil processing
- Main drivers of sour water stripping
  - Strict environmental regulations
  - Improvement in process efficiency
  - Cost effective performance

Armstrong et. al (1998); Byers et. al (1995)

Sources of Sour Water



Nomenclature:

CDU: Crude distillation unit
NHT: Naptha hydrotreater
DHT: Diesel hydrotreating unit
RFCC: Residue fluid catalytic cracking
VDU: Vacuum distillation unit
HDS: Hydrodesulphurization
ARU: Acid removal unit
VBU: Visbreaker unit
SRU: Sulphur recovery unit
SWS: Sour water stripping

Petroleum flow
Sour water flow

Application of Stripped Sour Water

- *Crude de-salter* for the removal of chloride salts to inhibit HCl formation

- *Hydrotreater* for the removal of ammonia sulphide

Design Basis

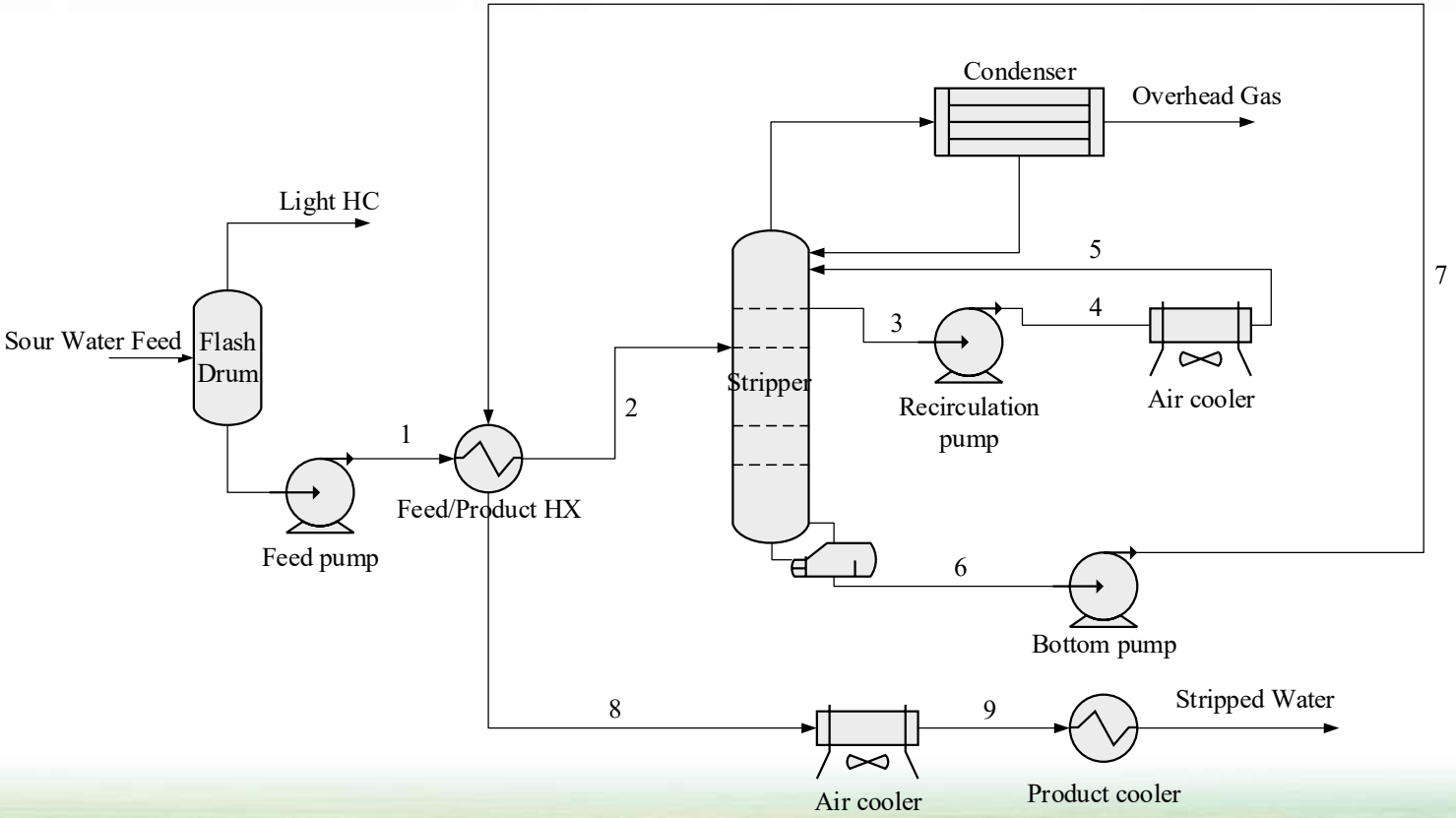
Simulator:
- Aspen HYSYS

Fluid Package :
- NRTL
- UNIFAC VLE

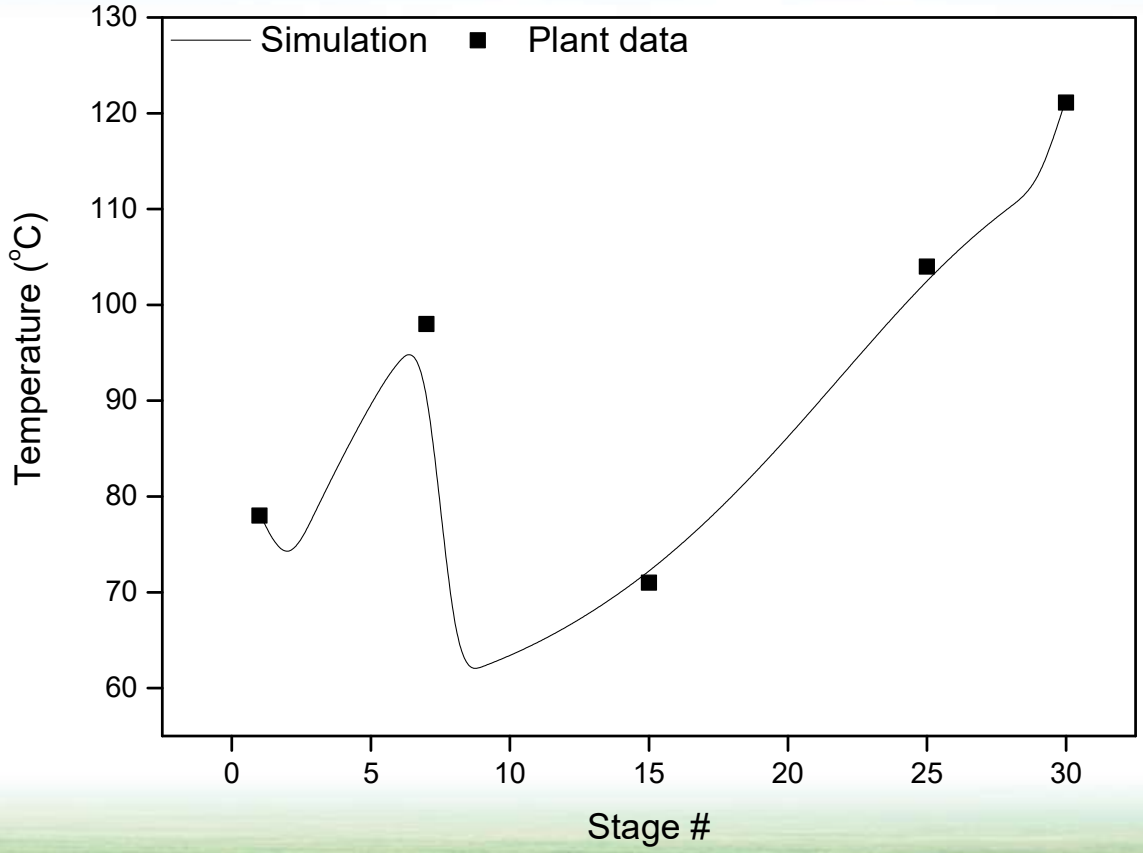
Purity Requirement:
- H_2S = 10 ppm
- NH_3 = 100 ppm

Feed flowrate (t/h)	185
Temperature (^oC)	40
Pressure (bar)	4.9
Composition (Mass fractions)	
H_2S	0.0030
NH_3	0.0016
H_2O	0.9953
NaCl	0.0001

Base Case Design



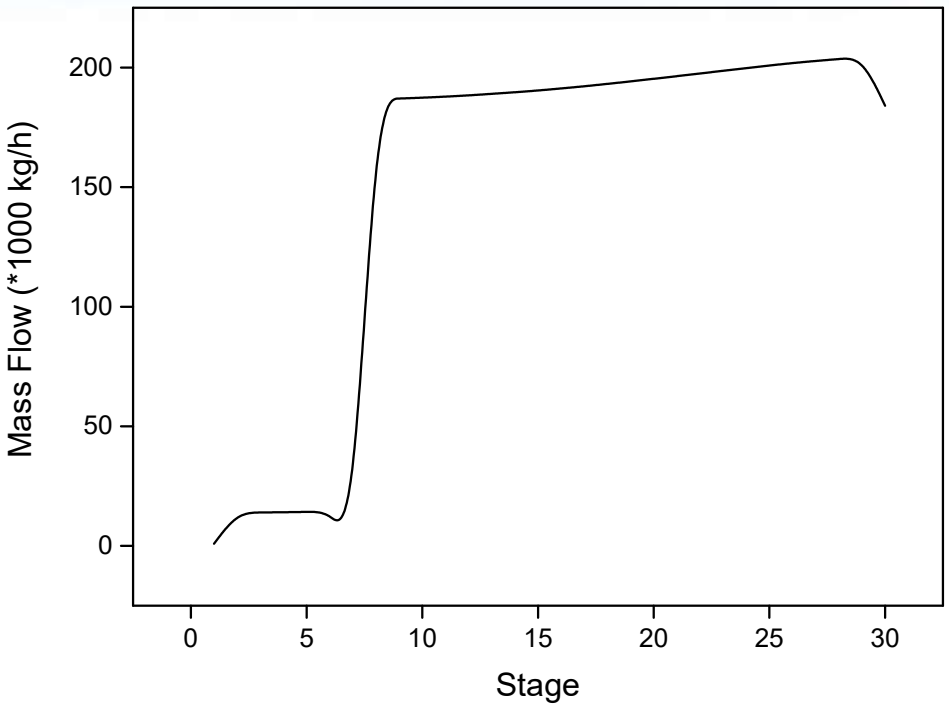
Model Validation



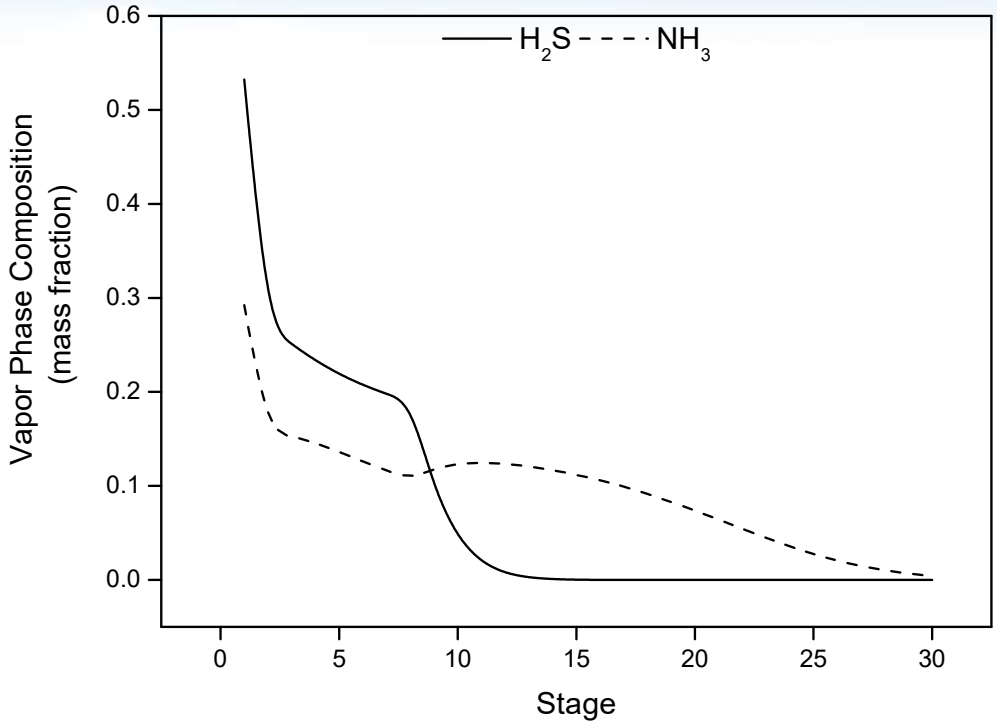
Model Validation

Parameter	Unit	Simulation result	Plant data
Stream 1 temperature	°C	40.1	40
Stream 2 temperature	°C	60	60 – 65
Stream 3 temperature	°C	96.5	98
Stream 4 temperature	°C	96.64	-
Stream 5 temperature	°C	65	65
Stream 6 temperature	°C	121.5	121.6
Stream 7 temperature	°C	121.8	-
Stream 8 temperature	°C	101.8	101.8
Stream 9 temperature	°C	65	65
Stripped water	°C	40	40
Condenser temperature	°C	78.2	-
Reboiler temperature	°C	121.5	121.1
Stripper top pressure	bar	1.9	1.9
Stripper bottom pressure	bar	2.1	2.1
Condenser duty	kW	582.1	-
Reboiler duty	kW	14506.7	-

Base Case Results



Bulk liquid flow in the stripper from top to bottom

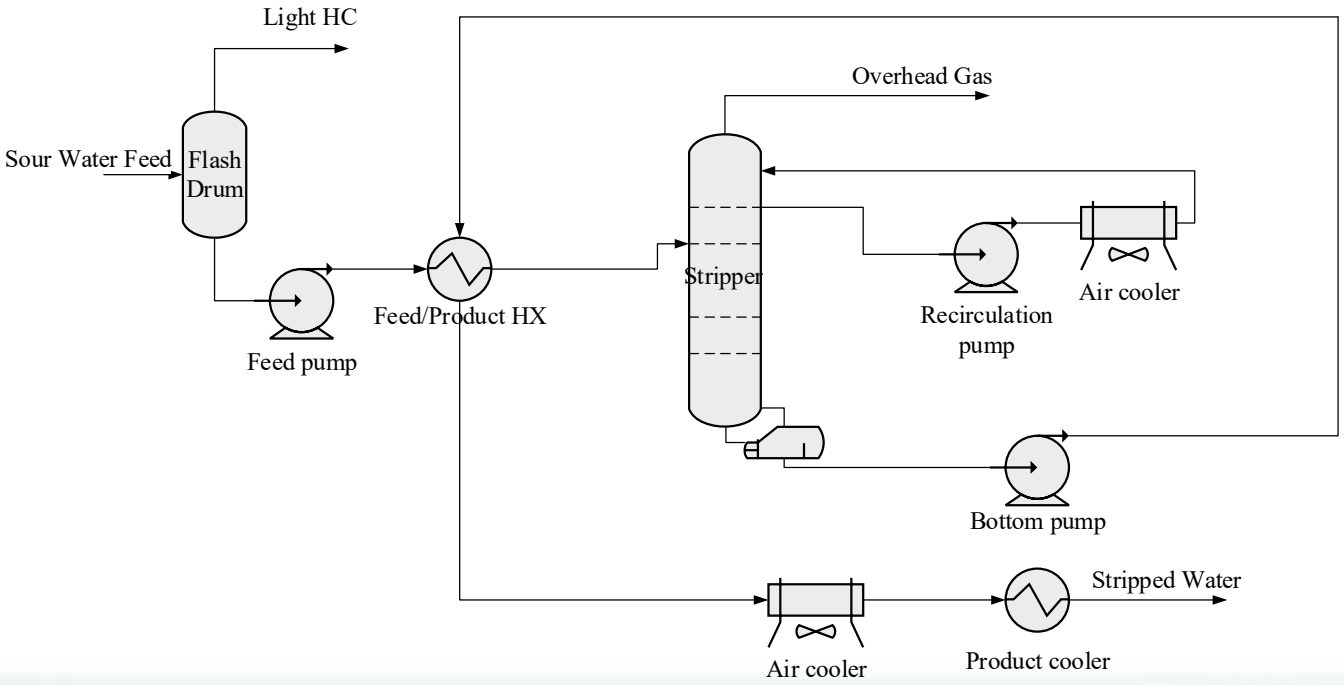


Vapor phase composition of H_2S and NH_3 in the stripper

- Overall tray efficiency – 15%

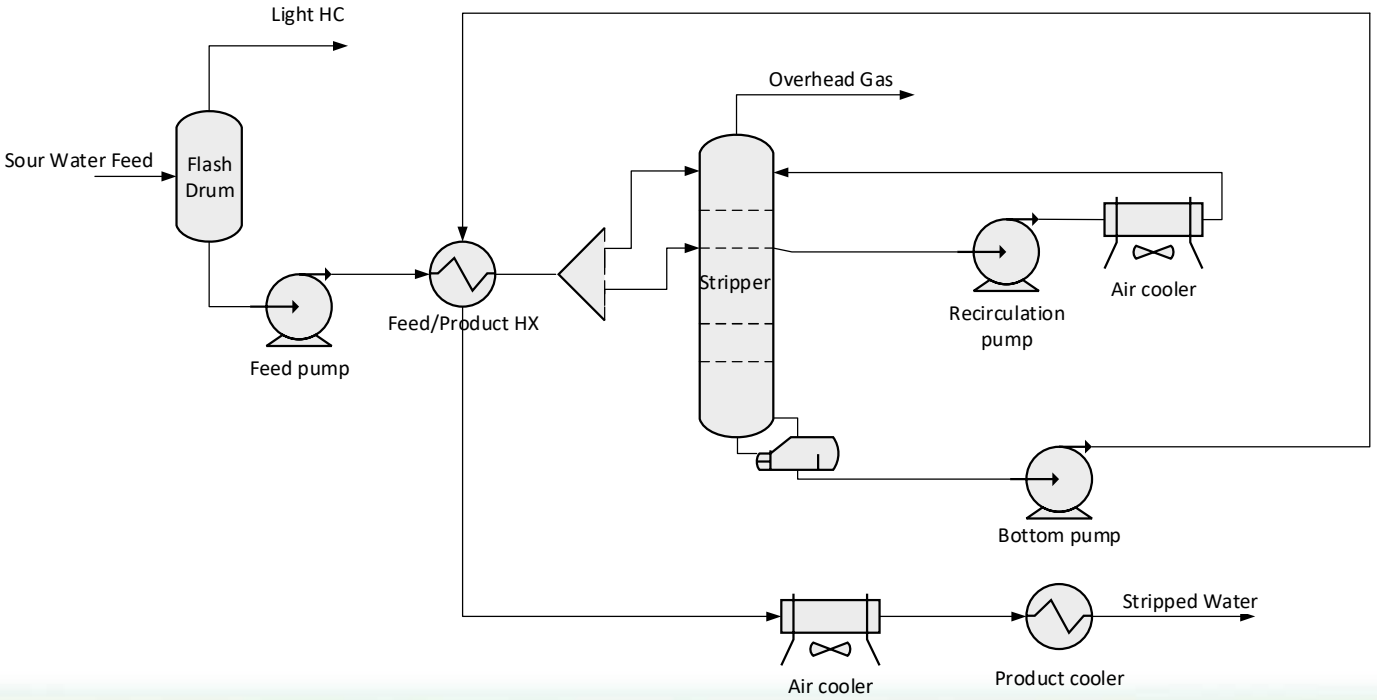
Alternative Designs

- Simple Stripper Design



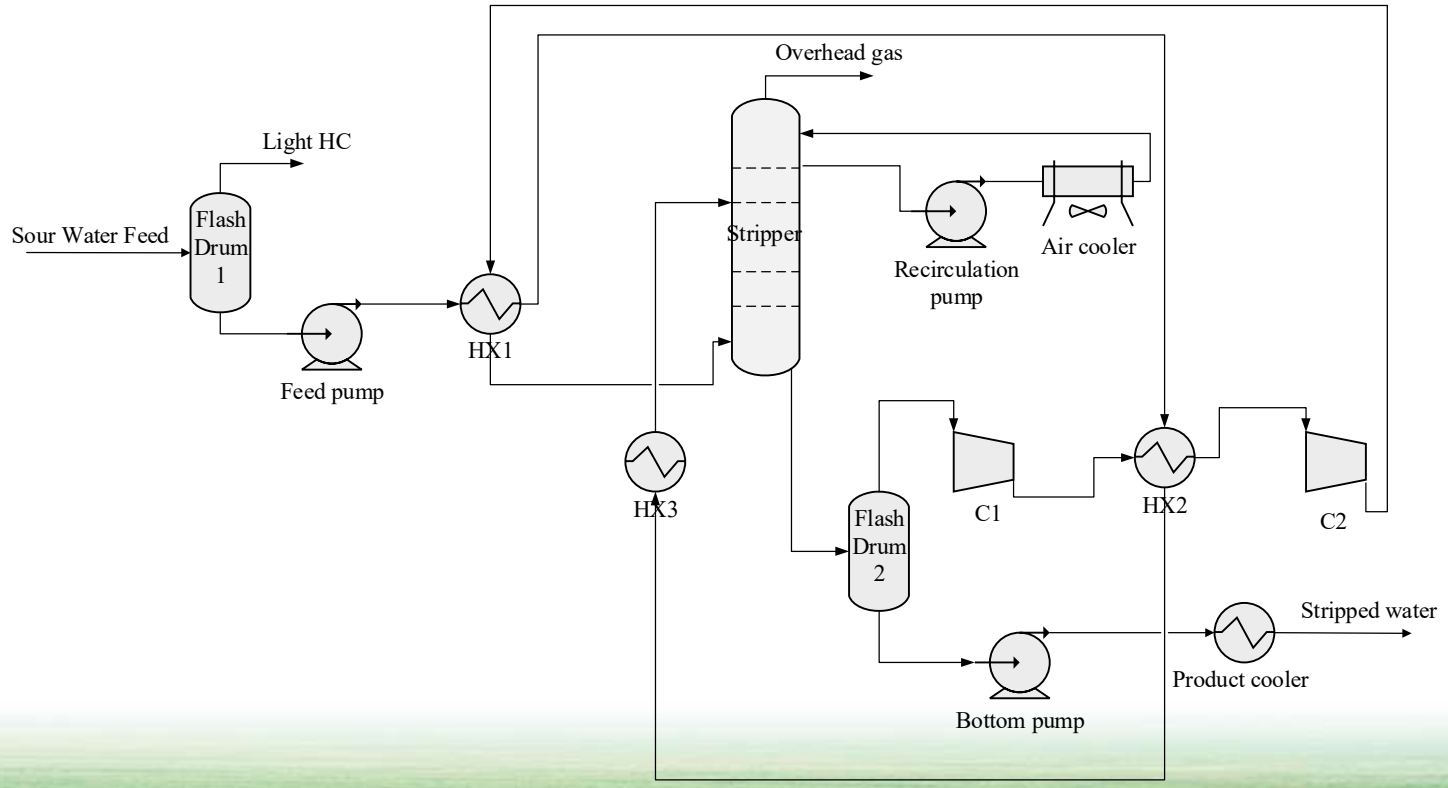
Alternative Designs

- Split Flow Design

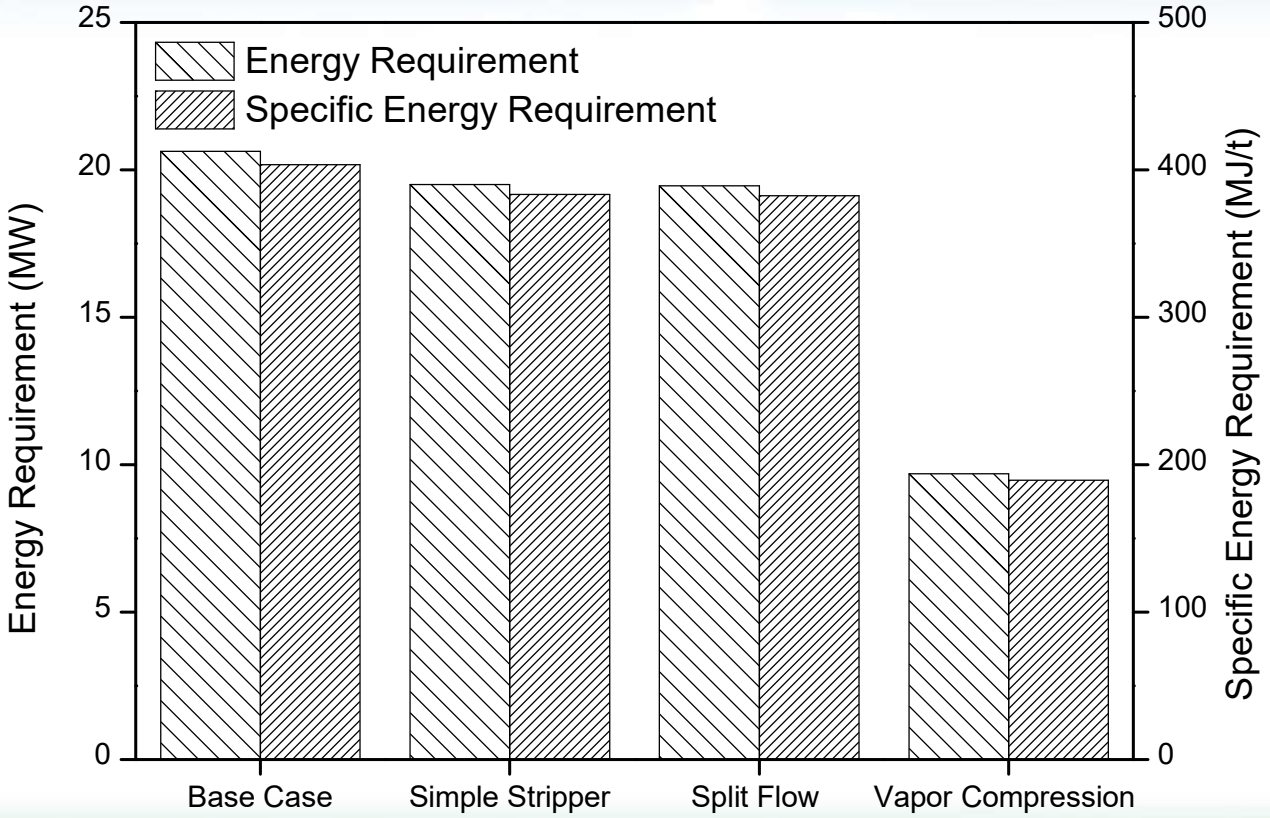


Alternative Designs

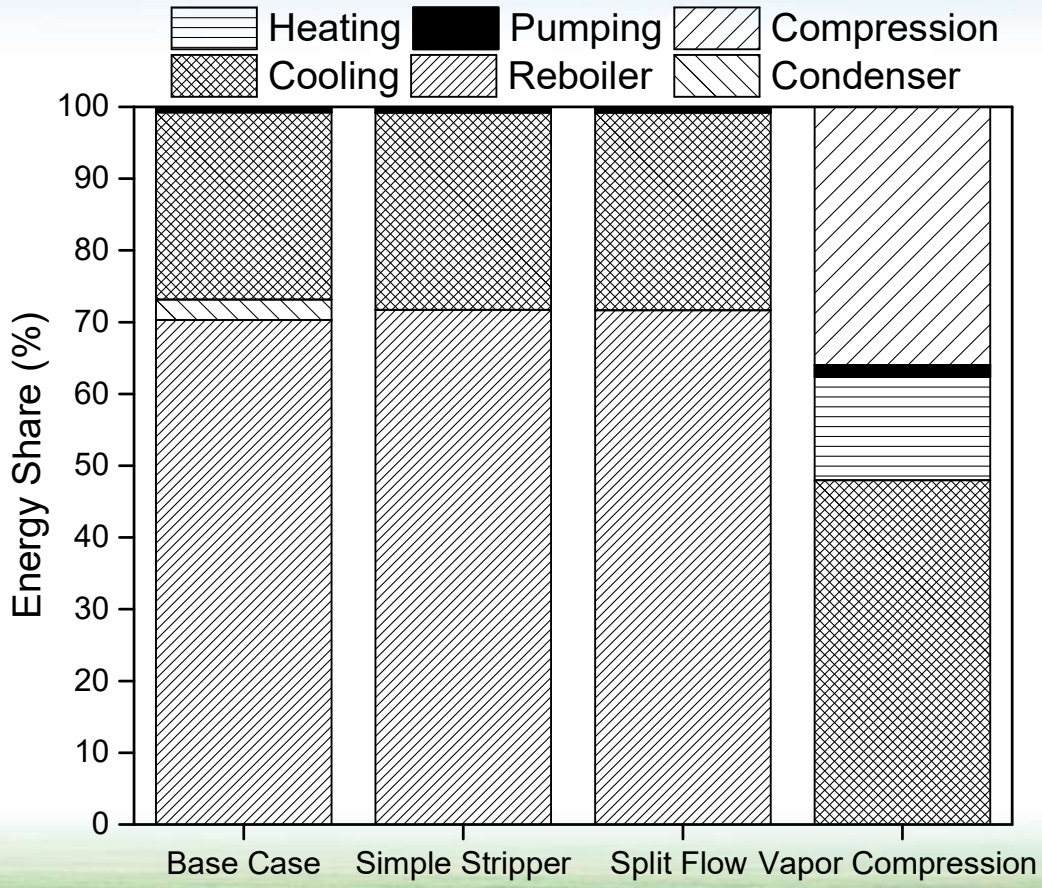
- Vapor Compression Design (Proposed Design)



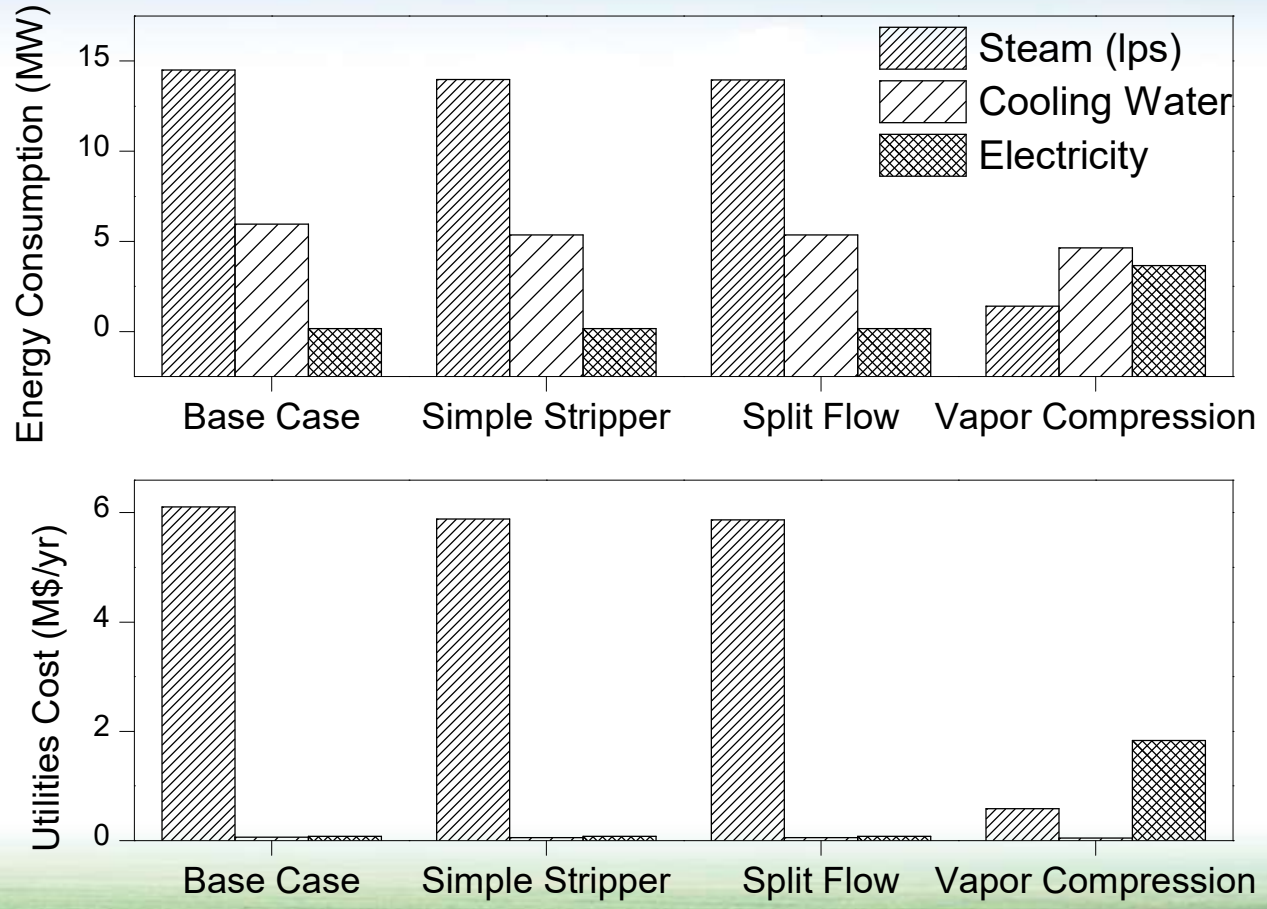
Results – Performance Analysis



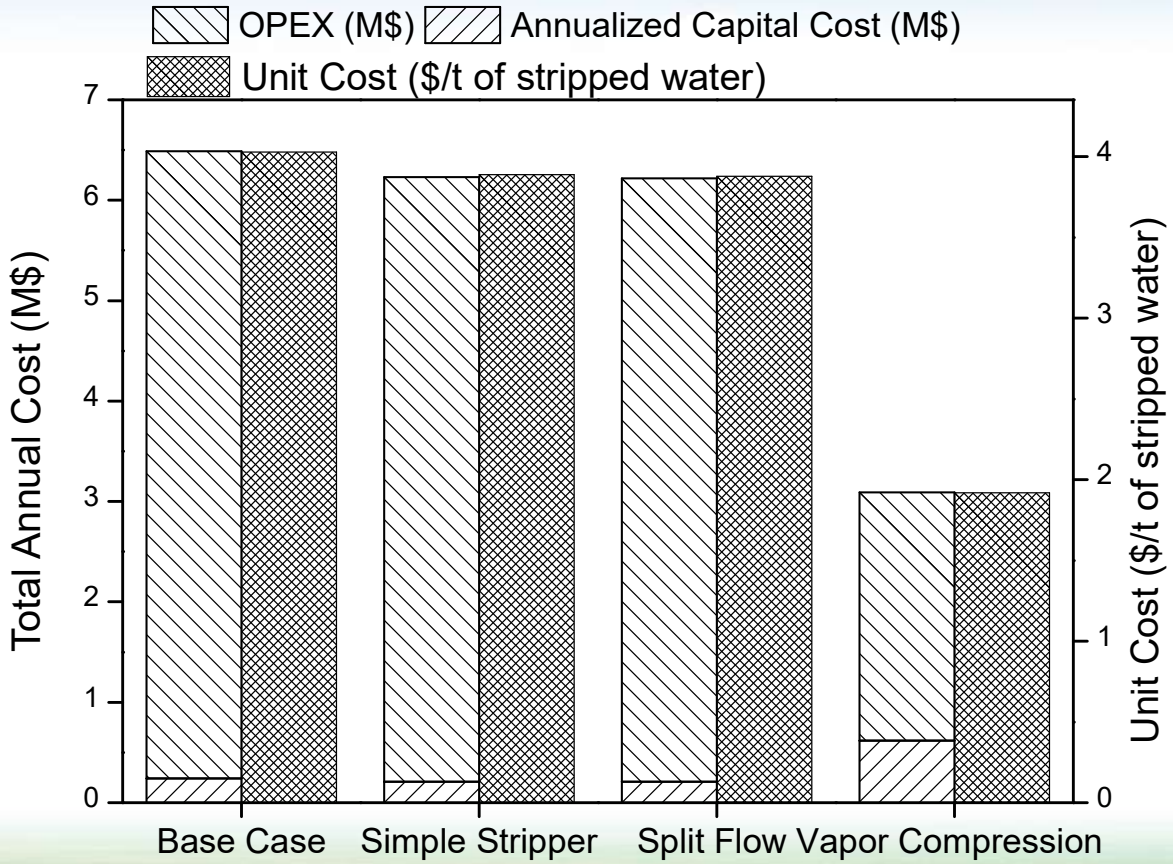
Results – Energy Share (%)



Results – Utilities Consumption



Results – Economic Analysis



Conclusion

- Sour water units are integral units in the refineries

- Proposed vapor compression design offers:
  - Hot utilities reduction of 90%
  - Cold utilities reduction of 22%
  - TAC reduction by 52%

Thank You