**Rubric for Grading of Capstone Design Reports**

Letter of Transmittal /10

A. This letter is a response to the memo that I gave to you. It can use the same format.

B. The memo indicates why the report has been prepared..

C. Gives essential results that have been specifically requested

Title Page /10

A. Title or Report.

B. Names of individuals to who report is submitted.

C. Name and address of all authors.

D. Date.

Table of Contents /10

A. Indicates location and title of all figures, tables, and all major sections.

Summary /10

A. Briefly presents essential results and conclusions in a clear and concise manner. Limit yourself to one paragraph.

Body of Report /110

A. Introduction /10

1. Present a brief discussion of what the report is about and the reason for doing the work. No results are presented here. Outline the general background of the problem. Why is acetic acid important?

B. Previous Work /10

1. Discusses important results obtained from literature or internet searches. How is acetic acid made? What are the reactions? How is it purified?

C. Discussion /10

1. Outlines the method of attack and gives the basis for the design. What is your design, and why does it work? Be as specific as you can be.

2. Indicates assumptions made and their importance.

D. Final Recommended Design with Data /40

1. Drawings of proposed design

    a. I/O diagram.

    b. Detailed Flow Sheet.

2. Tables listing equipment and specifications.

3. Complete material and energy balance results. This can be a ChemCAD report of all streams including enthalpy and entropy.

4. Process economics, including costs, profits, and return on investment. This is a full examination of the Cost Analysis Excel Spreadsheet.

E. Conclusions and Recommendations /10

1. Presented in greater detail than in the summary.

F. Acknowledgment /10

1. Acknowledge important assistance of others who are not listed as authors. Do not include this section if you have no acknowledgments.

G. Table of Nomenclature /10

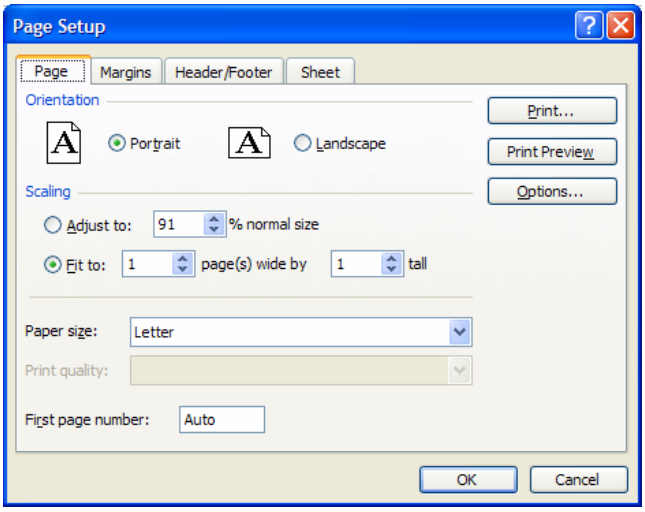
1. If any equations are used in your report, you must include a table with the symbol, a description of the quantity, and the units.

H. Documentation /10

1. Gives complete identification of literature sources and is consistent with Documentation of Written Work.

## A. Calculations

1. Complete printout of spreadsheet. Notice the screenshots below. The first screenshot shows how to scale the spreadsheet so that each worksheet takes one page. The second shows a sample of the results.



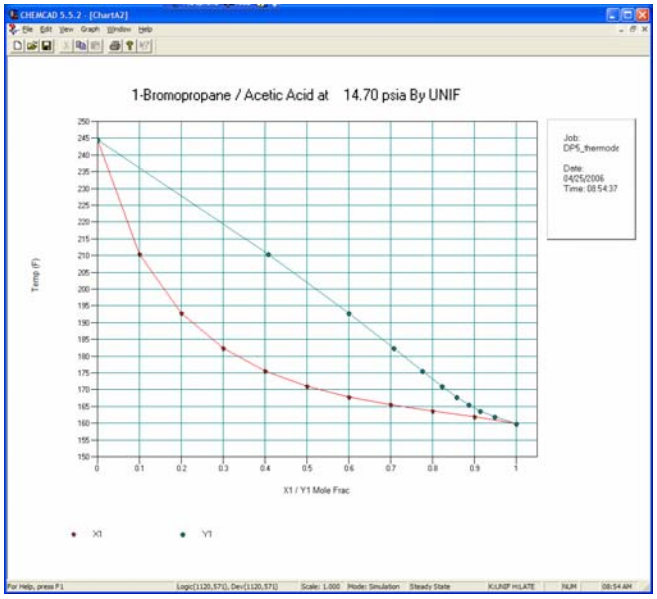

| ECONOMIC EVALUATION | | | | CURRENT, i.e. INFLATED, DOLLARS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Project identifier: Illustration 101 | | | | Construction inflation rate, fraction/y = | 0.02 | | | | | | | | | | | |
| Expenditures, entries must be negative | | | | Product price inflation rate, fraction/y = | 0 | | | | | | | | | | | |
| Default values, can be changed | | | | TPC inflation rate, fraction/y = | 0.02 | | | | | | | | | | | |
| Required, user must supply | | | | Annual-compounding discount rate, fraction/y = minimum acceptable rate of return, $m_w$ = | 0.15 | | | | | | | | | | | |
| Required, may be calculated here, in linked worksheet, or entered manually | | | | Continuous-compounding discount rate, fraction/y = minimum acceptable rate of return, $r_{cmw}$= | 0.14 | | | | | | | | | | | |
| Comments and notes begin in column S | | | RESULT | Income tax rate = | 0.35 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | Row | COMMENTS & NOTES |
| Year ending at time | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Sum | Time -3 is default time of estimate, time -2 is the first inflation. |
| 1. Land, $10^6$$ (see notes) | | 0.00 | 0.00 | 0.00 | | | | | | | | | | 0.00 | 0.00 | Land can be included, default is 0. |
| 2. Fixed Capital Investment, $10^6$$ | | -7.32 | -17.42 | -25.38 | | | | | | | | | | | -50.11 | Time 0 is startup time. |
| 3. Working Capital, $10^6$$ (see notes) | | | | -8.86 | | | | | | | | | | 8.86 | 0.00 | Working capital (-) at time 0, (+) when recovered. |
| 4. Salvage Value, $10^6$$ | | | | | | | | | | | | | | 0.00 | 0.00 | Salvage value is (+) at time of recovery. |
| 5. Total Capital Investment, $10^6$$ | | -7.32 | -17.42 | -34.23 | | | | | | | | | | | -58.96 | |
| 6. Annual Investment, $10^6$$ | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | Planned investments (e.g. replacements) entered here at inflated value. |
| 7. Start-up cost, $10^6$$ | | | | | -6.01 | | | | | | | | | | | Startup default is 10% of FCI. |
| 8. Operating rate, fraction of capacity | | | | | 0.50 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | | Two year ramp-up of production. |
| 9. Annual sales, $10^6$$ | | | | | 25.50 | 45.90 | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 | 51.00 | 479.40 | |
| 10. Annual Total Product Cost, depreciation not included, $10^6$$ | | | | | -17.93 | -26.76 | -29.45 | -30.04 | -30.64 | -31.25 | -31.88 | -32.51 | -33.17 | -33.83 | -297.45 | Operating rate affects only variable part of TPC. |
| 11. Annual depreciation factor, 1/y | | | | | 0.20 | 0.320 | 0.192 | 0.115 | 0.115 | 0.058 | | | | | | Depreciation default is 5-year MACRS. |
| 12. Annual depreciation, $10^6$$/y | | | | | 10.02 | 16.04 | 9.62 | 5.77 | 5.77 | 2.89 | | | | | 50.11 | |
| 13. Annual Gross Profit, $10^6$$ | | | | | -7.47 | 3.11 | 11.93 | 15.19 | 14.59 | 16.86 | 19.12 | 18.49 | 17.83 | 17.17 | 126.82 | Start costs subtracted here. |
| 14. Annual Net Profit, $10^6$$ | | | | | -7.47 | 2.02 | 7.75 | 9.87 | 9.48 | 10.96 | 12.43 | 12.02 | 11.59 | 11.16 | 79.82 | No income tax credit taken for losses. |
| 15. Annual operating cash flow, $10^6$$ | | | | | 2.56 | 18.06 | 17.38 | 15.65 | 15.25 | 13.85 | 12.43 | 12.02 | 11.59 | 11.16 | 129.93 | |
| 16. Total annual cash flow, $10^6$$ | 0.00 | -7.32 | -17.42 | -34.23 | 2.56 | 18.06 | 17.38 | 15.65 | 15.25 | 13.85 | 12.43 | 12.02 | 11.59 | 11.16 | 70.97 | =Annual operating cash flow + Annual investment |
| 17. Cumulative cash position, $10^6$$ | 0.00 | -7.32 | -24.74 | -58.96 | -56.41 | -38.35 | -20.98 | -5.33 | 9.92 | 23.77 | 36.20 | 48.22 | 59.81 | 70.97 | | |
| **Profitability measures, time value of money NOT included:** | | | | | | | | | | | | | | | | ROI, PBP and Net return do NOT include recovery amounts, by text definition. |
| 18. Return on investment, ave. %/y | 13.5 | | | | | | | | | | | | | | | Compare with ROI = 15.0 %/y |
| 19. Payback period, y | 3.6 | | | | | | | | | | | | | | | Compare with reference PBP = 3.6 y. |
| 20. Net return, $10^6$$ | -9.86 | at $m_w$ = | | 15.0 | %/y | | | | | | | | | | | Compare with net return = 0. |
| **Profitability measures including time value of money, with ANNUAL END-OF-YEAR cash flows and discounting** | | | | | | | | | | | | | | | | NPW and DCFR include recovery amounts, by text definition. |
| 21. Present worth factor | 1.52 | 1.32 | 1.15 | 1.00 | 0.87 | 0.76 | 0.66 | 0.57 | 0.50 | 0.43 | 0.38 | 0.33 | 0.28 | 0.25 | | Uses single-year present worth factor from Table 7-3. |
| 22. Present worth of annual cash flows, $10^6$$ | 0.00 | -9.68 | -20.03 | -34.23 | 2.22 | 13.65 | 11.42 | 8.95 | 7.58 | 5.99 | 4.67 | 3.93 | 3.30 | 2.76 | 0.53 | If there is more than one sign change in the annual cash flow, check DCFR value separately. |
| 23. Net present worth, $10^6$$ = | 0.53 | at discount rate= | | 15.0 | %/y | | | | | | | | | | | Compare with net present worth = 0. |
| 24. Discounted cash flow rate of return, DCFR, %/y = | 15.2 | To get DCFR, go to "Tools" and function "Solver." Set target cell as $R$41, to be made = 0 by changing cell $C$39. Solver must be rerun after a change on any sheet. | | | | | | | | | | | | | | "No value" results from a negative total cash flow in R27. Compare with R5. |
| Iterated discount rate= 0.152 | | | | | | | | | | | | | | | | |
| 25. Present worth factor | 1.53 | 1.33 | 1.15 | 1.00 | 0.87 | 0.75 | 0.65 | 0.57 | 0.49 | 0.43 | 0.37 | 0.32 | 0.28 | 0.24 | | |
| 26. Present worth of annual cash flows, $10^6$$ | 0.00 | -9.71 | -20.06 | -34.23 | 2.22 | 13.61 | 11.37 | 8.89 | 7.52 | 5.93 | 4.62 | 3.88 | 3.26 | 2.71 | 0.00 | |
| **Profitability measures including time value of money, with CONTINUOUS cash flows and discounting** | | | | | | | | | | | | | | | | NPW and DCFR include recovery amounts, by text definition. |
| 27. Present worth factor | 1.63 | 1.42 | 1.23 | 1.07 | 0.93 | 0.81 | 0.71 | 0.61 | 0.53 | 0.46 | 0.40 | 0.35 | 0.31 | 0.27 | | Uses 1-year present worth factor from Table 7-5. |
| 28. Present worth of annual cash flows, $10^6$$ | 0.00 | -10.39 | -21.60 | -36.74 | 2.39 | 14.65 | 12.26 | 9.60 | 8.14 | 6.42 | 5.02 | 4.22 | 3.54 | 2.96 | 0.57 | If there is more than one sign change in the annual cash flow, check DCFR value separately. |
| 29. Net present worth, $10^6$$ = | 0.57 | at discount rate= | | 14.0 | %/y | | | | | | | | | | | Compare with net present worth =0. |
| 30. Discounted cash flow rate of return, DCFR, %/y = | 14.1 | To get DCFR, go to "Tools" and function "Solver." Set target cell as $R$51, to be made = 0 by changing cell $C$49. Solver must be rerun after a change on any sheet. | | | | | | | | | | | | | | "No value" results from a negative cash flow in R26. Compare with R6 |
| Iterated discount rate= 0.141 | | | | | | | | | | | | | | | | |
| 31. Present worth factor | 1.64 | 1.43 | 1.24 | 1.07 | 0.93 | 0.81 | 0.70 | 0.61 | 0.53 | 0.46 | 0.40 | 0.35 | 0.30 | 0.26 | | |
| 32. Present worth of annual cash flows, $10^6$$ | 0.00 | -10.43 | -21.55 | -36.77 | 2.38 | 14.62 | 12.21 | 9.55 | 8.08 | 6.37 | 4.96 | 4.17 | 3.49 | 2.92 | 0.00 | |

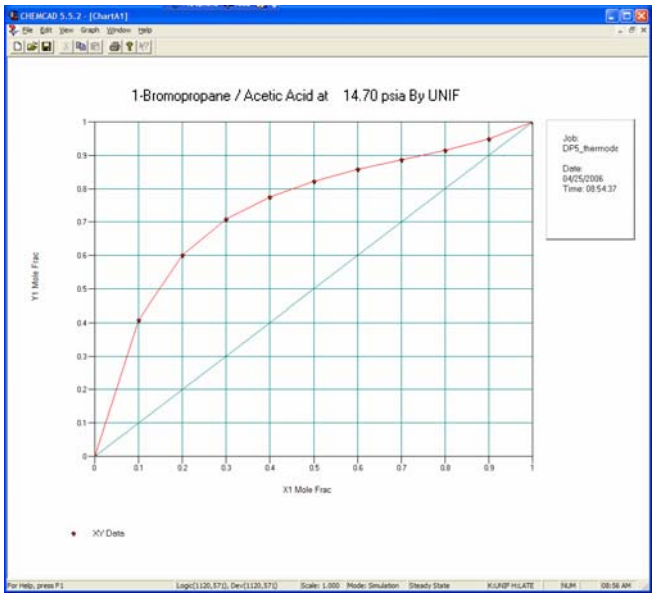
2. Complete listing of all ChemCAD results.

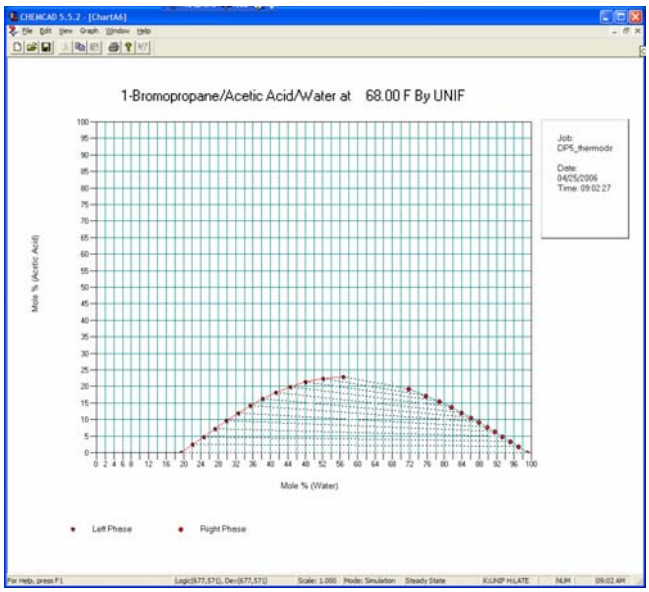
3. Complete listing of any Mathematica notebooks used in this project.

B. Thermodynamic Data.

1. Complete listing of any Mathematica notebooks used in this project. Note the examples shown below.






D. Results of Laboratory Tests

1. You probably do not have any lab tests here. But if you did they would be useful.

2. This section would include any experiments used to obtain design data, including apparatus, procedures, and results. An example would be measurement of $K_d$ in the liquid-liquid extractor.

3. An example would be to include your lab report from CH459 on the liquid-liquid extraction experiment.