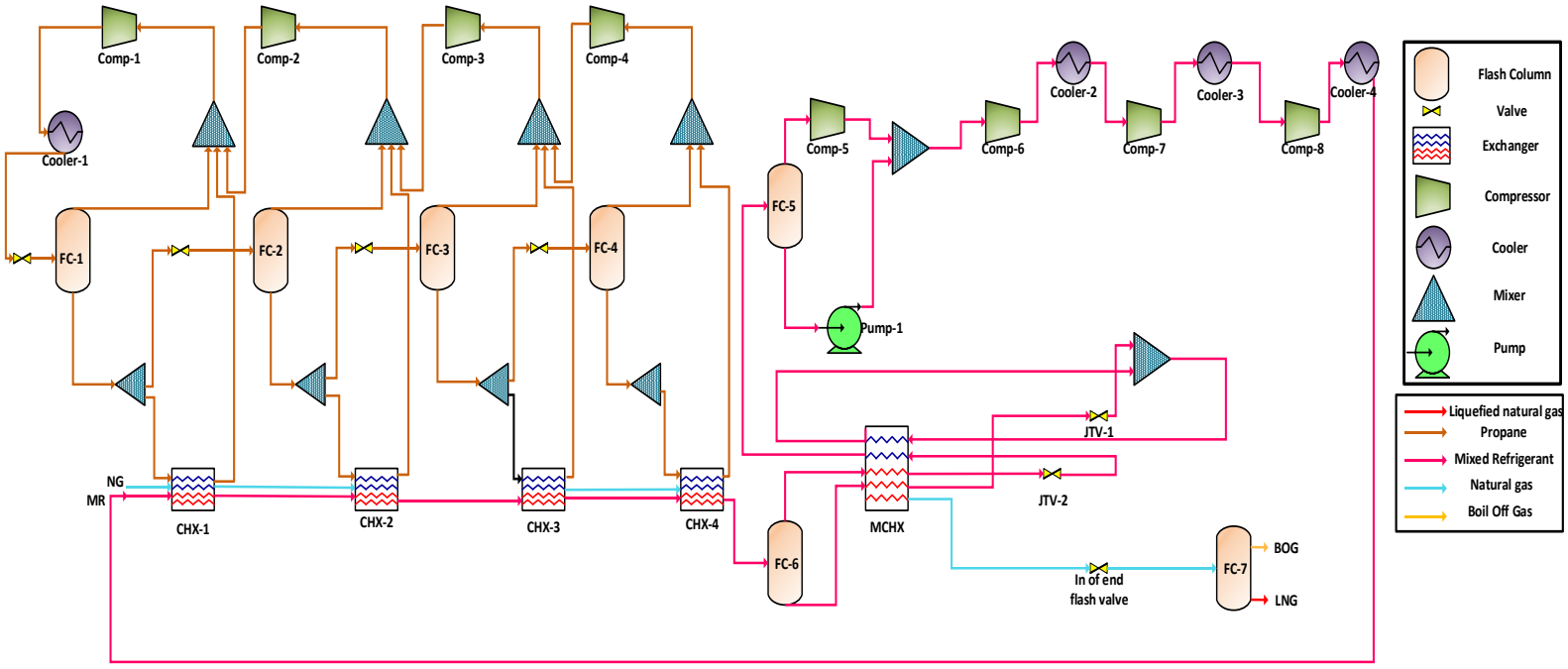
Final Year Project Showcase Batch-2019
Year 2023

Department: Chemical Engineering Programme: Chemical Engineering	
1	**Project Idea** Lifecycle Assessment and Techno-economic Analysis of Propane Pre-cooled Mixed Refrigerant (C3MR) Process for Natural Gas Liquefaction
2	**Process** The objective of this study was to reduce the specific energy consumption (SEC) of the C3MR process to make it more energy efficient by using knowledge based optimization (KBO) technique. Furthermore, the process was analyzed for its exergtic performance, economic feasibility and environmental effects.
3	**Outcome** The introduction of high boling components in mixed refrigerant along with optimal propane flowrate and process parametes, brought a synergistic effect to the whole process in terms of efficiency, sustainability and economic viability. The specific energy consumption was reduced to 0.219kWh/kgLNG from 2.51 kWh/kg LNG which is 2nd lowest according to literature, with achieving MITA of 2.695^{0}C of main cyrogenic heat exchanger. Moreover, the optimized case showed the least exergy destruction of 1982.34 kW with advanced exergy analysis providing the evidence of compressor and coolers to be most contributing. It also offered annual cost savings of 26.8 million and carbon emissions were also found to be significantly less due to low energy consumption.
4	**Evidence (Theoretical Basis)** Natural gas is the greenest fossil fuel with an existing dominancy in the world energy mix. It needs to be liquefied, to transport to far off places lacking pipe infrastructure. Focusing on the C3MR liquefaction process, it has ample margin of improvement in terms of energy and exergy efficiency, profitability and environmental perspective. Its robust design and the thermodynamic effect of natural hydrocarbons used as refrigerant allow the successful optimization to a great extent. In this project, simulation-based optimization of C3MR process was done on Aspen HYSYS to achieve lower energy consumption. Techinal constraint optimization was carried out by adding i-pentane in the mixed refrigerant blend, increasing the propane flowrate as well as altering other effective parameters. The optimized case was then evaluated on the basis of energy, exergy, economic and advanced exergy analysis, with results compared to the base case. It exhibited high exergy efficiency of 65.21% providing less energy losses in the system among which about 93.7% of the total thermodynamic irreversibilities present in the system are avoiadable with technical improvements in the operations and design. Operating cost savings of 72.85% were also attained. Furthermore, life-cycle assessment of both base case and optimized case was carried out using software GREET. The results showed that base case has 3.4 times more CO_2 emissions than optimized case making optimized case more environmentally friendly with higher environmental beign index value of 35.57.
5	**Competitive Advantage or Unique Selling Proposition** (Cost Reduction, Process improvement, Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new market or having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them). Please keep relevant options, delete the rest of them, and

	correct the sequence	
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region) The project achieved the following sustainable development goals (SDGs): **SDG#07: Affordable and Clean Energy** The proposed optimized case provides an energy-efficient process that is a source of liquified natural gas at relatively low prices. **SDG#09: Industry Innovation and Infrastructure** This study makes use of knowledge based optimization technique, which have not been previously applied for C3MR optimization. Moreover, the optimized blend of mixed refrigerant can be applied to any industry currently employing C3MR technology for natural gas liquefaction. **SDG#12: Responsible Consumption and Production** The decrease in specific energy consumption ultimately leads to lower emissions to the environment making natural gas more sustainable.	
b	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.) The project incorporates following environmental aspects: 1. Energy efficient process 2. Less exergy losses 3. Reduction in carbon emissions	
c	**Cost Reduction of Existing Product** According to the economic analysis, the use of 6 MR components with optimal selection of MR flowrate lead to operating cost savings and capital cost savings of 15.5million and 56.19million respectively.	
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** (e.g. What is the issue is current process and what improvement you suggests) **Issues:** The current C3MR industry is reliant on energy intensive processes to achieve minimum internal temperature approach requirements in addition to high exergy losses and costs. **Suggestion:** The optimum blend of both low boiling and high boiling components in mixed refrigerant could be used to attain effective liquefaction with reduced overall SEC, meeting the sales gas requirements.	
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market) The reduction in overall costs incurred, results in substantial decrease in selling price due to which market share can be expanded.	
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) As the study deals with liquefaction of natural gas, the main target market is natural gas industry involved in storage, production and transportation of LNG.	
7	**Team Members** (Names along with email address)	Maria Hareem (mariahareem789@gmail.com) Rumaisa Ghauri (rumaisaghauri63@gmail.com) Kanza Zafar (kanzazafar0815@gmail.com) Hamna Ahmed (ahmedhamna01@gmail.com)
8	**Supervisor Name** (along with email address)	Associate Professor Dr. Faizan Raza (razafaizan@neduet.edu.pk)
10	**Pictures (If any)**	Process Simulation


Comp-1
Comp-2
Comp-3
Comp-4
Cooler-1
FC-1
FC-2
FC-3
FC-4
NG
MR
CHX-1
CHX-2
CHX-3
CHX-4
Comp-5
Comp-6
Comp-7
Comp-8
Cooler-2
Cooler-3
Cooler-4
FC-5
Pump-1
JTV-1
JTV-2
MCHX
FC-6
In of end
flash valve
FC-7
BOG
LNG
Flash Column
Valve
Exchanger
Compressor
Cooler
Mixer
Pump
Liquefied natural gas
Propane
Mixed Refrigerant
Natural gas
Boil Off Gas