

## Supplementary material to

### CONCEPTUALIZATION AND PROCESS SIMULATION OF A CO<sub>2</sub>-BASED METHANOL PRODUCTION PLANT

Saman Khawaja<sup>1,2</sup>, Muhammad Rashid Usman<sup>1,3\*</sup>, Rabya Aslam<sup>1</sup>

<sup>1</sup>Institute of Chemical Engineering and Technology, University of Punjab, New Campus, Lahore 54590, Pakistan

<sup>2</sup>School of Chemical Engineering, Minhaj University Lahore, Civic Center, Twp, Lahore 54770, Pakistan

<sup>3</sup>Engineering Research Centre, University of Punjab, New Campus, Lahore 54590, Pakistan

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#### S-1. Cost Estimation and Profitability of the CO<sub>2</sub> to methanol synthesis plant

*Table S-1 Elements of total capital investment [34] for Case-VII-11 (Case-VII with split ratio of 0.00575).*

Component of cost	Factor	Cost (\$)
Purchased equipment	1	15051627.02
Delivery of purchased equipment	0.1	1505162.70
Delivered equipment cost		16556789.72
Purchased equipment installation	0.47	7781691.17
Instrumentation and controls (installed)	0.36	5960444.30
Piping (installed)	0.68	11258617.01
Electric systems (installed)	0.11	1821246.87
Buildings (including services)	0.18	2980222.15
Yard improvements	0.1	1655678.97
Service facilities (installed)	0.7	11589752.81
Land	0.02	2010752.29
<b>Total direct cost</b>		<b>61615195.29</b>
Engineering and supervision	0.33	5463740.61
Construction expenses	0.41	6788283.79
Legal expenses	0.04	662271.59
Contractor's fee	0.22	3642493.74
Contingency	0.44	7284987.48
<b>Total indirect cost</b>		<b>23841777.20</b>
<b>Fixed capital investment</b>		<b>85456972.50</b>
<b>Working capital</b>	0.15	<b>15080642.21</b>
<b>Total capital investment</b>		<b>100537614.70</b>

\* Corresponding Author: [mrusman.icet@pu.edu.pk](mailto:mrusman.icet@pu.edu.pk)

*Table S-2 Components of total product cost [34] for Case-VII-11 (Case-VII with split ratio of 0.00575).*

Total capital investment			100537614.70
Working capital			15080642.21
Fixed capital investment			85456972.50
Product capacity, kg/h			24852.23
Operating time, h/yr			8400
Product capacity, kg/yr			208758749.50
Value of rented land (for rent)			-
<b>Component of cost</b>	<b>Factor</b>	<b>Factor based on</b>	<b>Cost (\$/yr)</b>
Raw material 1 (CO <sub>2</sub> )		Capacity of plant	13852950.38
Raw material 2 (H <sub>2</sub> )		Capacity of plant	60279013.83
Operating labor	0.15	Total product cost	40216186.38
Operating supervision	0.15	Operating labor	6032427.96
Cooling water (Utilities)		Capacity of plant	2944159.20
Boiler feed water (Utilities)		Capacity of plant	8002657.21
Electricity (Utilities)		Capacity of plant	8674397.94
Combustion off-gas (Utilities)		Capacity of plant	-868199.49
Fuel (Utilities)		Capacity of plant	19853001.41
Refrigeration (Utilities)		Capacity of plant	0
Steam, LP (Utilities)		Capacity of plant	-26018800.07
Steam, HP (Utilities)		Capacity of plant	6937265.62
Waste treatment and disposal (Utilities)		Capacity of plant	734520.31
Maintenance and repairs	0.05	Fixed capital investment	4272848.62
Operating supplies	0.15	Maintenance and repairs	640927.29
Laboratory charges	0.15	Operating labor	6032427.96
Royalties (if not on lump-sum basis)	0.03	Total product cost	8043237.28
Catalysts		Capacity of plant	6377155.33
Solvents		Capacity of plant	0
Additives		Capacity of plant	0
<i>Total variable production cost</i>			166006177.10
Taxes (property)	0.025	Fixed capital investment	2136424.31
Financing (interest)	0.05	Total capital investment	5026880.74
Insurance	0.007	Fixed capital investment	598198.81
Rent	0.1	Value of rented land	0
Depreciation	0.1	Fixed capital investment	8545697.25
<i>Total fixed production charges</i>			16307201.10
Plant overhead cost	0.1	Total product cost	26810790.92
<i>Plant overhead cost</i>			26810790.92
<b>Manufacturing cost</b>			209124169.20
Administrative cost	0.035	Total product cost	9383776.82
Distribution and marketing	0.11	Total product cost	29491870.01
Research and development	0.05	Total product cost	13405395.46
<b>General expenses</b>			52281042.29
<b>Contingency</b>	0.025	Total product cost	6702697.73
<b>Total product cost</b>			<b>268107909.20</b>

*Table S-3 Profitability measures for Case-VII-11 (Case-VII with split ratio of 0.00575).*

Particular	Value
Selling price of methanol, \$/kg	1.5
Gross profit, \$/yr	45030215.12
Income tax, \$/yr	15760575.29
Net profit, \$/yr	29269639.83
Cash flow, \$/yr	37815337.08
Return on investment (ROI)	0.2911
Payback period, yr	2.2598
Selling price of methanol for ROI = 0%, \$/kg	1.2843

$$\text{Gross Profit} = \text{Revenue} - \text{Product Cost} \quad (\text{S-1})$$

$$\text{Net Profit} = \text{Gross Profit} - \text{Income Tax} \quad (\text{S-2})$$

$$\text{Cash Flow} = \text{Net Profit} + \text{Depreciation} \quad (\text{S-3})$$

$$\text{Return on Investment} = \frac{\text{Net Profit}}{\text{Total Capital Investment}} \quad (\text{S-4})$$

$$\text{Payback Period} = \frac{\text{Fixed Capital Investment}}{\text{Cash Flow}} \quad (\text{S-5})$$

**S-2. Results for the Effect of Change in Price of Feed Materials on the Plant Economics**

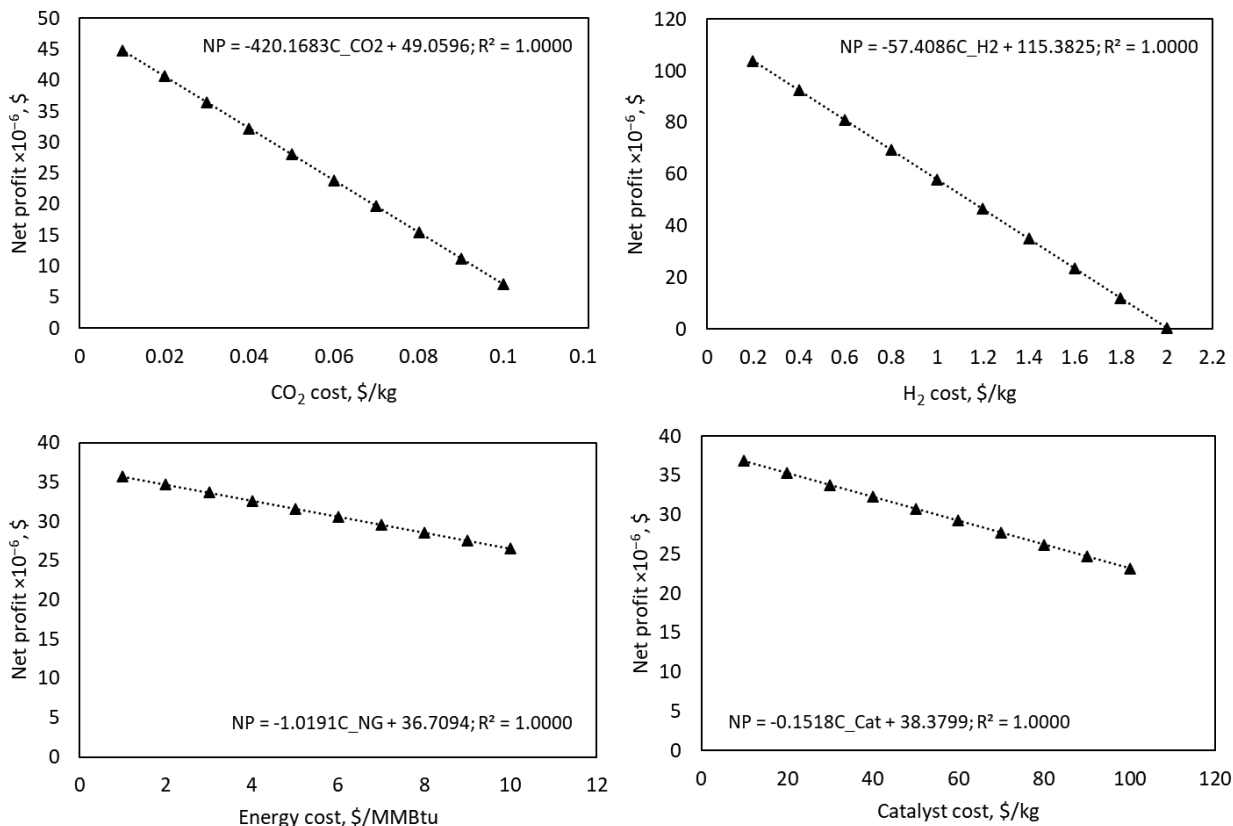


Figure S-1. Effect of variation in costs of CO<sub>2</sub>, H<sub>2</sub>, energy (NG), and catalyst on the net profit. When not varying in the above relationships, the costs were fixed at \$0.0471/kg CO<sub>2</sub>, \$1.5/kg H<sub>2</sub>, \$7.3/MMBtu energy (NG), and \$60/kg catalyst.

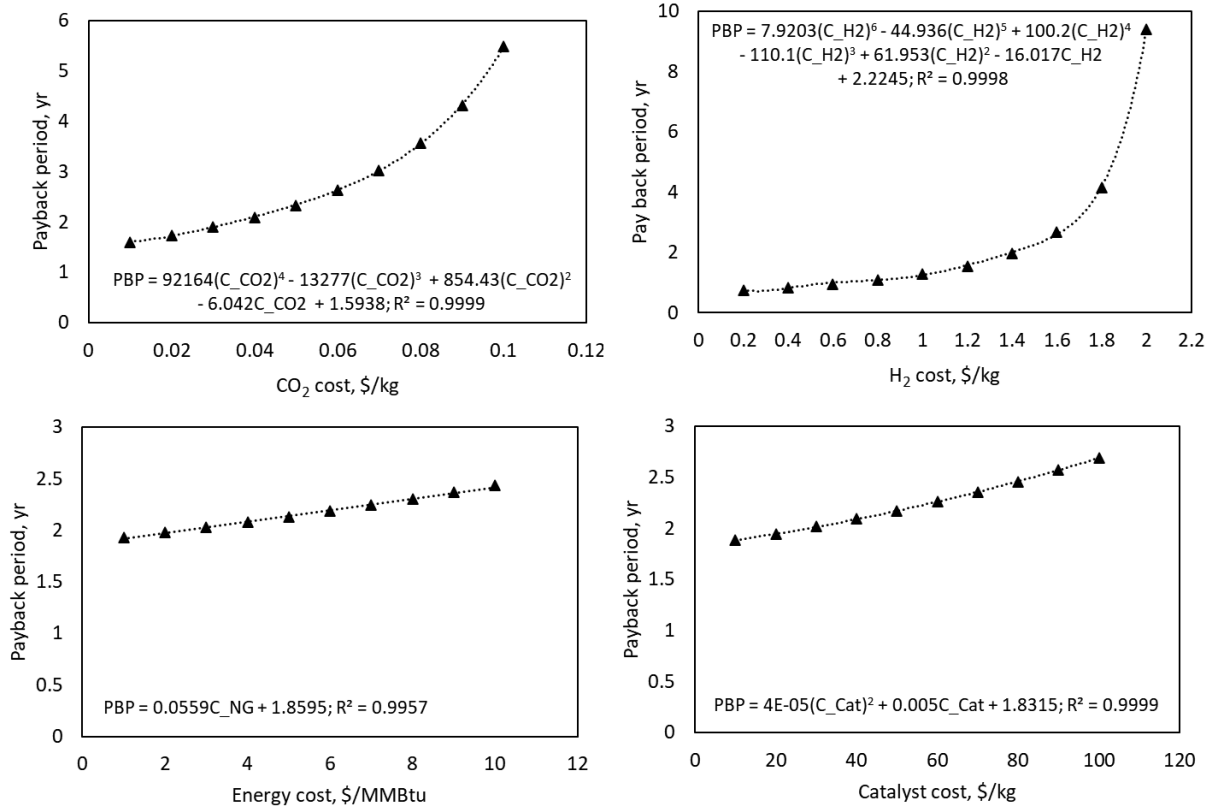


Table S-2. Effect of variation in costs of CO<sub>2</sub>, H<sub>2</sub>, energy (NG), and catalyst on payback period. When not varying in the above relationships, the costs were fixed at \$0.0471/kg CO<sub>2</sub>, \$1.5/kg H<sub>2</sub>, \$7.3/MMBtu energy (NG), and \$60/kg catalyst.