



PLASTIC TO PROFIT: PURIFICATION AND SEPARATION OF CRUDE PYROLOSIS OIL

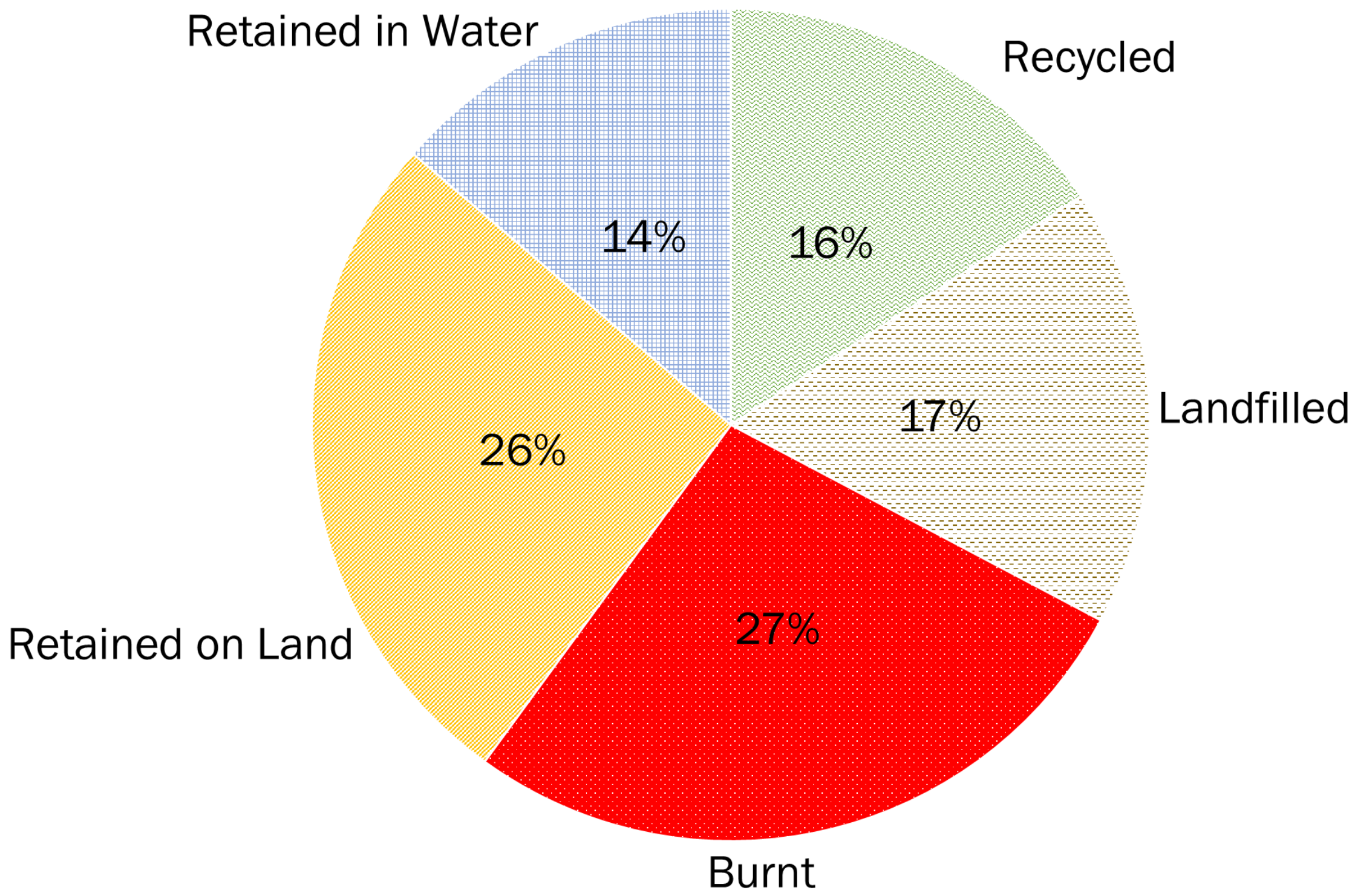
AARON LAW | ISAAC BLAKE | JUHYUNG LEE | RAHUL BHUSAL



Objective: Separate crude pyrolysis oil into four sellable fractions, producing energy and circularizing the plastic waste lifecycle.

Background: Large quantities of plastic waste are generated daily and handled inappropriately, and this facility is designed to accommodate the wasted generated in a regency of Bali. Pyrolysis converts flexile plastic waste into a crude pyoil, but the crude must be cleaned and separated for environmentally responsible use. This closes the loop for plastic circularity as pyoil can be used to synthesize new plastics or generate energy.

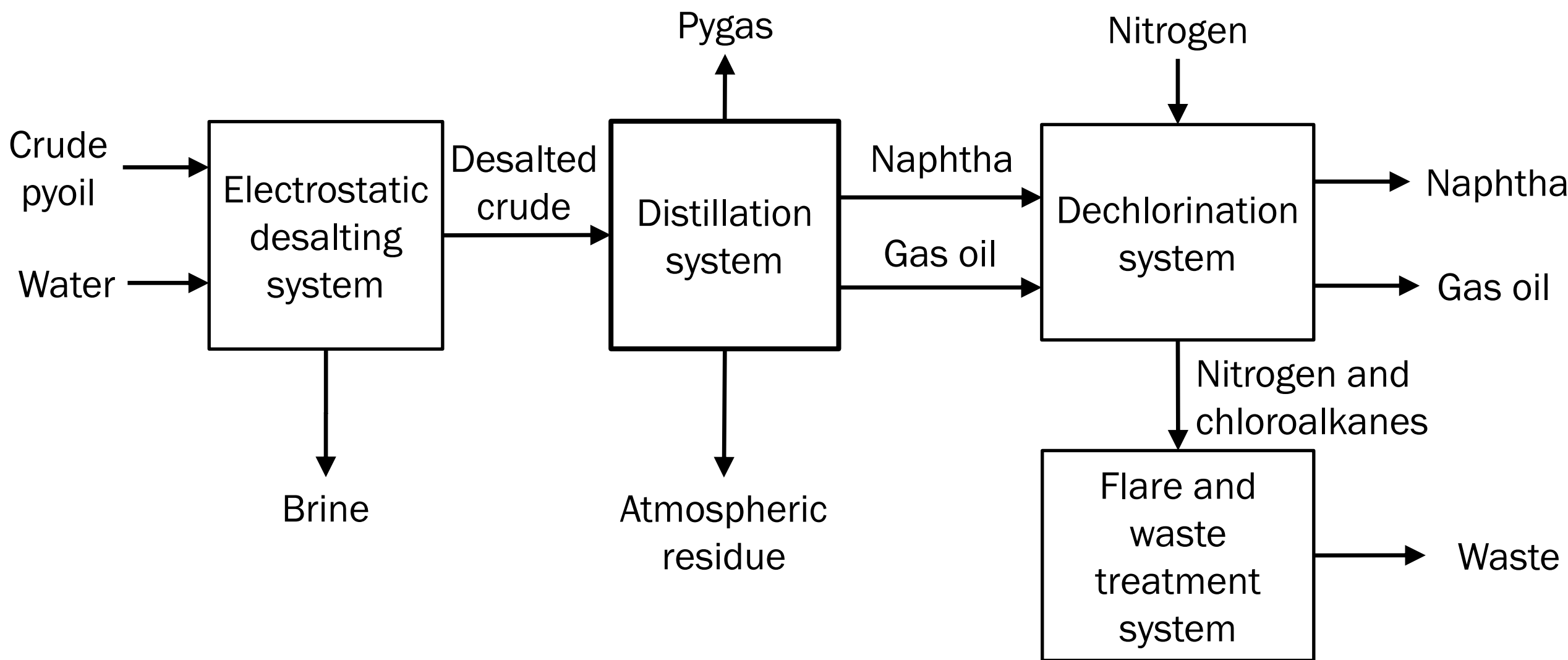
Breakdown of 53.9 tons/day plastic waste in Jembran Regency, Bali



Economics: Economic values were calculated on a basis of a 10-year operating period, using a 5-year MACRS depreciation.

Categorized Costs	
Capital Cost	\$27.33 Million
Variable Cost	\$2.50 Million per Year
Fixed Cost	\$2.77 Million per Year
Profitability	
Revenue	\$119.79 Million per Year
Discounted Pay Back Period	0.23 Years
Discounted Rate of Return	88.64%
Discounted Net Present Value	\$316.63 Million

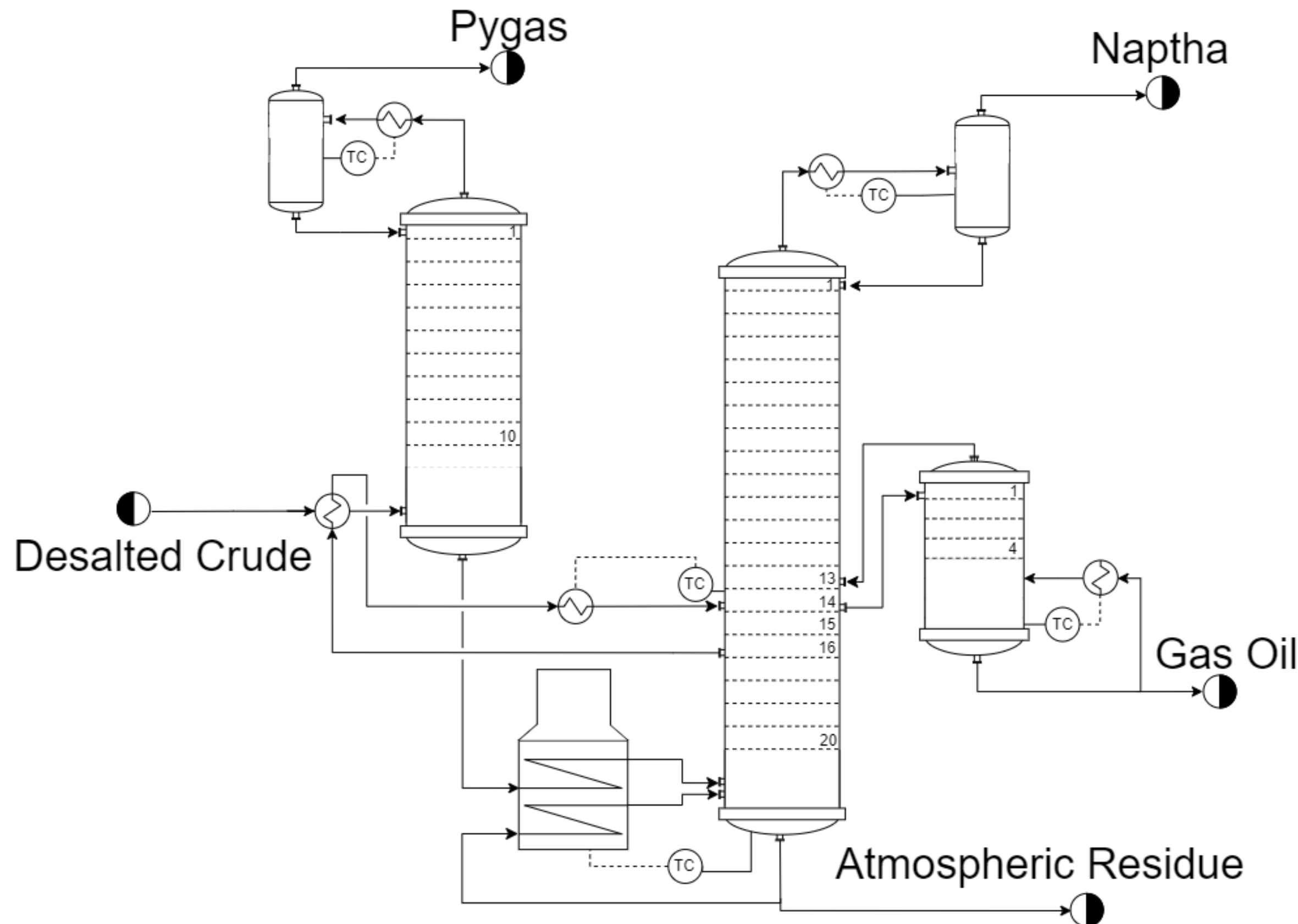
System BFD:



Process Description:

- Electrostatic desalting extracts salt contaminants from crude pyoil.
- Distillation separates the crude into four different streams or ‘cuts’: pygas, naphtha, gas oil, and atmospheric residue.
- Adsorbent beds remove remaining chlorides from two of the four cuts to meet product specifications.
- Chloroalkanes from the absorber go to waste storage and the flare was sized to handle upset conditions.

Simplified Process Diagram of Distillation System:



Main Column Behavior:

- High temperatures and heating at the bottom of the column necessitate a fired heater for the feed and reboiler.
- The addition of a side stripper and condenser allow product specifications to be met for all streams.

Safety:

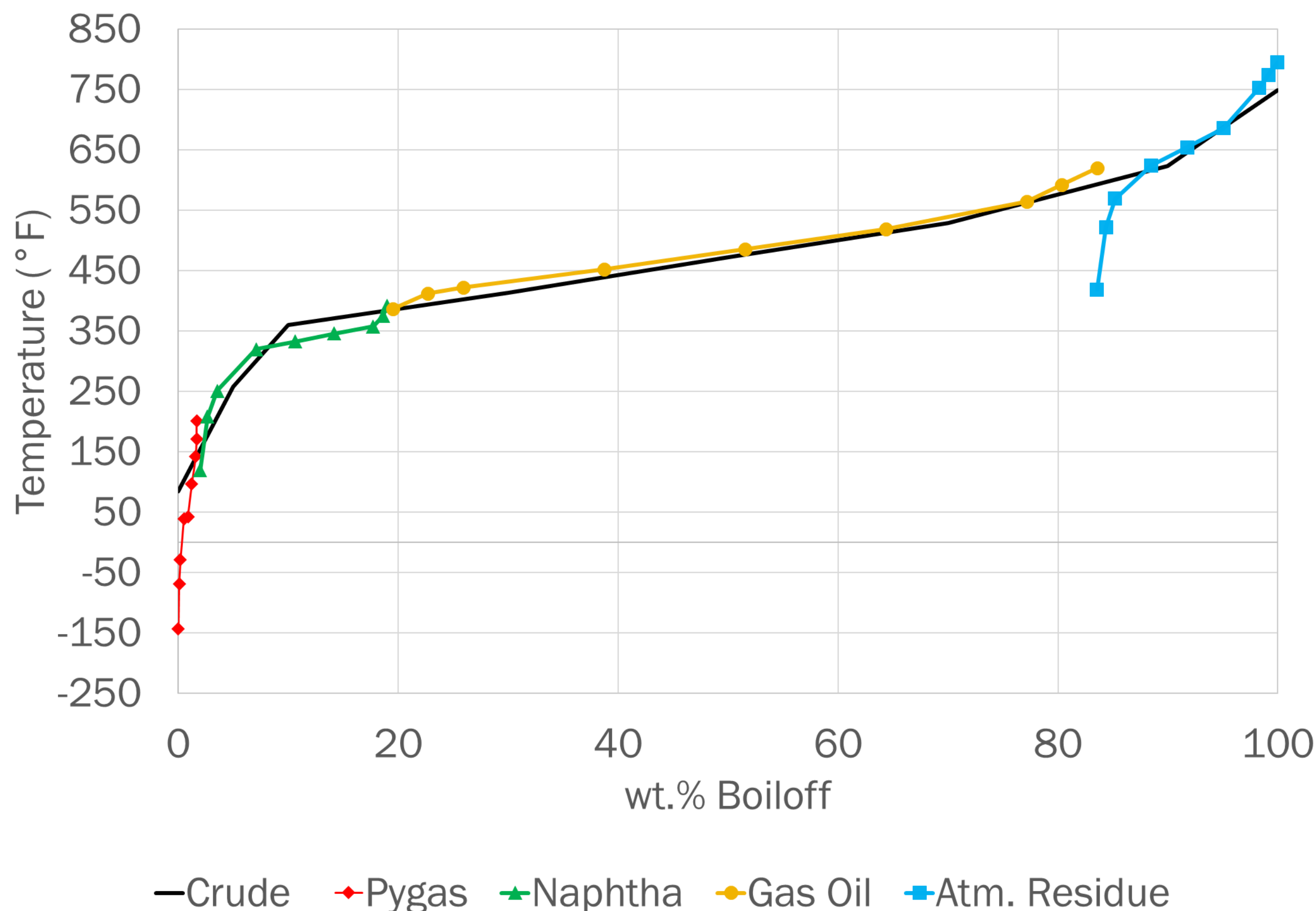
- Pressure safety valves sized for the main distillation system.
- HAZOP analysis highlights key safety challenges in distillation.
- Meets BACT standards of 98% recovery.

Final Products:

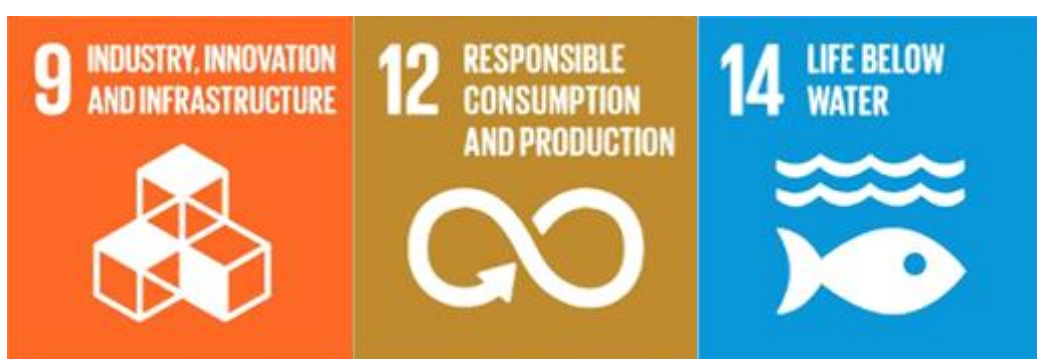
- Pygas: 11 tons/day; \$1,555,649 per year.
- Naphtha: 864 Barrels/day; \$24,616,685 per year.
- Gas Oil: 2,605 Barrels/day; \$93,617,000 per year.
- Atmospheric Residue: 712 Barrels/day.

Pygas to be converted to ethylene; Naphtha and gas oil to be reformed to produce various final products in the fuel industry; Atmospheric residue proposed use as carbon black for electronics industry.

Product Boiling Curves:



Conclusion: Plastic waste poses a significant environmental challenge. Pyrolysis units represent a profitable way to convert plastic waste into useful products.



2023 Capstone Project