Final Year Project Showcase Batch-2018
Year 2022

Department: Chemical Engineering **Programme: Chemical Engineering**		
1	**Project Idea**	Energy, Exergy, Economic, Environmental, and Exergoenvironmental (5Es) analyses of CO_2 capture from Natural Gas using Hybrid Physical and Chemical Solvents – A Simulation study
2	**Process**	The objective was to find a solvent that could replace MEA in a commercial Natural gas sweetening process. The solvent blend must be energy efficient, have fewer exergy losses, have low capital and operating cost, and must be the most environmentally friendly among all the studied blends.
3	**Outcome**	The blend of MDEA+SULFOLANE was found to be the best performing one among all the 31 studied solvents, based on the 5Es analyses. It required the least energy consumption of 23067.37 kW and offered the highest annual cost savings of $34.14 million, apart from this it also showed the least exergy destruction of $2.5x10^4$ kW and an environmental benign index of 367.43. It also showed satisfactory performance in Environmental analysis with CO_2 emissions of 73.2316×10^{-5} kg of CO_2 in sweet gas/kmol.
4	**Evidence (Theoretical Basis)**	Natural gas is the cleanest form of fossil fuel that needs to be purified from CO_2 and H_2S to diminish harmful emissions and provide feasible processing. The conventional chemical and physical solvents used for this purpose have many drawbacks, including corrosion, solvent loss, high energy requirement, and the formation of toxic compounds, which ultimately disrupt the process and affect the environment. Hybrid solvents have lately been researched to cater to these liabilities and enhance process economics. In this study, processes for different amines (including MEA) and their blends (in total 31 solvents) are simulated and optimized on Aspen HYSYS® according to the given sour gas conditions and required product specifications. 5Es (Energy, Exergy, Economic, Environmental, and Exergoenvironmental) analyses were performed on optimized cases, and results were compared with the base case, MEA (30 wt.%). The hybrid blend of Sulfolane and MDEA with weight percentages of 6% and 24%, respectively, showed the highest energy saving of 20% concerning the base case. In addition, it offered 93% savings in exergy destruction and 17.26% in the total operating cost of the process. It is also promising to the environment due to reduced entropy sent to the ecosystem and controlled CO_2 emissions. Therefore, the blend of Sulfolane and MDEA is proposed to be superseded by the conventional solvent MEA for the natural gas sweetening process.
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#4: Quality Education** Test and application of previously studied concepts related to chemical engineering and generation of new ideas for further studies. **SDG#7: Affordable and Clean Energy** The proposed solvent provides an energy-efficient process that is a source of refined gas at a low price.

		SDG#9: Industry, Innovation, and Infrastructure The study covers a vast range of solvents that have not been studied previously moreover, the proposed solvent can be used directly in any industry previously using MEA for natural gas sweetening, without any further modification in the process.
b	**Any Environmental Aspect** (e.g. carbon reduction, energy-efficient, etc.)	The project dealt with the following environmental aspects 1. Carbon reduction 2. Energy efficient process 3. Less exergy losses
c	**Cost Reduction of Existing Product**	As per the economic analysis, MDEA+SULFOLANE blend was found to be saving $7.16million in terms of total operating and maintenance costs and a $6.75 million savings in terms of total annualized cost in comparison with the base case MEA.
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process**)	**Issues:** The issues with the commercial MEA process are low acid gas loadings, the high energy requirement for gas sweetening, solvent degradation, & corrosion. **Suggestion:** MDEA+Sulfolane could be used as a replacement for MEA in a commercial natural gas sweetening process.
e	**Expanding of Market share** (e.g. how it expand and what is the problem with the current market	The market share can be expanded because the gas can be refined at a much cheaper price than the existing commercial process (MEA). It will attract more customers hence the market shares will expand.
f	**Capture New Market** (e.g. Niche market or unaddressed segment)	The idea of using MDEA+Sulfolane for natural gas sweetening is not a commercialized process so there is a huge market for both chemical manufacturers and gas refining industries.
6	**Target Market** (Industries, Groups, Individuals, Families, Students, etc)	MDEA and Sulfolane are great alternatives for the purpose of gas purification instead of MEA. So the main target markets are the gas refineries and chemical manufacturing plants.
7	**Team Members** (Names along with email address)	Aisha Ellaf (aishaellaf0@gmail.com) Durreshehwar Zaeem (durreshehwarzaeemofficial@gmail.com) Faizan-ul Haque Siddqui (faizan16siddiqui@gmail.com) Syed Nehal Ikram Hassan (nehalikram80@gmail.com)
8	**Supervisor Name**	Associate Professor Dr. Syed Ali Ammar Taqvi (aliammar@neduet.edu.pk)
10	**Pictures**	Process Simulation