Liquefied Natural Gas Technology

IPRO 304a

http://www.iit.edu/~ipro304f03/

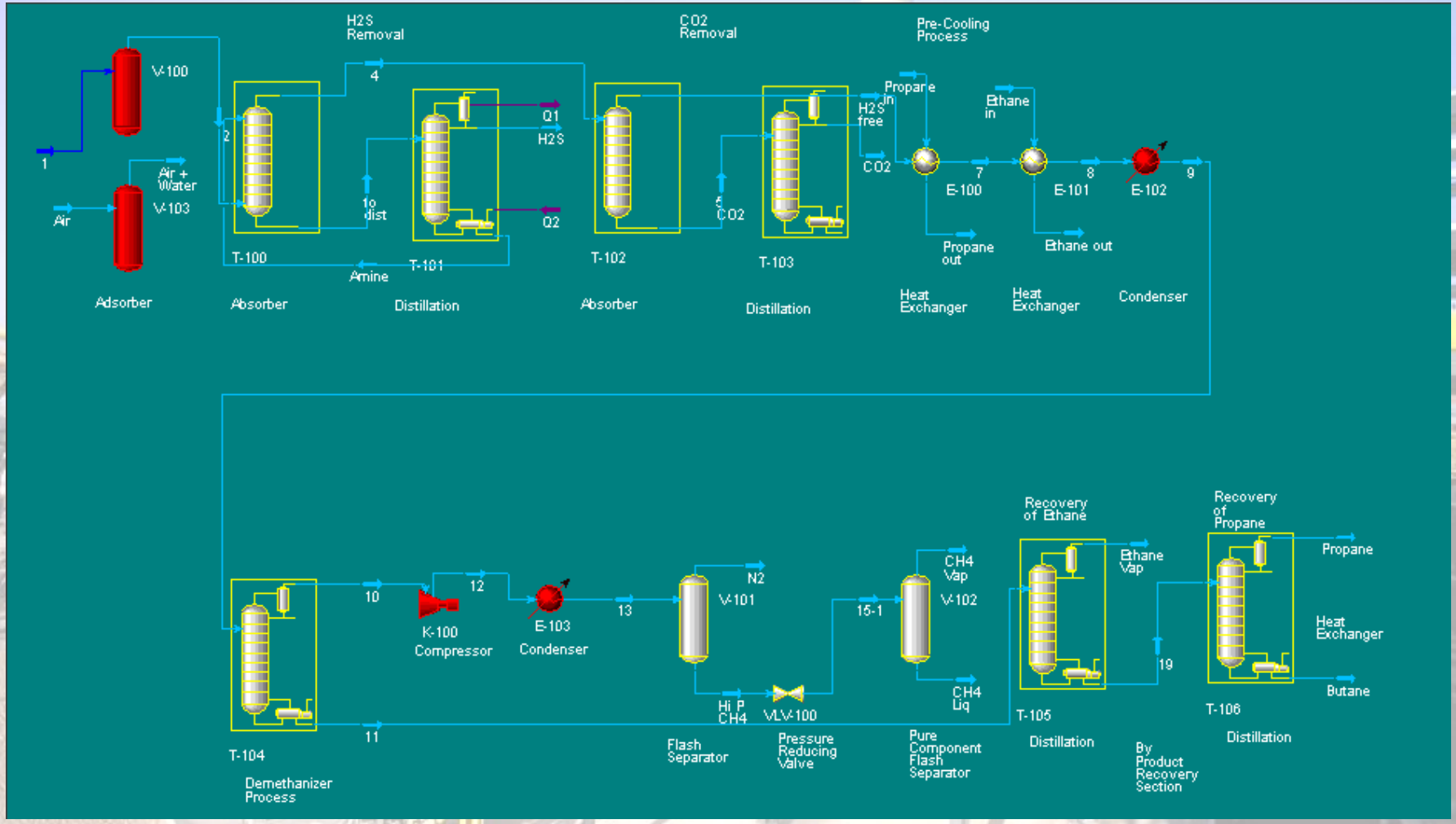
Objectives

- Design and model a production process for the manufacture of liquefied natural gas (LNG)
- Understand the economic aspects of running a facility and the worldwide market of LNG and its by products
- To identify environmental and safety concerns

Approach

- Team arranged in 3 groups
  - General research
  - Process design
  - Website development
- Research
  - Work with faculty advisor
  - Innovative ways of researching

Process Overview



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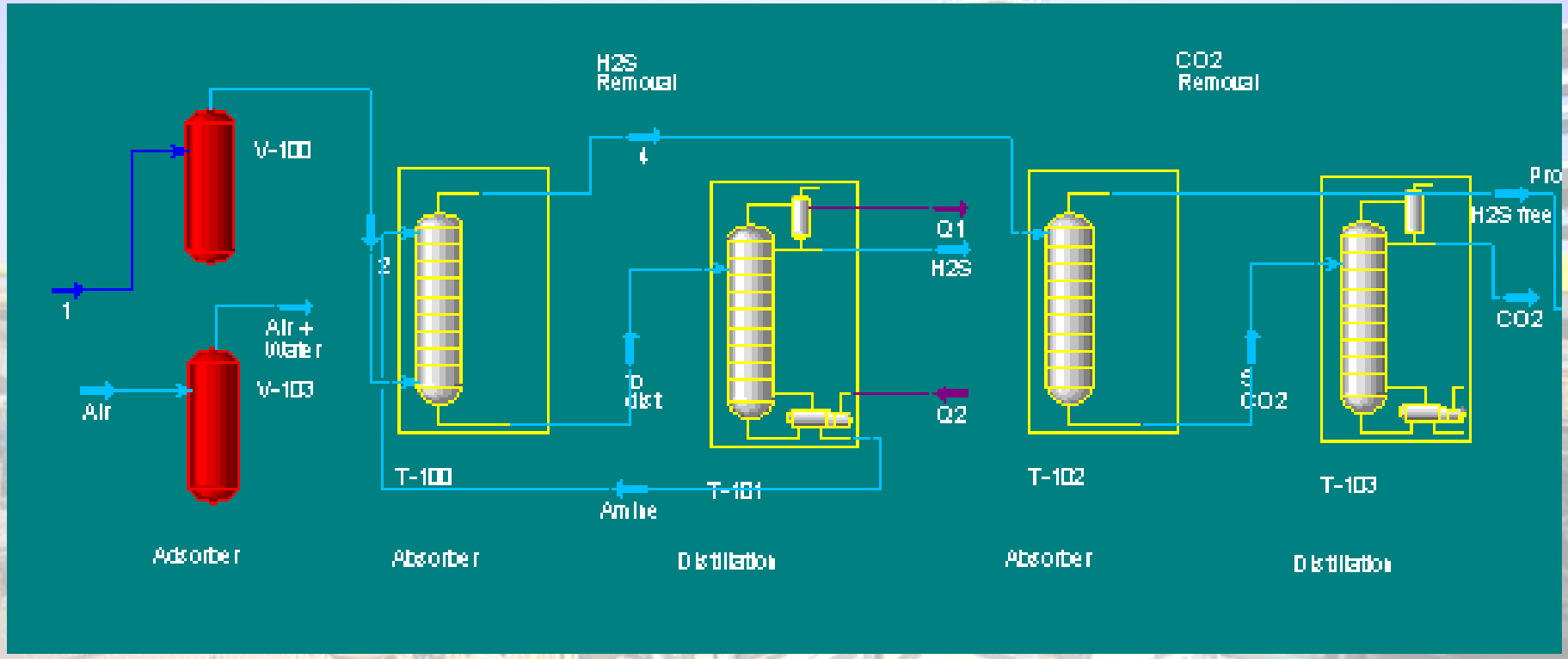
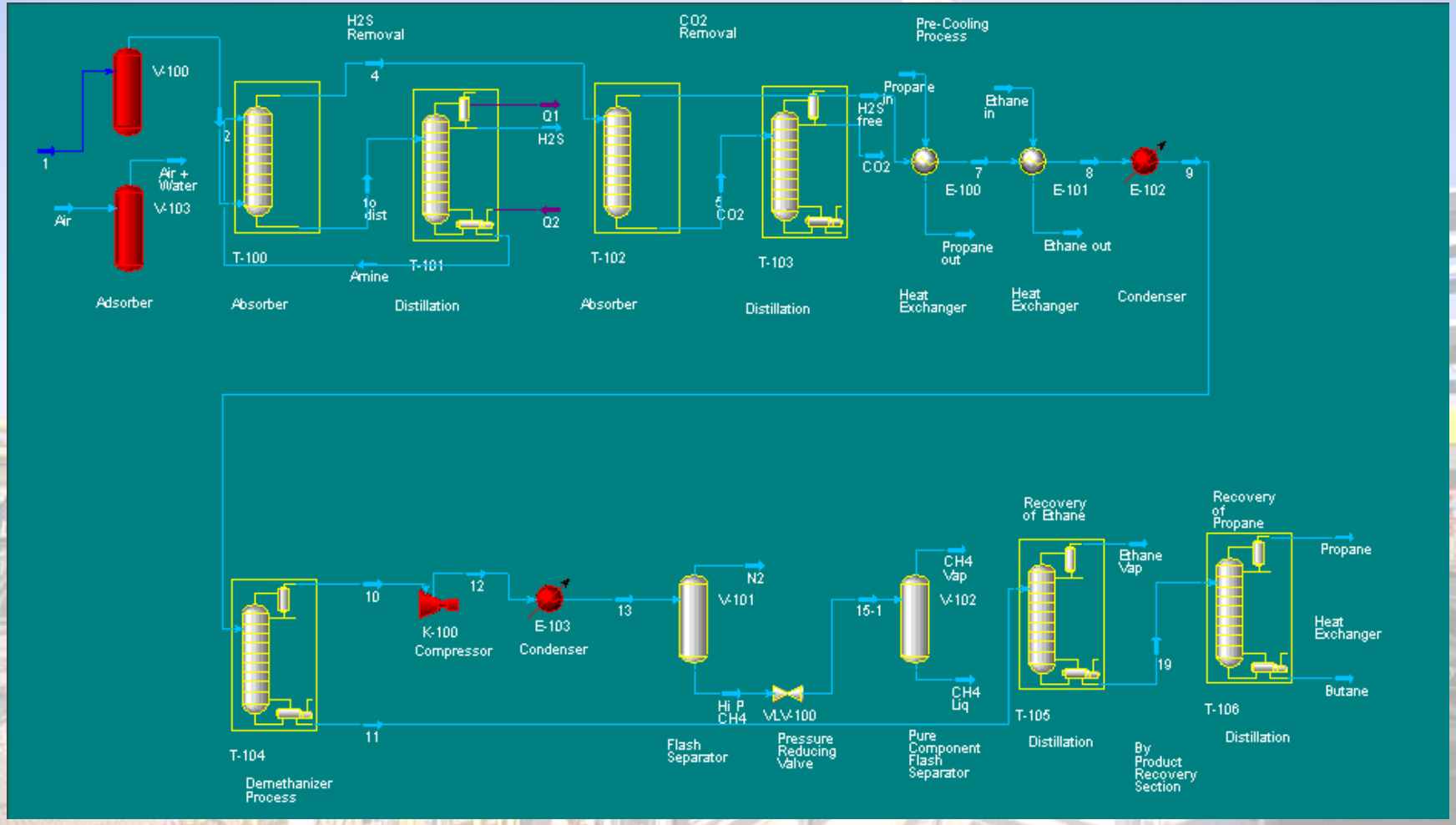
Contaminant Removal





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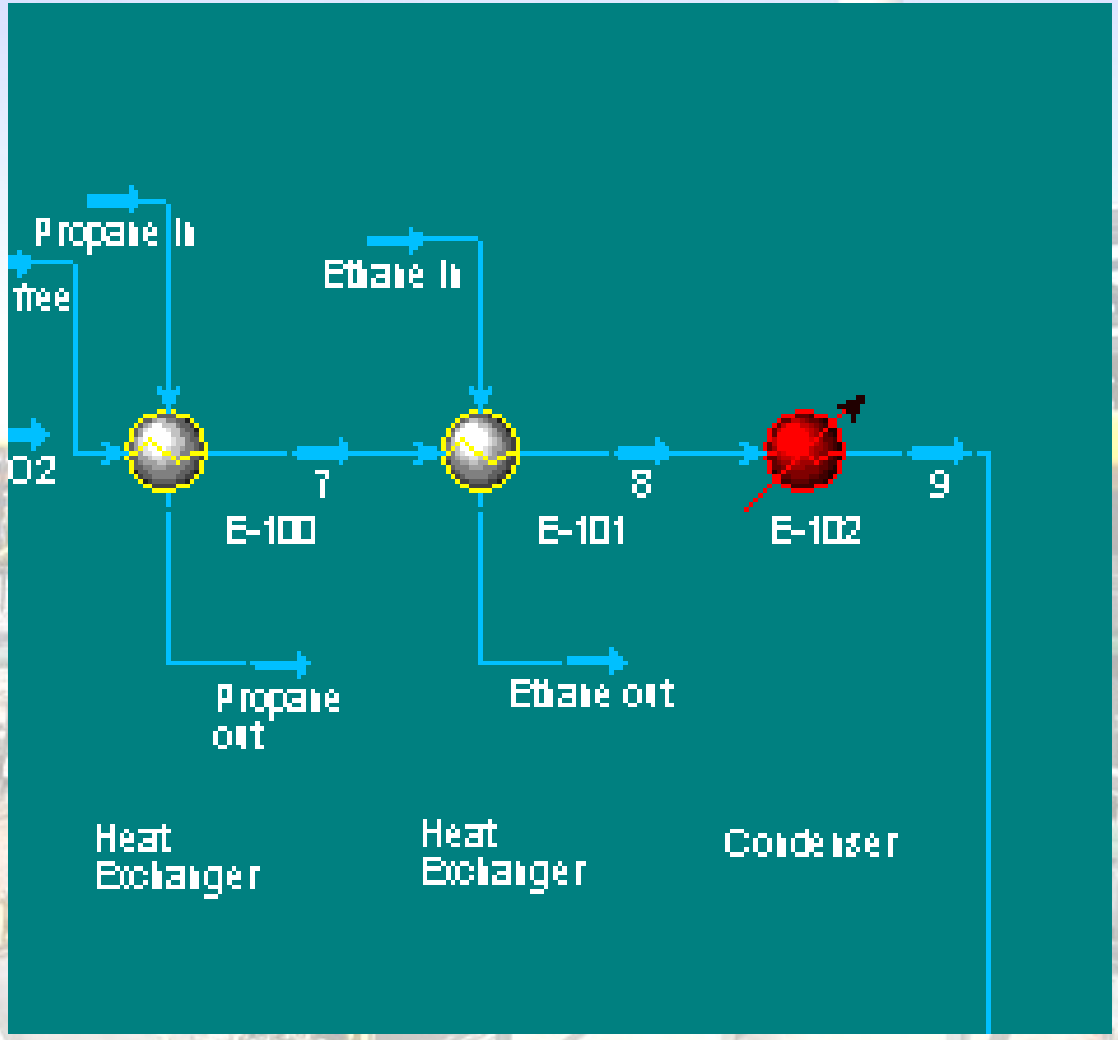
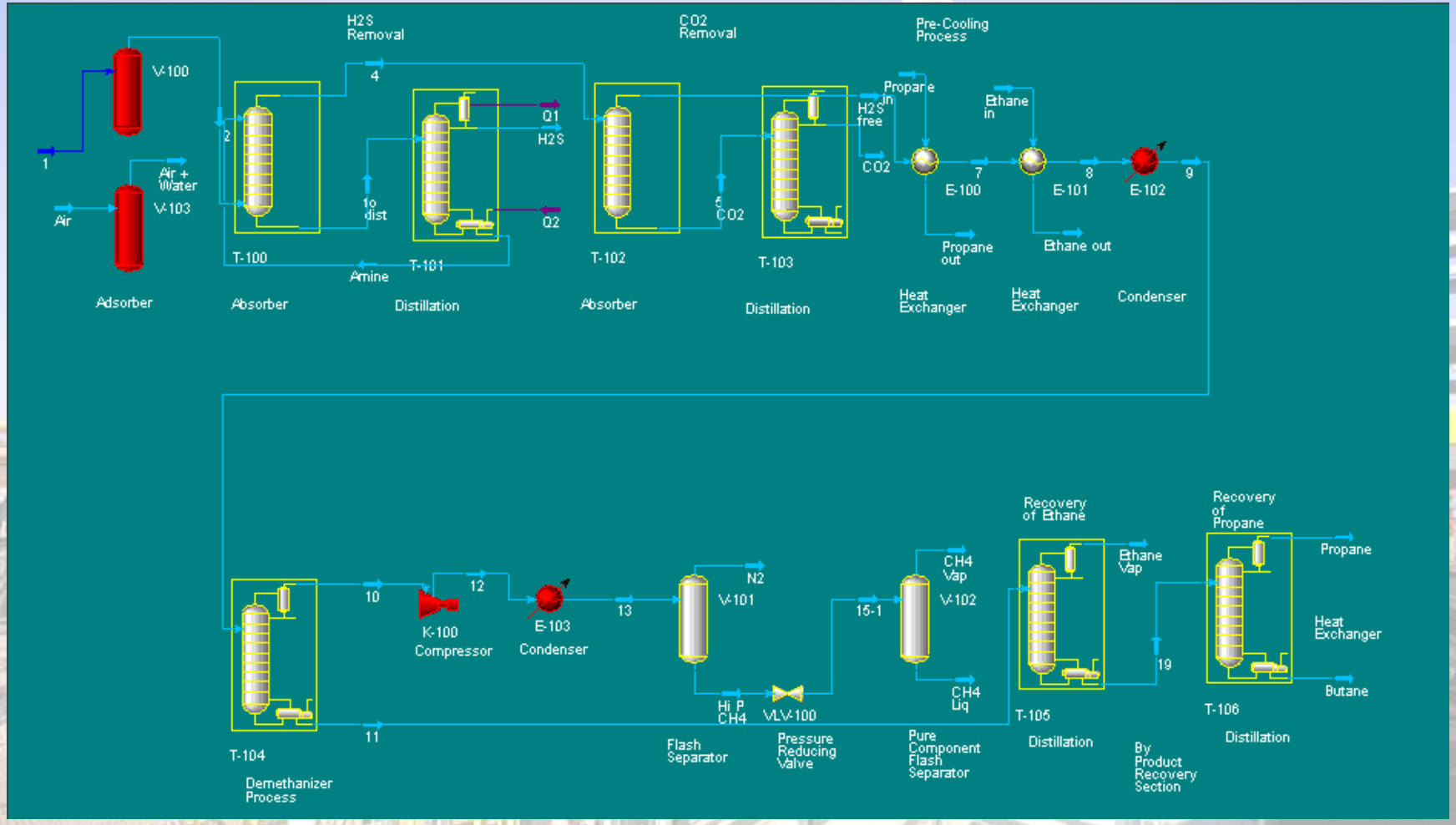
Pre-cooling


Propane In
Ethane In
02
7
8
9
E-100
E-101
E-102
Propane out
Ethane out
Heat Exchanger
Heat Exchanger
Condenser



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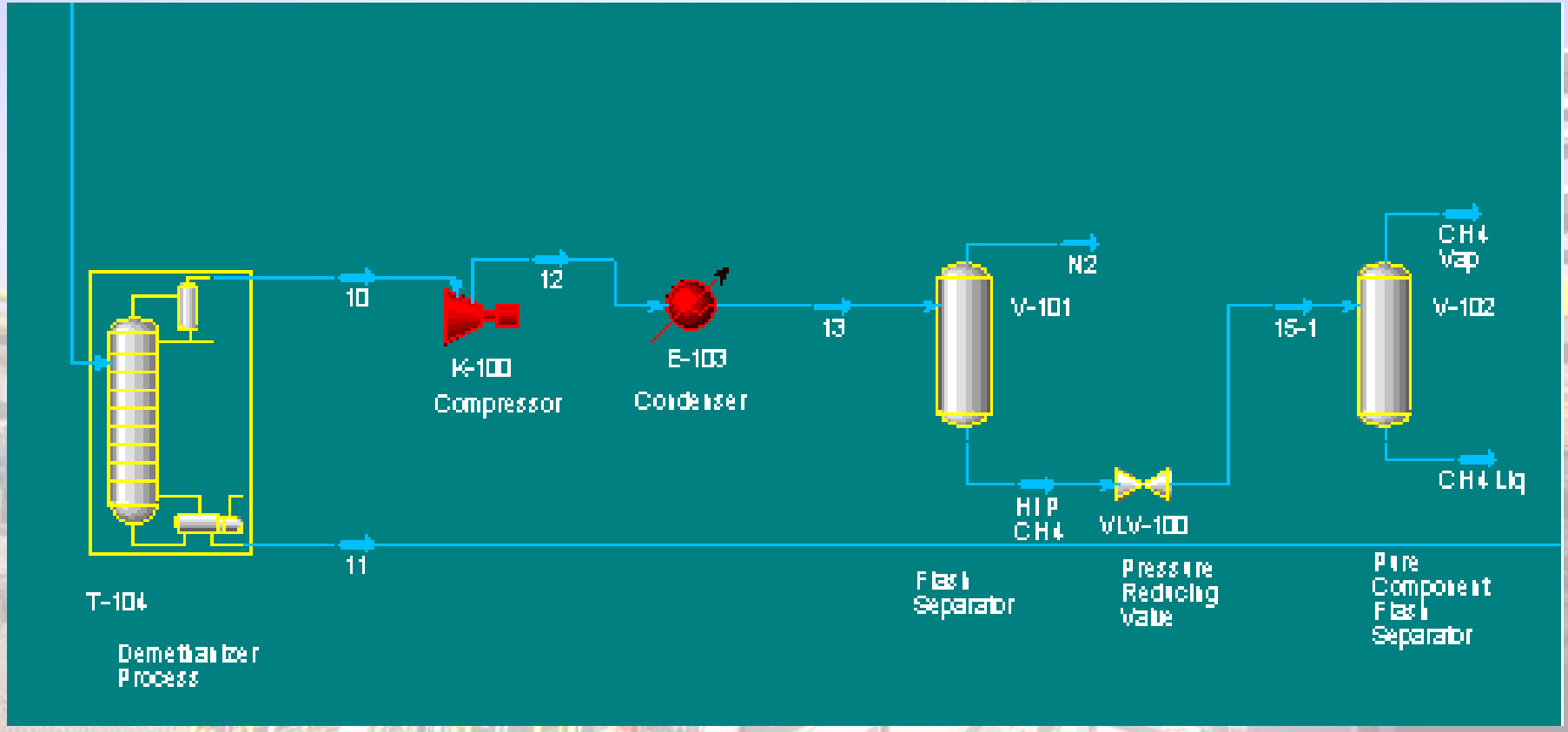
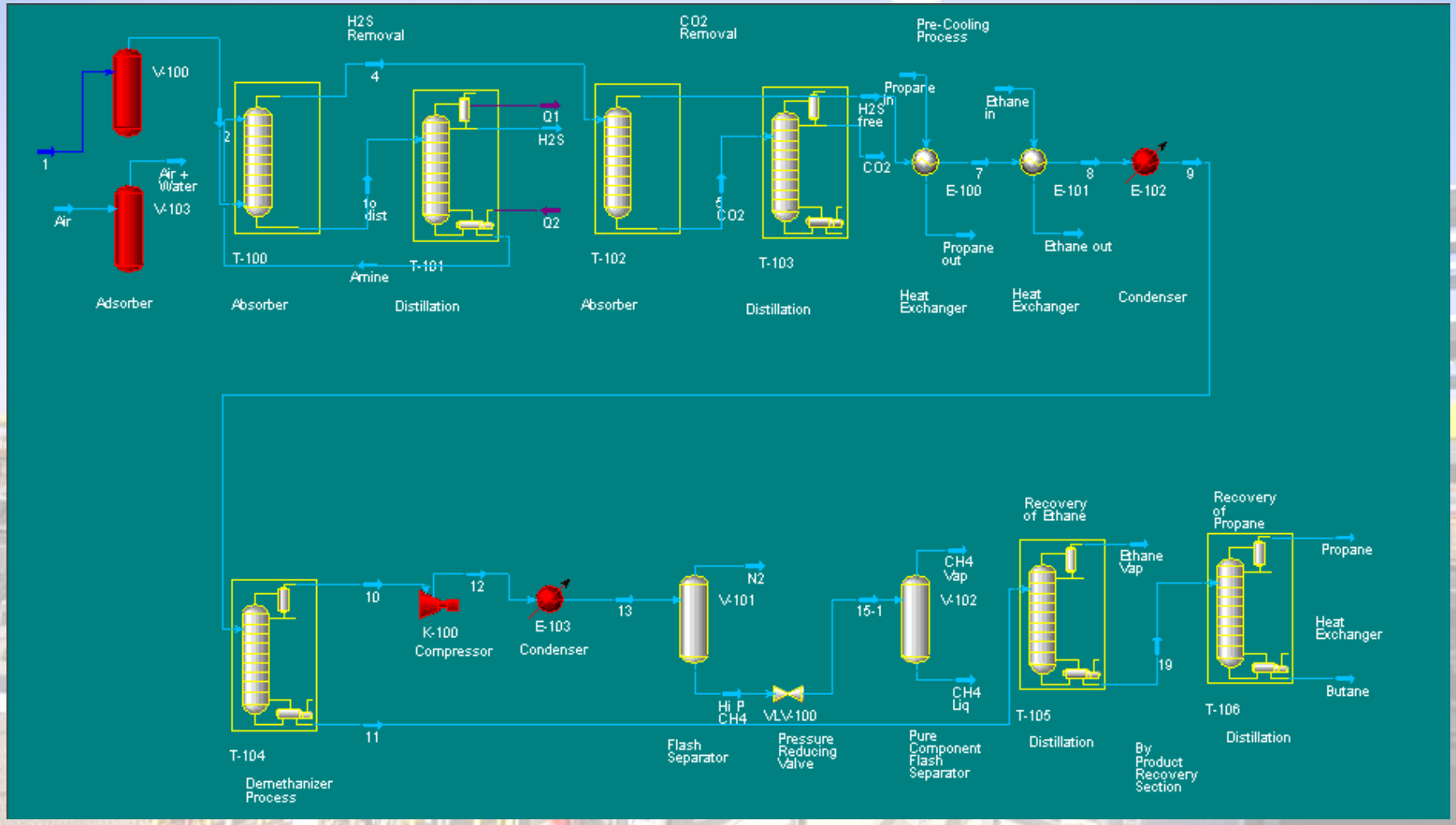
Demethanizer





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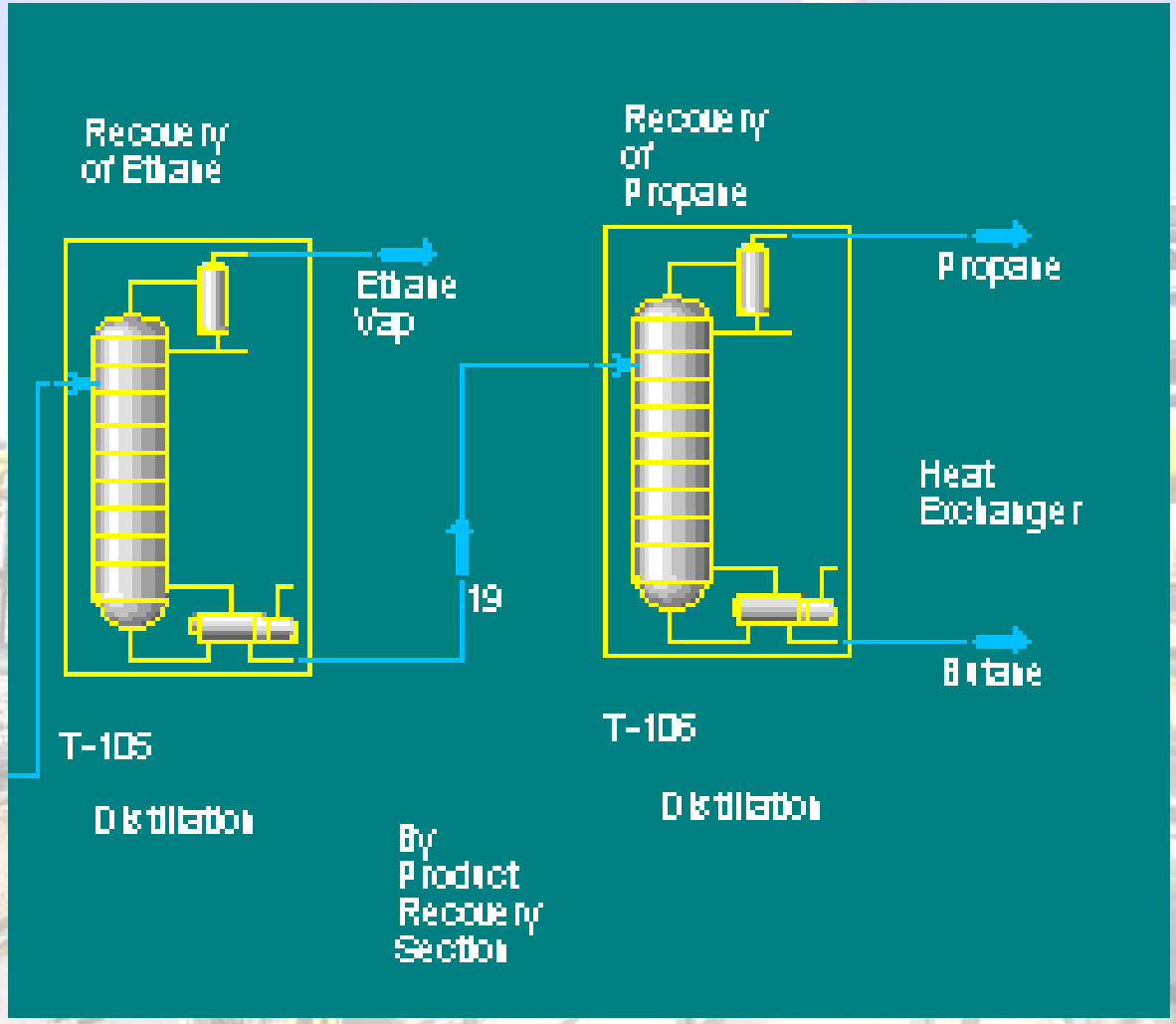
By product recovery



Cost Analysis

Capital Costs

ISBL Fixed Capital = 44.98 $MM
OSBL Fixed Capital = 11.24 $MM
Total Fixed Capital = 56.22 $MM

Startup Costs

Thirty Days of Variable Costs – Fresh Feed and Utilities = 24.0 $MM
Fixit Costs at 5% of Total Fixed Capital = 2.0 $MM
Total Startup Costs = 26.0 $MM

Working Capital

Product Inventory : 30 Days Storage = 9.0 $MM
Raw Material Inventory : 30 Days Storage = 24.0 $MM
Cash, Stores, Accounts Payable 1% TFC =.56 $MM
Total Working Capital = 33.0 $MM

Variable Operating Costs

Fresh Feed 450.0 MLbs / Hr At 7.5 Cents / Lb = 281.0 $MM / Yr
Utilities 97.0 MMBtu/Hr At 3.50 $ / MMBtu = 3.0 $MM / Yr
Total Variable Operating Costs = 284.0 $MM / Yr

Fixed Operating Costs

Fixed Costs At 30% of Total Fixed Capital = 16.0 $MM / Yr

Production Schedule

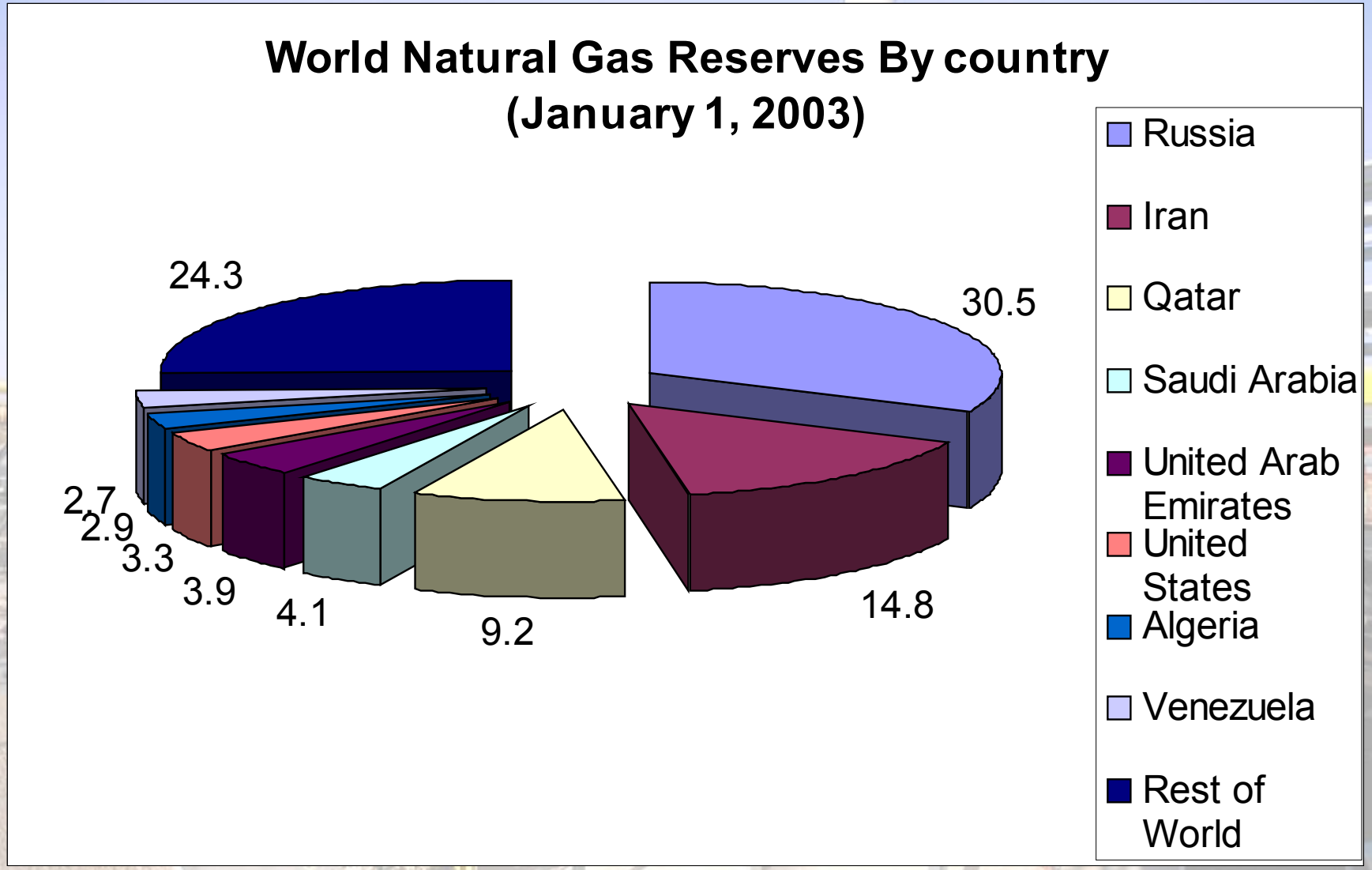
Methane 254002.0 Lbs / Hr At 12.0 Cents / Lb = 267.0 $MM / Yr
Ethane 28322.0 Lbs / Hr At 24.0 Cents / Lb = 56.0 $MM / Yr
Propane 20679 Lbs/Hr at 20.0 Cents/Lb = 34.0 $MM/Yr
Fuel 1382.0 MMBtu / Hr At 3.50 $ / MMBtu = 4.0 $MM / Yr
Total Revenue = 361.0 $MM / Yr

Salvage Value

Salvage Value = 5.6 $MM

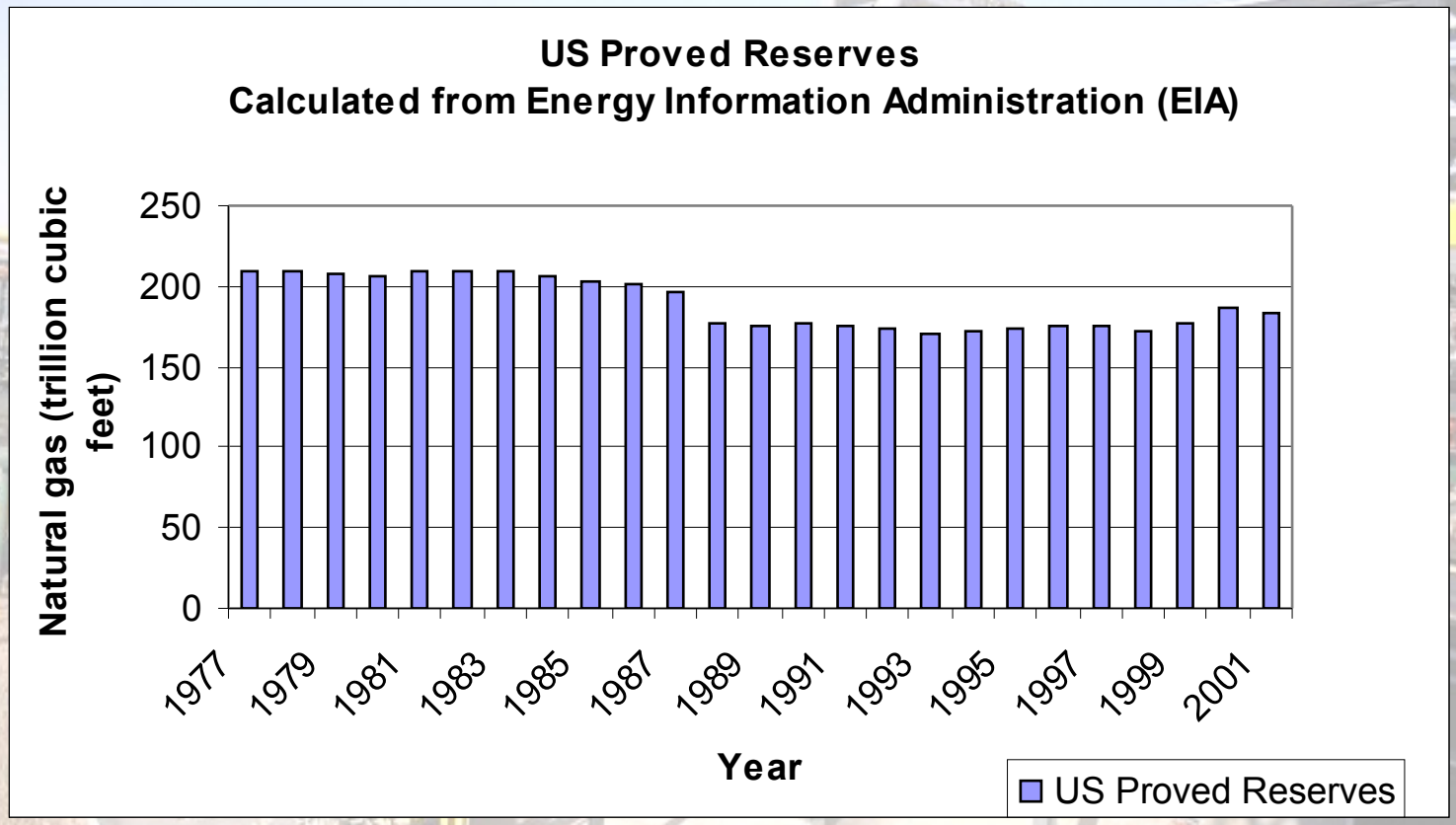
Discounted Cash Flow Profitability Index = 14.7

Sources of Natural Gas

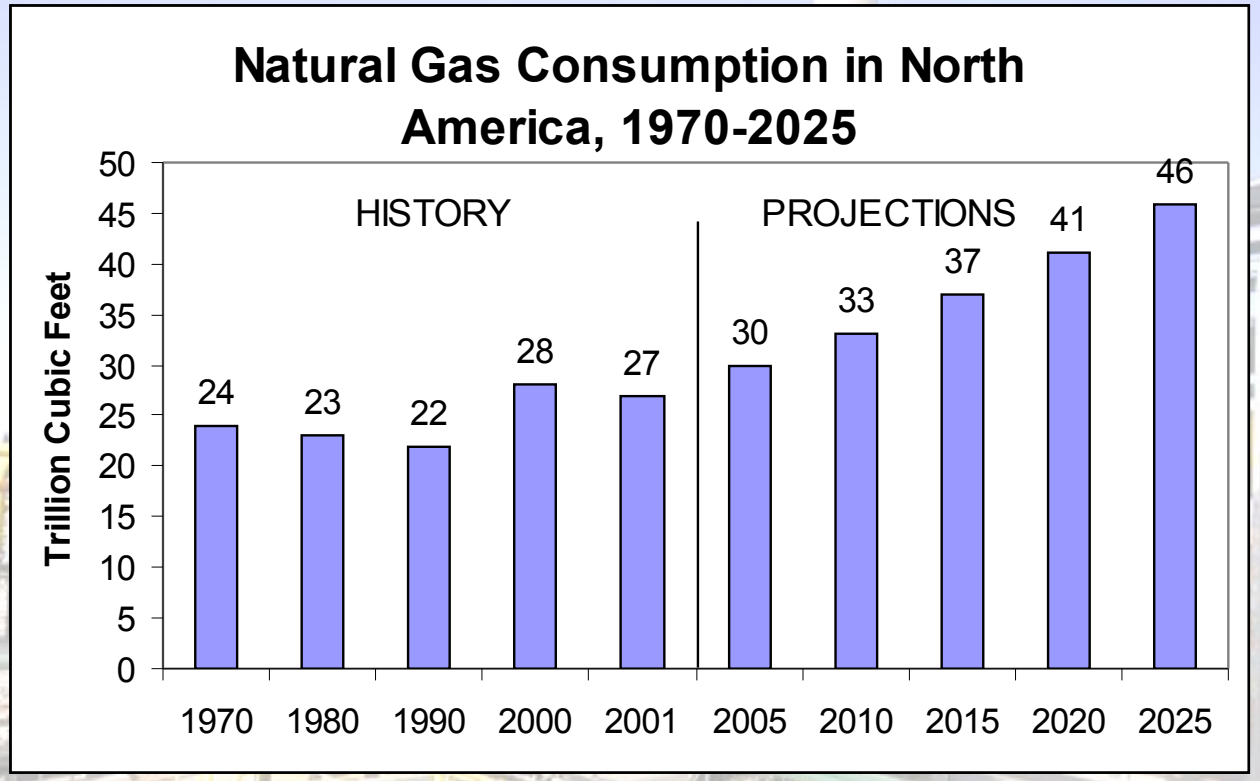


National Reserves

- The proven gas reserves in the US increased by 6 trillion cubic feet between 2002 and 2003.



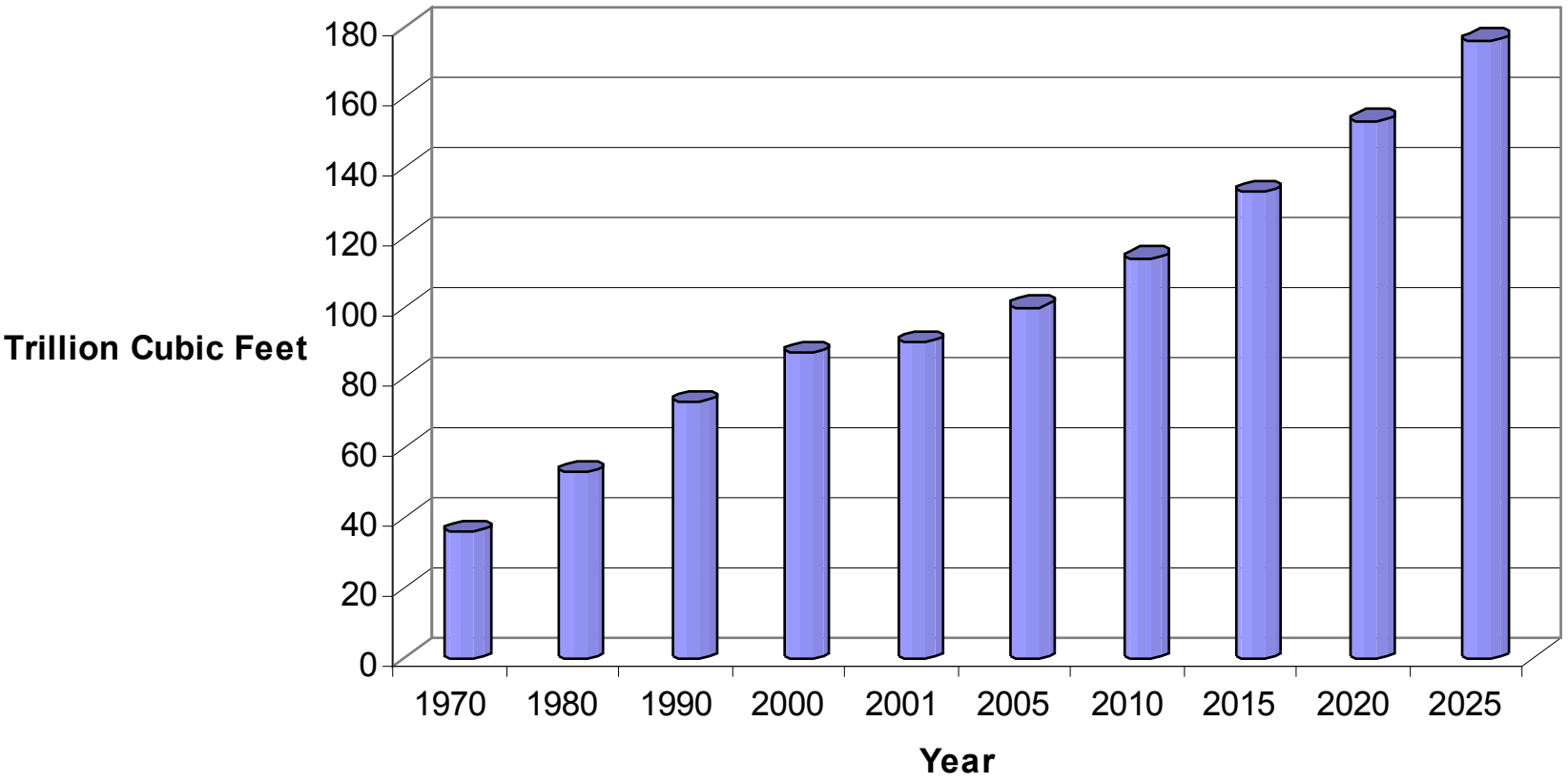
Domestic Usage and Demand



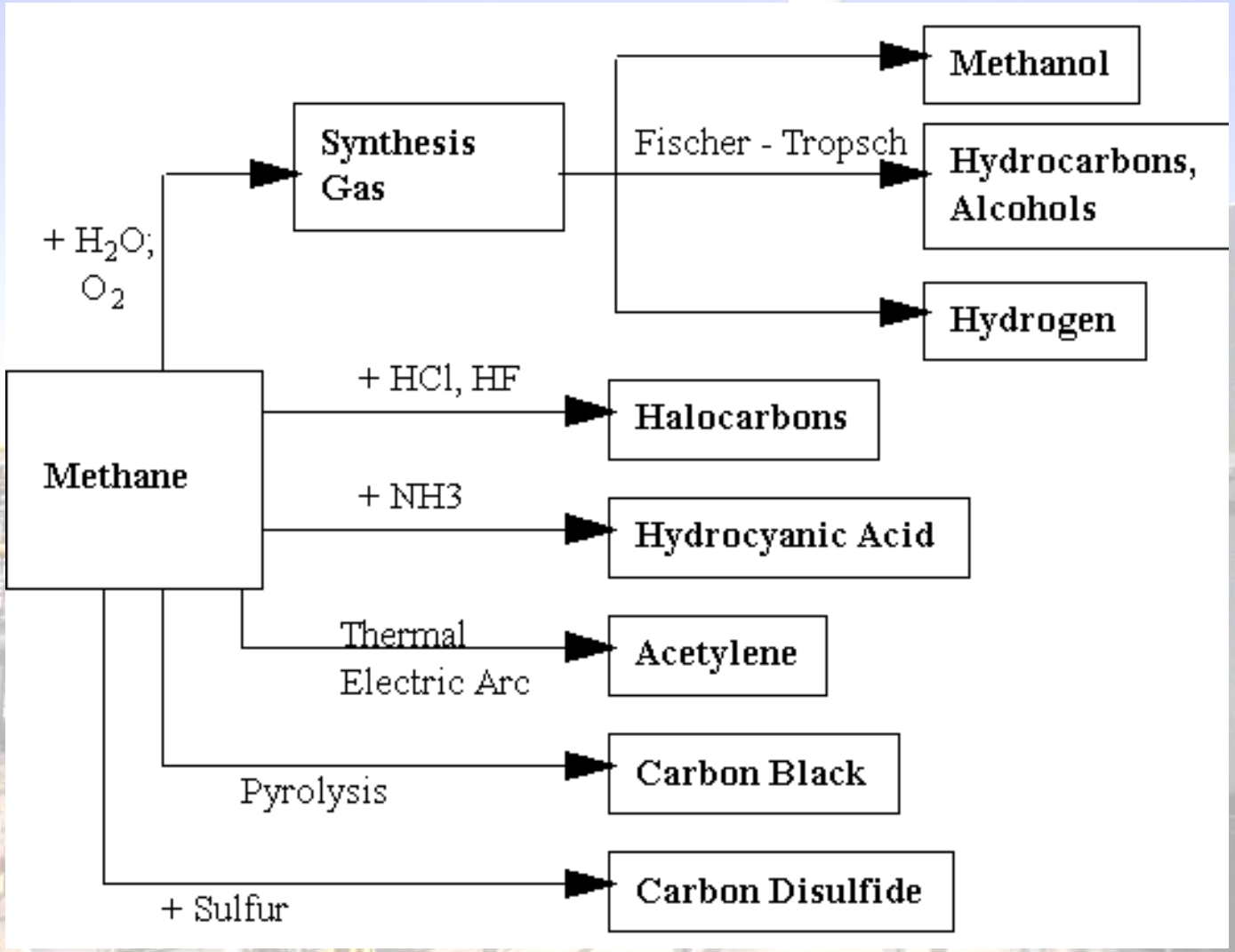
- Natural gas consumption is projected to grow by 2.2 percent per year on average between 2001 and 2025 in North America.

Worldwide Demand

- Consumption will increase at a rate that is higher than that of the other fossil fuels.
- Consumption is projected to increase by an average of 2.8% annually, compared with rates of 1.8% for oil consumption and 1.5% for coal.
- The natural gas share of total energy consumption is projected to increase from 23 percent in 2001 to 28 percent in 2025.


World Natural Gas Consumption, 1970-2025
Trillion Cubic Feet
180
160
140
120
100
80
60
40
20
0
1970
1980
1990
2000
2001
2005
2010
2015
2020
2025
Year

Chemical Precursor Status



By Product Usage

By Product	Uses	
LPG's	aerosols	plastic
	ceramics	rubber
	recycling	construction
	paper	metal
	food	drink
sulfur	gun powder	fertilizers
	pharmaceuticals	
nitrogen	ammonia production	electronics
	refrigeration	fertilizers
carbon dioxide	refrigeration	carbonation
	Urea	methanol
	oil recovery	

Emissions Management

Reduce greenhouse gases by:

- Natural solutions (carbon sinks)
- Reduce to 90% emissions by 2010
- Kyoto Protocol's Emissions Trading Scheme

Safety Considerations

- Company Responsibilities:
  - Provide adequate training for personnel
  - Risk Management and Crisis Management
  - Comply with federal safety standards
  - Workman's Compensation
- Employee Training:
  - Emergency procedures
  - Safe handling of toxic substances
  - On-site safety

Conclusions

- We have learned that our facility:
  - Has a competitive and efficient modern design
  - Is economically profitable

- Our approach enabled us to:
  - Analyze and understand all important aspects of the project
  - Achieve a rewarding experience together
  - Share our results in a meaningful way

Special Thanks to

Professor H Lindahl
Faculty Advisor

Thank you!

Discussion

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