**Cost Analysis of Methanol Production**

LAB 3

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Aim

*The aim is to evaluate and understand the cost structure associated with the production of methanol in a chemical process and to calculate the total cost of production of methanol considering the various cost components and to provide optimization efforts in the production of methanol.*

Method

*The methodology for analyzing methanol production costs involves a step-by-step approach to understanding the chemical process and its associated costs. The process can be summarized as follows:*

1. ***Initial Conditions****: Start with the given initial conditions, including the flow rate of CO2 (2000 kmol/hr) and the molar flow rate of water (3.103 kmol/hr in stream 5).*
2. ***Chemical Reaction****: Converting CO2 and H2 to methanol and water. Calculate the extent of CO2 conversion based on the stoichiometry of the reaction.*

*CO2 + 3H2 → CH3OH + H2O*

1. ***Process Equipment****: Consider the various process equipment units listed in Table 1. These units include compressors, reactors, coolers, flash drums, and a distillation column. Consider their capital costs, electricity consumption, steam consumption, and cooling water usage.*
2. ***Utility Costs****: Utilize the utility prices listed in Table 2 to calculate annual electricity costs, steam costs, and cooling water costs associated with operating the equipment.*
3. ***Annual Reactant Costs****: Calculate the annual costs of CO2 and H2 reactants. This involves considering the variable CO2 and H2 prices and the flow rates of these reactants through the process.*
4. ***Total Annual Cost (TAC)****: Compute the total annual cost (TAC) as the sum of capital costs, annual electricity costs, annual steam costs, annual cooling water costs, and annual reactant costs. Apply the capital recovery factor (phi = 0.1) to annualize the capital costs.*

*TAC = phi \* Total equipment capital costs + Annual electricity costs + Annual steam costs + Annual cooling water costs + Annual reactant costs*

1. ***Annual Methanol Production****: Calculate the annual production of methanol in tons. This is based on the CO2 conversion, initial CO2 flow rate, and the assumed operating hours per year (7884 hours).*

*Annual production of methanol = CO2 conversion \* Initial CO2 flow rate \* Operating hours per year*

1. ***Cost of Methanol Production (CMethanol)****: Determine the cost of methanol production (CMethanol) as the ratio of TAC to the annual production of methanol in tons. This provides the cost per metric ton of methanol produced.*

*CMethanol = TAC / (Annual production of methanol \* 1000)*

*The approach involves utilizing mass balance equations, performing degree of freedom analysis, and employing Gauss Elimination for validation.*

*The detailed process flow diagram is as follows:*

A diagram of a machine

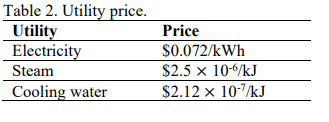
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*Table given in the problem statement mentioning the capital cost and energy consumption:*

*A table with numbers and symbols

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*Utility price table:*

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Results and Analysis:

*CO2\_5a: 0.0010, H2\_5a: 0.0000, CH3OH\_5a: 0.4943, H2O\_5a: 0.5047*

Graph Obtained:

Conclusions:

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Appendix: