

## 17.8 PROFITABILITY ANALYSIS SPREADSHEET

This section shows how to use purchase and installation cost estimates from Aspen IPE, and other sources, together with an economics spreadsheet by Holger Nickisch (2003) to estimate profitability measures for the monochlorobenzene (MCB) separation process, which was introduced in Section 4.4. In Section 16.7, IPE was used to estimate the total permanent investment for this process. The economics spreadsheet, Profitability Analysis-1.0.xls, is on the CD-ROM that accompanies this textbook.

Holger Nickisch, a graduate of the University of Pennsylvania, with dual degrees in chemical engineering and business, designed the spreadsheet for use with Chapters 16 and 17 of *Product and Process Design Principles: Synthesis, Analysis, and Evaluation* (Seider, Seader, and Lewin, Wiley, 2004). It replaces Version 3.0 of an earlier spreadsheet, entitled HNP.xls.

The spreadsheet utilizes extensive Visual BASIC (VBA) programming to reduce the most common sources of error when setting up a complicated spreadsheet in Microsoft EXCEL. The use of VBA makes it possible to avoid common mistakes in entering specifications, allows the output to be formatted into presentable pages, and ensures that the output is not altered inadvertently after specifications have been entered. The user of the spreadsheet is not required to know VBA.

### **General Instructions for Use of Profitability Analysis-1.0.xls**

Depending on the version of EXCEL being used, the procedures to activate “Macro Code” differ. In EXCEL 97, when the spreadsheet is loaded, the user is asked whether macros should be enabled. An affirmative response is necessary, after which EXCEL loads the complete file, which contains many worksheets most of which are hidden. In EXCEL 2000, and later versions, three security settings under the *Tool, Macros* menu are offered. The highest setting does not allow VBA code to be opened.

The intermediate setting causes the user to be prompted, as in EXCEL 97, and the lowest setting causes VBA code to be opened without user approval. The latter is recommended.

After the spreadsheet is started with the “Macro Code” activated, the introductory page is displayed briefly. Then, the *Login* dialog box appears in which a user name and password must be entered. For students, the user name is ‘student’ and the password is ‘engineer’ (which can be altered). When proper entries have been provided, the *Save/New* dialog box appears in which the user selects either *Start New Analysis* or *Load Existing Analysis* and clicks on the *OK* button.

When a new analysis is initiated, the *Step 1* dialog box is displayed, into which input specifications are entered. The user provides entries for the title of the process, the name of the product, the location of the plant site, and the site factor (which is obtained from Table 16.13). Then the annual operating hours are entered, either hr/yr, day/yr, or the operating factor (fraction of hours in operation per year). Finally, the timelines and investment distribution are provided for the total permanent investment,  $C_{TPM}$ , and the working capital,  $C_{WC}$ . When the *Timelines* button is depressed, the *Timelines* dialog box appears. Entries are provided for the starting year, the number of years of design and construction, and plant life in years. When the *Investment Distribution* is pressed, the *Investment Distribution* dialog box appears, in which percentage distribution in each year can be adjusted for  $C_{TPM}$  and  $C_{WC}$ . Note that when the percentages sum to 100%, the sum is displayed with a green background. Otherwise the background is red, signaling to the user that corrections must be made. Specific entries are shown below in Example 17.32, in which a profitability analysis for the MCB separation process is completed. After these specifications are completed, the *OK* button is depressed and the *Input Summary* form is displayed. By scrolling down on this form, the following sections appear:

General Information

Chronology

Product Information

Raw Materials  
Equipment Costs  
Total Permanent Investment  
Working Capital  
Utilities  
Byproducts  
Other Variable Costs  
Fixed Costs

Note that the specifications just entered in the General Information section are displayed. Associated with each section heading is a blue button: *CLICK HERE FOR MENU*. When pressed, the spreadsheet menu appears at the top of the screen. To enter the specifications in any section, point anywhere within the section, except for the section heading. This produces a dialog box that guides the specification of many of the required inputs. Other entries are provided in dialog boxes produced by pressing the *Menu* buttons. Note that for most entries default values are provided. These are displayed on the *Input Summary* form and remain unaltered unless new entries are provided. The default values are those recommended in Chapters 16 and 17. Next, the entries in each section are described.

### General Information

These entries have been discussed above. To produce the *Step 1* dialog box, point to the General Information section and left click.

### Chronology

This section lists each year during the life of the project, beginning with the starting year. The Action in each year is indicated as Design, Construction, or Production. As discussed above, these specifications are entered using the *Step 1* dialog box, which is obtained by pointing to the Chronology section and left-clicking. To change the

Production Capacity (i.e., the percent of design capacity) in each year and the MACRS tax-basis depreciation schedule, on the *Menu*, press the *Options* button, which produces the *Options* dialog box. Press the *Production Capacity* tab to enter Production Capacity at full production (the percent of design capacity at full production) and information to ramp-up to full production, that is, the years to achieve full production, and the Start Production percentage (the percent of design capacity during the first year of production.) Note that a linear ramp is computed. Also, the number of operator shifts per week is specified. Using the *Depreciation Schedule* tab, the number of years in the MACRS Tax-basis Depreciation schedule is specified. Note that 5, 7, 10, and 15 year schedules are displayed.

### Product Information

When left-clicking within this section, the *Product Units* dialog box is displayed. In this box, the unit in which the primary product is specified is entered in five characters or less (e.g., lb). This produces the *Capacity and Product Price* dialog box in which the capacity of the plant is entered (e.g., lb/hr of MCB) and the product price is entered in \$/unit (e.g., \$/lb MCB).

### Raw Materials

Similar entries are provided for each raw material. When left-clicking within the Raw Materials section, the *Raw Materials* dialog box is produced. To add a raw material, press the *Add* button. This produces the *Raw Materials: NEW* dialog box, in which the raw material name and unit of measure are entered (e.g., FEED and lb). This produces the Raw Materials: 'FEED' dialog box, within which the units of the raw material per unit of product (e.g., lb FEED/lb MCB) and the price per unit of raw material (e.g., \$/lb FEED) are entered. Subsequently, this entry can be edited by displaying the *Raw Materials* dialog box and selecting an existing raw material using the pull-down menu. The entries for this raw material can be edited by pressing the *Edit* button or the raw material can be deleted by pressing the *Delete* button.

## Equipment Costs

When left-clicking within the Equipment Costs section, the *Equipment Costs* dialog box is produced. Herein, equipment items are identified to be in one of five categories: Fabricated Equipment,  $C_{FE}$ ; Process Machinery,  $C_{PM}$ ; Spares,  $C_{spare}$ ; Storage,  $C_{storage}$ ; or Catalysts,  $C_{catalyst}$ ; as grouped in Table 16.9 and discussed in Section 16.3. Entries in each category can be entered, edited, and deleted. After one of the categories is selected, a dialog box, with the name of the category, appears. In this box, the user chooses to add, edit, or delete an equipment item. When pressing the *Add* button, the *New Equipment Item* dialog box appears. The user chooses to enter (1) the purchase cost only, (2) the purchase cost and bare module factor, or (3) the bare module cost. For the first option, the *Entering Purchase Costs Only* dialog box appears, in which the equipment name and purchase cost are entered. In this case, a default bare module factor, 3.21, is used. Note that to alter the default bare module factor, on the *Menu*, press the *Options* button to produce the *Options* dialog box. Select the *Derived Bare Module Factor* tab. On this form, the factors in Table 16.10 are entered, as fractions of the purchase cost to compute the cost of installation materials,  $C_M$ ; labor,  $C_L$ ; freight, insurance, and taxes,  $C_{FIT}$ ; construction overhead,  $C_O$ ; and contractor engineering,  $C_E$ . These factors are summed to give the total bare module factor. For the second option, the *Entering Purchase Cost and Bare Module Factor* dialog box appears, in which the equipment name, purchase cost, and bare module factor are entered. Bare module factors for a number of types of equipment are given in Table 16.11. Alternatively, for the third option, the *Entering Bare Module Cost* dialog box appears. Here, just the equipment name and bare module cost are entered.

Aspen IPE Specifications. When Aspen IPE is used to estimate purchase and installation costs for the entire plant, or a portion of the plant, click the *Options* entry in the *Menu* and check the *Allow IPE Entries* box at the bottom of the dialog box that appears. This produces the IPE Specifications subsection in the Equipment Costs section. Then left-click within the IPE Specifications subsection to produce the *IPE Specifications*

dialog box. The entries, Total Direct Materials and Labor Costs, Material and Labor G&A Overhead and Contractor Fees, Contractor Engineering Costs, and Indirect Costs, are obtained from the Aspen IPE *Capital Estimate Report*, as discussed in Section 16.7. Other costs can be entered (e.g., for pipe racks and sewers/sumps) under Miscellaneous Installation Costs, if desired. The entries are summed and added to the Total Bare Module Cost.

### Total Permanent Investment

When left clicking within the Total Permanent Investment section, the *Direct Permanent Investment* dialog box appears. For each of the pertinent entries in Table 16.9, the default entry can be altered. Either a percentage value or an absolute dollar amount is entered.

### Working Capital

When left-clicking within the Working Capital section, the *Working Capital* dialog box appears, on which the numbers of days are provided for the product, accounts receivable, cash reserves, and accounts payable, as discussed in Section 17.3, with defaults for each. If desired, additional entries can be made for any or all of the raw materials.

### Utilities

When left-clicking within the Utilities section, the *Utilities* dialog box appears. An entry is provided for six default utilities in the spreadsheet: high pressure steam, low pressure steam, process water, cooling water, natural gas, and electricity. Additional utilities can be entered by pressing the *Options* button in the *Menu*, selecting the *Utilities* tab, pressing the *Add* button to produce the *Add a Utility* dialog box, entering the name of the utility (e.g., medium pressure steam), and pressing the *Add* button. The additional utilities appear in the *Utilities* dialog box. Then check the box for each utility in the

process and press the *OK* button, to produce a box into which its unit of measure is entered (e.g., kWhr for electricity). This produces a named utility dialog box in which the units of utility per unit of product is entered (e.g., lb high pressure steam/lb MCB), as well as the price of the utility (e.g., \$/kWhr). By pressing the next button, a similar dialog box is produced for the next utility, until this information is entered for all utilities in the process. Representative prices for many utilities are listed in Table 17.1.

### Byproducts

When left-clicking within the Byproducts section, the *Byproducts* dialog box appears. As in the specification of raw materials, byproducts are added individually, with a specification of the unit of measure, the unit of byproduct per unit of product, and the price per unit of byproduct.

### Other Variable Costs

When left-clicking within the Other Variable Costs section, the *General Expenses* dialog box appears, which permits the specification of percentages of product sales charged for selling/transfer expenses, direct research, allocated research, administrative expenses, and management incentives compensation. The defaults shown are those in the cost sheet of Table 17.1 and discussed in Section 17.2.

### Fixed Costs

The entries under Fixed Costs appear in six subsections: Operations, Maintenance, Operating Overhead, Property Taxes and Insurance, Straight-line Depreciation, and Depletion Allowance. When left-clicking within each subsection, the appropriate dialog box appears, in which the default entries can be replaced when desired. Note that the default entries are those in Table 17.1. However, under Operations, entries must be made for (1) the number of operators per shift, (2) technical

assistance to manufacturing, and (3) control laboratory, for which see page 576 and Table 17.1. If a depletion allowance applies, see pages 606-608 for estimating it.

### Financial Information

In addition to the above entries, it is necessary to specify financial information for calculation of the return on investment (ROI), the net present value (NPV) and the investor's rate of return (IRR), also known as the discounted cash flow rate of return (DCFRR). To accomplish this, select the *Options* button in the *Menu*, and the *Financial Information* tab. Then enter the income tax rate, the cost of capital (for the NPV calculation) and the inflation rate. Note that a general inflation rate can be specified, applicable to all operating costs, or by checking the Different Inflation Rate box, separate inflation rates can be specified for fixed and variable costs.

### Running the Analysis and Creating a Report

To initiate the profitability analysis, on the *Menu*, press the *Create Report* button to produce the *Create Report* dialog box. After entering the Report Name, to which the word "Report" is automatically appended, and the directory into which the report file is to be stored (i.e., the report path), press the *Create Report* button. The results, which are placed in an EXCEL report file, include sections on the Investment Summary, which presents cost estimates for all entries associated with the total permanent investment, the working capital, and the total capital investment (i.e., the entries shown in Table 16.9). Also included are sections on the Variable Costs at design capacity (not production during a specific year) of operations and for the Fixed Costs. These correspond to the entries shown in Table 17.1. Then, a section on the cash flows, and the elements that contribute to them, is displayed for each year during the life of the project. Finally, a section on the NPV and the IRR is provided. Each section is accessed by clicking on the appropriate tab at the bottom of the frame.



It is also possible to have the ROI (during the third operating year) estimated and to carry out sensitivity studies. This is accomplished by pressing the *Choose Custom Analyses* button, which produces the *Custom Analyses* dialog box, and checking the ROI (Third Year) entry. In addition, the IRR can be computed as a function of a single variable or as a function of two variables. These variables are the product price, variable cost, fixed cost, initial investment, and the rate of inflation.

### Saving or Loading an Analysis

At any point when entering specifications or after completing an analysis, the contents of the worksheet can be saved in a file. Alternatively, an existing file can be loaded into the spreadsheet. To accomplish this, on the spreadsheet *Menu*, press the *Save/New* button to produce the *Save/New* dialog box. To save a file, check the *Save Current Analysis* button and press *OK*. On the *Save As* dialog box, enter a file name and a file path. To load a file, check the *Load Existing Analysis* button and press *OK*, which produces the *Browse for Folder* dialog box, within which the file is located. Note that the *Save/New* dialog box also permits the user to start a new analysis.

Having described the details of data entry into the spreadsheet, Profitability Analysis-1.0.xls, Example 17.32 is provided to illustrate its use for the MCB separation process.

#### ***Example 17.32***

It is desired to carry out a profitability analysis for the monochlorobenzene (MCB) separation process using (a) purchase costs and bare module factors, (b) purchase and installation costs estimated by Aspen IPE. In Section 16.7, the latter estimates were computed, beginning with the ASPEN PLUS simulation in the file, MCB.bkp. Plant location is the Gulf Coast. The design time is estimated to be one year, the construction time at one year, and the total operating life of the project at 15 years. Assume that 5% of the total permanent investment is

allocated to engineering during the design year. The cost of capital is taken to be 15% annually.

SOLUTION:

From the simulation results:

$$\begin{aligned} \text{MCB production rate} &= 5,572.1 \frac{\text{lb}}{\text{hr}} \times 24 \frac{\text{hr}}{\text{day}} \times 330 \frac{\text{day}}{\text{yr}} \\ &= 44,131,000 \frac{\text{lb}}{\text{yr}} \end{aligned}$$

The MCB product (stream S14) is valued at \$0.54/lb. Furthermore, from the simulation results:

$$\frac{9,117.1 \text{ lb S01/hr}}{5,572.1 \text{ lb S14/hr}} = 1.636 \frac{\text{lb S01}}{\text{lb S14}}$$

and the price of the feed stream (S01) is \$0.30/lb.

The utility costs are estimated as follows, with the quantities per pound of product determined based upon the simulation results.

$$\text{High Pressure Steam} - 4.00 \frac{\$}{1,000 \text{ lb}} = 0.004 \frac{\$}{\text{lb}}$$

$$\frac{1,365.5 \text{ lb steam/hr}}{5,572.1 \text{ lb S14/hr}} = 0.2451 \frac{\text{lb steam}}{\text{lb S14}}$$

$$\text{Cooling Water} - 0.05 \frac{\$}{1,000 \text{ gal}} = 5 \times 10^{-5} \frac{\$}{\text{gal}} = 6 \times 10^{-6} \frac{\$}{\text{lb}}$$

$$\frac{1.2927 \times 10^5 \text{ lb H}_2\text{O/hr}}{5,572.1 \text{ lb S14/hr}} = 23.2 \frac{\text{lb H}_2\text{O}}{\text{lb S14}}$$

$$\text{Electricity} - 0.04 \frac{\$}{\text{KWhr}}$$

$$\frac{9.60 \text{ kW}}{5,572.1 \text{ lb S14/hr}} = 0.00172 \frac{\text{kWh}}{\text{lb S14}}$$

The byproduct benzene (stream S11) is valued at \$0.15/lb and the quantity per pound of product is determined from the simulation results:

$$\frac{3,132.7 \text{ lb S11/hr}}{5,572.1 \text{ lb S14/hr}} = 0.5622 \frac{\text{lb S11}}{\text{lb S14}}$$

Results from the Profitability Analysis Spreadsheet – Part (a) – Purchase Costs and Bare Module Factors

The pages that follow contain the:

1. Input Summary. Note that all specifications are shown, with the default values used in most cases.
2. Investment Summary.
3. Variable Cost Summary. These costs are estimated for the third operating year.
4. Fixed Cost Summary.
5. Cash Flow Summary.
6. Profitability Measures. As seen, the IRR is 27.9%, the ROI is 34.0%, and the NPV is \$2,888,500.
7. Sensitivity Analyses. Here, the IRR is studied as the product price and variable costs are adjusted.

Note that the results are displayed sometimes as 0.00, having just two decimal places. To avoid this, the user can adjust the units of measure.

1. Input Summary - Part (a) – Purchase Costs and Bare Module Factors

## Input Summary

### General Information

Process Title: **Monochlorobenzene Separation Process**  
 Product: **Monochlorobenzene**  
 Plant Site Location: **Gulf Coast**  
 Site Factor: **1.00**  
 Operating Hours per Year: **7,920**  
 Operating Days per Year: **330**  
 Operating Factor: **0.9041**

### Chronology

Year	Action	Distribution of Total Permanent Investment	Distribution of Total Working Capital	Production Capacity (% of Design Capacity)	Percentage of Total
					Capital Investment for Depreciation
<i>Start Year</i> 2003	Design	5.0%	0.0%	0.0%	
2004	Construction	95.0%	100.0%	0.0%	
2005	Production			45.0%	20.0%
2006	Production			67.5%	32.0%
2007	Production			90.0%	19.2%
2008	Production			90.0%	11.5%
2009	Production			90.0%	11.5%
2010	Production			90.0%	5.8%
2011	Production			90.0%	
2012	Production			90.0%	
2013	Production			90.0%	
2014	Production			90.0%	
2015	Production			90.0%	
2016	Production			90.0%	
2017	Production			90.0%	
2018	Production			90.0%	
<i>End Year</i> 2019	Production			90.0%	

### Product Information

The Process will yield:     α           **5,572** lb of Monochlorobenzene per hour.  
    α           **133,730** lb of Monochlorobenzene per day.  
    α           **44,131,032** lb of Monochlorobenzene per year.

The Price per lb of Monochlorobenzene is: **\$ 0.54**

### Raw Materials

Raw Material	Unit of Measure	Ratio to Product	Cost of Raw Material
FEED	lb	1.6400 lb per lb of Monochlorobenzene	\$0.3000 per lb

### Equipments Costs

Fabricated Equipment	Purchase Cost	Bare Module Factor	Bare Module Cost
Absorber	\$ 29,900	4.16	\$ 124,384
Distillation Column	\$ 115,600	4.16	\$ 480,896
Heat Exchangers	\$ 11,900	3.17	\$ 37,723
Flash Vessels and Storage Tanks	\$ 87,200	4.16	\$ 362,752

Process Machinery	Purchase Cost	Bare Module Factor	Bare Module Cost
Pumps	\$ 5,000	3.3	\$ 16,500

\*Derived Bare Module Factor

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**Total Permanent Investment**

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Cost of Site Preparations: **5.0% of Total Bare Module Costs**  
Cost of Service Facilities: **5.0% of Total Bare Module Costs**  
Allocated Costs for utility plants and related facilities: **\$0**  
Cost of Contingencies and Contractor Fees: **18.0% of Direct Permanent Investment**  
Cost of Land: **2.0% of Total Depreciable Capital**  
Cost of Royalties: **\$0**  
Cost of Plant Start-Up: **10.0% of Total Depreciable Capital**

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**Working Capital**

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Monochlorobenzene	α	Inventory: <b>4 Days</b>	α	534,921.60 lb
FEED	α	Inventory: <b>2 Days</b>	α	438,635.71 lb
Accounts Receivable	α	<b>30 Days</b>		
Cash Reserves	α	<b>None</b>		
Accounts Payable	α	<b>None</b>		

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**Utilities**

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<u>Utility</u>	<u>Unit of Measure</u>	<u>Ratio to Product</u>	<u>Cost of Utility</u>
High Pressure Steam	lb	0.2500 lb per lb of Monochlorobenzene	\$0.0040 per lb
Cooling Water	Mlb	0.0232 Mlb per lb of Monochlorobenzene	\$0.0060 per Mlb
Electricity	kWhr	0.0017 kWhr per lb of Monochlorobenzene	\$0.0400 per kWhr

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**Byproducts**

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<u>Byproduct</u>	<u>Unit of Measure</u>	<u>Ratio to Product</u>	<u>Price of Raw Byproduct</u>
Benzene	lb	0.5600 lb per lb of Monochlorobenzene	\$0.1500 per lb

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**Other Variable Costs**

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General Expenses

Selling / Transfer Expenses: **3.00% of Sales**  
Direct Research: **4.80% of Sales**  
Allocated Research: **0.50% of Sales**  
Administrative Expense: **2.00% of Sales**  
Management Incentive Compensation: **1.25% of Sales**

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**Fixed Costs**

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Operations

Operators per Shift: 1 (Assuming 5 Shifts)  
Direct Wages and Benefits: **\$30.00 per Operator Hour**  
Direct Salaries and Benefits: **15.00% of Direct Wages and Benefits**  
Operating Supplies and Services: **6.00% of Direct Wages and Benefits**  
Technical Assistance to Manufacturing: **\$0.00 per year, for each Operator per Shift**  
Control Laboratory: **\$0.00 per year, for each Operator per Shift**

Maintenance

Wages and Benefits: **3.50% of Total Depreciable Capital**  
Salaries and Benefits: **25.00% of Maintenance Wages and Benefits**  
Materials and Services: **100.00% of Maintenance Wages and Benefits**  
Maintenance Overhead: **5.00% of Maintenance Wages and Benefits**

Operating Overhead

General Plant Overhead: **7.10% of Maintenance and Operations Wages and Benefits**  
Mechanical Department Services: **2.40% of Maintenance and Operations Wages and Benefits**  
Employee Relations Department: **5.90% of Maintenance and Operations Wages and Benefits**  
Business Services: **7.40% of Maintenance and Operations Wages and Benefits**

Property Taxes and Insurance

Property Taxes and Insurance: **2.00% of Total Depreciable Capital**

Straight Line Depreciation

Direct Plant: **8.00% of Total Depreciable Capital, less 1.18 times the Allocated Costs for Utility Plants and Related Facilities**  
Allocated Plant: **6.00% of 1.18 times the Allocated Costs for Utility Plants and Related Facilities**

Depletion Allowance

Annual Depletion Allowance: **\$0.00**

2. Investment Summary - Part (a) – Purchase Costs and Bare Module Factors

		TOTAL
<b>Bare Module Costs</b>		
<b>Fabricated Equipment</b>		
Absorber	\$124,400	
Distillation Column	\$480,900	
Heat Exchangers	\$37,700	
Flash Vessels and Storage Tanks	\$362,800	
<b>Total Fabricated Equipment: \$1,005,800</b>		
<b>Process Machinery</b>		
Pumps	\$16,500	
<b>Total Process Machinery: \$16,500</b>		
<b>Total Bare Module Costs:</b>		<b>\$1,022,000</b>
<b>Direct Permanent Investment</b>		
Cost of Site Preparation:	\$51,100	
Cost of Service Facilities:	\$51,100	
Allocated Costs for utility plants and related facilities	\$0	
<b>Direct Permanent Investment:</b>		<b>\$1,124,000</b>
<b>Total Depreciable Capital</b>		
Cost of Contingencies and Contractor Fees:	\$202,300	
<b>Total Depreciable Capital:</b>		<b>\$1,326,000</b>
<b>Total Permanent Investment</b>		
Cost of Land:	\$26,500	
Cost of Royalties:	\$0	
Cost of Plant Start-Up:	\$132,600	
<b>Total Permanent Investment:</b>		<b>\$1,485,000</b>
<b>Working Capital</b>		
<b>Inventory</b>		
Monochlorobenz	α 481,000 lb	\$260,000
FEED	α 395,000 lb	\$118,400
<b>Total Inventory: \$378,400</b>		
<b>Accounts Receivable:</b>		\$2,166,400
<b>Cash Reserves:</b>		\$0
<b>Accounts Payable:</b>		\$0
<b>Total Working Capital:</b>		<b>\$2,544,800</b>
<b>TOTAL CAPITAL INVESTMENT</b>		<b>\$4,029,800</b>

3. Variable Cost Summary - Part (a) – Purchase Costs and Bare Module Factors

May, 2003

## Variable Cost Summary

### Monochlorobenzene Separation Process

	Per lb Monochlorobenzene		TOTAL
<b>Raw Materials</b>			
FEED	\$0.49 per lb of Monochlorobenzene	\$21,712,500	
<b>Total Raw Materials:</b>	<b>\$0.49 per lb of Monochlorobenzene</b>	<b>\$21,712,500</b>	<b>\$21,712,500</b>
<b>Utilities</b>			
High Pressure Steam	\$0.00 per lb of Monochlorobenzene	\$44,100	
Cooling Water	\$0.00 per lb of Monochlorobenzene	\$6,100	
Electricity	\$0.00 per lb of Monochlorobenzene	\$3,000	
<b>Total Raw Materials:</b>	<b>\$0.00 per lb of Monochlorobenzene</b>	<b>\$53,300</b>	<b>\$21,765,800</b>
<b>Byproducts</b>			
Benzene	\$0.08 per lb of Monochlorobenzene	-\$3,707,000	
<b>Total Byproducts:</b>	<b>\$0.08 per lb of Monochlorobenzene</b>	<b>-\$3,707,000</b>	<b>\$18,058,800</b>
<b>General Expenses</b>			
Selling / Transfer:	\$0.02 per lb of Monochlorobenzene	\$714,900	
Direct Research:	\$0.03 per lb of Monochlorobenzene	\$1,143,900	
Allocated Research:	\$0.00 per lb of Monochlorobenzene	\$119,200	
Administrative Expense:	\$0.01 per lb of Monochlorobenzene	\$476,600	
Management Incentives:	\$0.01 per lb of Monochlorobenzene	\$297,900	
<b>Total Byproducts:</b>	<b>\$0.06 per lb of Monochlorobenzene</b>	<b>\$2,752,500</b>	<b>\$20,811,300</b>
<b>TOTAL</b>	<b>\$0.47 per lb of Monochlorobenzene</b>	<b>\$20,811,200</b>	<b>\$20,811,200</b>

4. Fixed Cost Summary - Part (a) – Purchase Costs and Bare Module Factors

		TOTAL
<b>May, 2003</b>		
<b>Fixed Cost Summary</b>		
<b>Monochlorobenzene Separation Process</b>		
<b>Operations</b>		
Direct Wages and Benefits:	\$312,000	
Direct Salaries and Benefits:	\$46,800	
Operating Supplies and Services:	\$18,720	
Technical Assistance to Manufacturing:	\$0	
Control Laboratory:	\$0	
<b>Total Operations: \$377,520</b>		<b>\$377,520</b>
<b>Maintenance</b>		
Wages and Benefits:	\$46,410	
Salaries and Benefits:	\$11,603	
Materials and Services:	\$46,410	
Maintenance Overhead:	\$2,321	
<b>Total Maintenance: \$106,744</b>		<b>\$484,264</b>
<b>Operating Overhead</b>		
General Plant Overhead:	\$29,594	
Mechanical Department Services:	\$10,004	
Employee Relations Department:	\$24,592	
Business Services:	\$30,844	
<b>Total Operating Overhead: \$95,034</b>		<b>\$579,298</b>
<b>Property Insurance and Taxes</b>		
<b>Total Property Insurance and Taxes: \$26,520</b>		<b>\$605,818</b>
<b>TOTAL</b>		<b>\$605,818</b>



5. Cash Flow Summary - Part (a) – Purchase Costs and Bare Module Factors

Cash Flow Summary													
Monochlorobenzene Separation Process													
Year	Percentage of Design Capacity	Sales	Capital Costs	Working Capital	Variable Costs	Fixed Costs	Depreciation Allowance	Depletion Allowance	Taxable Income	Income Tax Costs	Net Earnings	Annual Cash Flow	Cumulative Net Present Value at 15.0%
2003	0.0%	Design	-\$74,300	\$0								-\$74,300	-\$74,300
2004	0.0%	Construction	-\$1,410,800	-\$2,544,800								-\$3,955,600	-\$3,514,000
2005	45.0%	\$10,723,800			-\$9,365,000	-\$605,800	-\$265,200	\$0	\$487,800	-\$180,500	\$307,300	\$572,500	-\$3,081,100
2006	67.5%	\$16,085,800			-\$14,047,600	-\$605,800	-\$424,300	\$0	\$1,008,100	-\$373,000	\$635,100	\$1,059,400	-\$2,384,500
2007	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	-\$254,600	\$0	\$1,857,200	-\$687,200	\$1,170,000	\$1,424,600	-\$1,570,000
2008	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	-\$152,800	\$0	\$1,959,000	-\$724,800	\$1,234,200	\$1,387,000	-\$880,400
2009	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	-\$152,800	\$0	\$1,959,000	-\$724,800	\$1,234,200	\$1,387,000	-\$280,800
2010	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	-\$76,400	\$0	\$2,035,400	-\$753,100	\$1,282,300	\$1,358,700	\$230,000
2011	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$664,900
2012	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$1,043,100
2013	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$1,372,000
2014	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$1,658,000
2015	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$1,906,700
2016	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$2,122,900
2017	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$2,310,900
2018	90.0%	\$21,447,700			-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$1,330,400	\$2,474,400
2019	90.0%	\$21,447,700		\$2,544,800	-\$18,730,100	-\$605,800	\$0	\$0	\$2,111,800	-\$781,400	\$1,330,400	\$3,875,200	\$2,888,500

6. Profitability Measures - Part (a) – Purchase Costs and Bare Module Factors

May, 2003

## Profitability Measures

### Monochlorobenzene Separation Process

The Investor's Rate of Return (IRR) for this Project is: **27.86%**

The Net Present Value (NPV) at 15% for this Project is: **\$2,888,500**

**ROI Analysis (Third Production Year)**

Annual Sales:	\$21,447,700
Annual Costs:	-\$19,335,900
Depreciation:	-\$106,100
Income Tax:	-\$742,100
Net Earnings:	\$1,369,700
Total Capital Investment:	\$4,029,800
ROI:	<b>34.0%</b>

7. Sensitivity Analyses - Part (a) – Purchase Costs and Bare Module Factors

**IRR Analysis - Two Variable**  
**Monochlorobenzene Separation Process**

May, 2003

**Product Prices vs Variable Costs**

		Variable Costs											
		\$17,689,500	\$18,209,800	\$18,730,100	\$19,250,400	\$19,770,600	\$20,290,900	\$20,811,200	\$21,331,500	\$21,851,800	\$22,372,000	\$22,892,300	\$23,412,600
Product Prices	\$ 0.46	24.98%	18.44%	11.26%	3.06%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.47	31.49%	25.51%	19.12%	12.14%	4.25%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.49	37.46%	31.87%	26.01%	19.77%	12.99%	5.38%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.50	43.01%	37.73%	32.24%	26.50%	20.40%	13.79%	6.43%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.51	48.22%	43.18%	37.99%	32.60%	26.97%	21.00%	14.56%	7.43%	-0.75%	Out of Range	Out of Range	Out of Range
	\$ 0.53	53.14%	48.31%	43.35%	38.24%	32.95%	27.42%	21.58%	15.30%	8.38%	0.52%	Out of Range	Out of Range
	\$ 0.54	57.81%	53.16%	48.40%	43.52%	38.49%	33.29%	27.86%	22.13%	16.00%	9.29%	1.70%	Out of Range
	\$ 0.55	62.27%	57.76%	53.17%	48.48%	43.67%	38.73%	33.61%	28.28%	22.67%	16.68%	10.15%	2.82%
	\$ 0.57	66.52%	62.15%	57.71%	53.18%	48.56%	43.83%	38.96%	33.93%	28.69%	23.19%	17.33%	10.97%
	\$ 0.58	70.60%	66.35%	62.04%	57.66%	53.20%	48.64%	43.98%	39.18%	34.23%	29.08%	23.69%	17.95%
	\$ 0.59	74.51%	70.38%	66.19%	61.93%	57.61%	53.21%	48.72%	44.12%	39.40%	34.53%	29.47%	24.17%
	\$ 0.61	78.28%	74.25%	70.16%	66.03%	61.83%	57.56%	53.22%	48.79%	44.26%	39.61%	34.81%	29.84%
	\$ 0.62	81.91%	77.97%	73.98%	69.95%	65.87%	61.73%	57.52%	53.23%	48.87%	44.40%	39.81%	35.09%

Results from the Profitability Analysis Spreadsheet – Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

The pages that follow contain the:

1. Input Summary. Note that all specifications are shown, with the default values used in most cases.
2. Investment Summary.
3. Variable Cost Summary. These costs are estimated for the third operating year.
4. Fixed Cost Summary.
5. Cash Flow Summary.
6. Profitability Measures. As seen, the IRR is 21.0%, the ROI is 25.0%, and the NPV is \$1,625,500.
7. Sensitivity Analyses. Here, the IRR is studied as the product price and variable costs are adjusted.

Note that the results are displayed sometimes as 0.00, having just two decimal places. To avoid this, the user can adjust the units of measure.

1. Input Summary - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

## Input Summary

### General Information

Process Title: **Monochlorobenzene Separation Process**  
 Product: **MCB**  
 Plant Site Location: **Gulf Coast**  
 Site Factor: **1.00**  
 Operating Hours per Year: **7,920**  
 Operating Days per Year: **330**  
 Operating Factor: **0.9041**

### Chronology

Year	Action	Distribution of Total Permanent Investment	Distribution of Total Working Capital	Production Capacity (%) of Design Capacity)	Percentage of Total	
					Capital Investment for Depreciation	
Start Year	2003	Design	5.0%	0.0%	0.0%	
	2004	Construction	95.0%	100.0%	0.0%	
	2005	Production			45.0%	20.0%
	2006	Production			67.5%	32.0%
	2007	Production			90.0%	19.2%
	2008	Production			90.0%	11.5%
	2009	Production			90.0%	11.5%
	2010	Production			90.0%	5.8%
	2011	Production			90.0%	
	2012	Production			90.0%	
	2013	Production			90.0%	
	2014	Production			90.0%	
	2015	Production			90.0%	
	2016	Production			90.0%	
	2017	Production			90.0%	
	2018	Production			90.0%	
	End Year	2019	Production			90.0%

### Product Information

The Process will yield:

α	5,572 lb of MCB per hour.
α	133,730 lb of MCB per day.
α	44,131,032 lb of MCB per year.

The Price per lb of MCB is: **\$ 0.54**

### Raw Materials

Raw Material	Unit of Measure	Ratio to Product	Cost of Raw Material
FEED	lb	1.6400 lb per lb of MCB	\$0.3000 per lb

### Equipments Costs

#### IPE Specifications

Total Direct Materials and Labor Costs: **\$785,700**  
 Miscellaneous Installation Costs: **\$0**  
 Material and Labor G&A Overhead and Contractor Fees: **\$69,700**  
 Contractor Engineering Costs: **\$558,300**  
 Indirect Costs: **\$482,600**

\*Derived Bare Module Factor

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**Total Permanent Investment**

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Cost of Site Preparations: **5.0% of Total Bare Module Costs**  
Cost of Service Facilities: **5.0% of Total Bare Module Costs**  
Allocated Costs for utility plants and related facilities: **\$0**  
Cost of Contingencies and Contractor Fees: **18.0% of Direct Permanent Investment**  
Cost of Land: **2.0% of Total Depreciable Capital**  
Cost of Royalties: **\$0**  
Cost of Plant Start-Up: **10.0% of Total Depreciable Capital**

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**Working Capital**

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MCB	α	Inventory: <b>4 Days</b>	α	534,921.60 lb
FEED	α	Inventory: <b>2 Days</b>	α	438,635.71 lb
Accounts Receivable	α	<b>30 Days</b>		
Cash Reserves	α	<b>None</b>		
Accounts Payable	α	<b>None</b>		

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**Utilities**

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<u>Utility</u>	<u>Unit of Measure</u>	<u>Ratio to Product</u>	<u>Cost of Utility</u>
High Pressure Steam	lb	0.2500 lb per lb of MCB	\$0.0040 per lb
Cooling Water	Mlb	0.0232 Mlb per lb of MCB	\$0.0060 per Mlb
Electricity	kWhr	0.0017 kWhr per lb of MCB	\$0.0400 per kWhr

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**Byproducts**

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<u>Byproduct</u>	<u>Unit of Measure</u>	<u>Ratio to Product</u>	<u>Price of Raw Byproduct</u>
Benzene	lb	0.5600 lb per lb of MCB	\$0.1500 per lb

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**Other Variable Costs**

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General Expenses

Selling / Transfer Expenses: **3.00% of Sales**  
Direct Research: **4.80% of Sales**  
Allocated Research: **0.50% of Sales**  
Administrative Expense: **2.00% of Sales**  
Management Incentive Compensation: **1.25% of Sales**

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**Fixed Costs**

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Operations

Operators per Shift: **1** (Assuming 5 Shifts)  
Direct Wages and Benefits: **\$30.00 per Operator Hour**  
Direct Salaries and Benefits: **15.00% of Direct Wages and Benefits**  
Operating Supplies and Services: **6.00% of Direct Wages and Benefits**  
Technical Assistance to Manufacturing: **\$0.00 per year, for each Operator per Shift**  
Control Laboratory: **\$0.00 per year, for each Operator per Shift**

Maintenance

Wages and Benefits: **3.50% of Total Depreciable Capital**  
Salaries and Benefits: **25.00% of Maintenance Wages and Benefits**  
Materials and Services: **100.00% of Maintenance Wages and Benefits**  
Maintenance Overhead: **5.00% of Maintenance Wages and Benefits**

Operating Overhead

General Plant Overhead: **7.10% of Maintenance and Operations Wages and Benefits**  
Mechanical Department Services: **2.40% of Maintenance and Operations Wages and Benefits**  
Employee Relations Department: **5.90% of Maintenance and Operations Wages and Benefits**  
Business Services: **7.40% of Maintenance and Operations Wages and Benefits**

Property Taxes and Insurance

Property Taxes and Insurance: **2.00% of Total Depreciable Capital**

Straight Line Depreciation

Direct Plant: **8.00% of Total Depreciable Capital, less 1.18 times the Allocated Costs for Utility Plants and Related Facilities**  
Allocated Plant: **6.00% of 1.18 times the Allocated Costs for Utility Plants and Related Facilities**

Depletion Allowance

Annual Depletion Allowance: **\$0.00**

2. Investment Summary - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

May, 2003

**Investment Summary**  
**Monochlorobenzene Separation Process**

		TOTAL
<b><u>Bare Module Costs</u></b>		
<b><u>IPE Specifications</u></b>		
Total Direct Materials and Labor Costs: <b>\$785,700</b>		
Miscellaneous Installation Costs: <b>\$0</b>		
about G&A Overhead and Contractor Fees: <b>\$69,700</b>		
Contractor Engineering Costs: <b>\$558,300</b>		
Indirect Costs: <b>\$482,600</b>		
<b>Total from IPE: \$1,896,300</b>		
<b>Total Bare Module Costs:</b>		<b>\$1,896,300</b>
<b><u>Direct Permanent Investment</u></b>		
Cost of Site Preparation: \$94,800		
Cost of Service Facilities: \$94,800		
Allocated Costs for utility plants and related facilities \$0		
<b>Direct Permanent Investment:</b>		<b>\$2,086,000</b>
<b><u>Total Depreciable Capital</u></b>		
Cost of Contingencies and Contractor Fees: \$375,500		
<b>Total Depreciable Capital:</b>		<b>\$2,461,000</b>
<b><u>Total Permanent Investment</u></b>		
Cost of Land: \$49,200		
Cost of Royalties: \$0		
Cost of Plant Start-Up: \$246,100		
<b>Total Permanent Investment:</b>		<b>\$2,756,000</b>
<b><u>Working Capital</u></b>		
<b><u>Inventory</u></b>		
MCB	α 481,000 lb	\$260,000
FEED	α 395,000 lb	\$118,400
<b>Total Inventory: \$378,400</b>		
<b><u>Accounts Receivable:</u></b>		<b>\$2,166,400</b>
<b><u>Cash Reserves:</u></b>		<b>\$0</b>
<b><u>Accounts Payable:</u></b>		<b>\$0</b>
<b>Total Working Capital:</b>		<b>\$2,544,800</b>
<b>TOTAL CAPITAL INVESTMENT</b>		<b>\$5,300,800</b>

3. Variable Cost Summary - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

May, 2003

## Variable Cost Summary

### Monochlorobenzene Separation Process

	Per lb MCB		TOTAL
<b>Raw Materials</b>			
FEED	\$0.49 per lb of MCB	\$21,712,500	
<b>Total Raw Materials:</b>	<b>\$0.49 per lb of MCB</b>	<b>\$21,712,500</b>	<b>\$21,712,500</b>
<b>Utilities</b>			
High Pressure Steam	\$0.00 per lb of MCB	\$44,100	
Cooling Water	\$0.00 per lb of MCB	\$6,100	
Electricity	\$0.00 per lb of MCB	\$3,000	
<b>Total Raw Materials:</b>	<b>\$0.00 per lb of MCB</b>	<b>\$53,300</b>	<b>\$21,765,800</b>
<b>Byproducts</b>			
Benzene	-\$0.08 per lb of MCB	-\$3,707,000	
<b>Total Byproducts:</b>	<b>-\$0.08 per lb of MCB</b>	<b>-\$3,707,000</b>	<b>\$18,058,800</b>
<b>General Expenses</b>			
Selling / Transfer:	\$0.02 per lb of MCB	\$714,900	
Direct Research:	\$0.03 per lb of MCB	\$1,143,900	
Allocated Research:	\$0.00 per lb of MCB	\$119,200	
Administrative Expense:	\$0.01 per lb of MCB	\$476,600	
Management Incentives:	\$0.01 per lb of MCB	\$297,900	
<b>Total Byproducts:</b>	<b>\$0.06 per lb of MCB</b>	<b>\$2,752,500</b>	<b>\$20,811,300</b>
<b>TOTAL</b>	<b>\$0.47 per lb of MCB</b>	<b>\$20,811,200</b>	<b>\$20,811,200</b>

4. Fixed Cost Summary - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

**Fixed Cost Summary**  
**Monochlorobenzene Separation Process**

May, 2003

		TOTAL
<b><u>Operations</u></b>		
Direct Wages and Benefits:	\$312,000	
Direct Salaries and Benefits:	\$46,800	
Operating Supplies and Services:	\$18,720	
Technical Assistance to Manufacturing:	\$0	
Control Laboratory:	\$0	
<b>Total Operations:</b>		<b>\$377,520</b>
<b><u>Maintenance</u></b>		
Wages and Benefits:	\$86,135	
Salaries and Benefits:	\$21,534	
Materials and Services:	\$86,135	
Maintenance Overhead:	\$4,307	
<b>Total Maintenance:</b>		<b>\$198,111</b>
<b><u>Operating Overhead</u></b>		
General Plant Overhead:	\$33,119	
Mechanical Department Services:	\$11,195	
Employee Relations Department:	\$27,522	
Business Services:	\$34,519	
<b>Total Operating Overhead:</b>		<b>\$106,355</b>
<b><u>Property Insurance and Taxes</u></b>		
<b>Total Property Insurance and Taxes:</b>		<b>\$49,220</b>
<b>TOTAL</b>		<b>\$731,206</b>

5. Cash Flow Summary - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

Cash Flow Summary													
Monochlorobenzene Separation Process													
Year	Percentage of Design Capacity	Sales	Capital Costs	Working Capital	Variable Costs	Fixed Costs	Depreciation Allowance	Depletion Allowance	Taxable Income	Income Tax Costs	Net Earnings	Annual Cash Flow	Cumulative Net Present Value at 15.0%
2003	0.0%	Design	-\$137,800	\$0								-\$137,800	-\$137,800
2004	0.0%	Construction	-\$2,618,200	-\$2,544,800								-\$5,163,000	-\$4,627,400
2005	45.0%	\$10,723,800			-\$9,365,000	-\$731,200	-\$492,200	\$0	\$135,400	-\$50,100	\$85,300	\$577,500	-\$4,190,700
2006	67.5%	\$16,085,800			-\$14,047,600	-\$731,200	-\$787,500	\$0	\$519,500	-\$192,200	\$327,300	\$1,114,800	-\$3,457,700
2007	90.0%	\$21,447,700			-\$18,730,100	-\$731,200	-\$472,500	\$0	\$1,513,900	-\$660,100	\$953,800	\$1,426,300	-\$2,642,200
2008	90.0%	\$21,447,700			-\$18,730,100	-\$731,200	-\$283,500	\$0	\$1,702,900	-\$630,100	\$1,072,800	\$1,356,300	-\$1,967,900
2009	90.0%	\$21,447,700			-\$18,730,100	-\$731,200	-\$283,500	\$0	\$1,702,900	-\$630,100	\$1,072,800	\$1,356,300	-\$1,381,500
2010	90.0%	\$21,447,700			-\$18,730,100	-\$731,200	-\$141,800	\$0	\$1,844,600	-\$682,500	\$1,162,100	\$1,303,900	-\$891,300
2011	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	-\$482,200
2012	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	-\$126,500
2013	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$182,800
2014	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$451,800
2015	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$685,700
2016	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$889,100
2017	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$1,066,000
2018	90.0%	\$21,447,700			-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$1,251,400	\$1,219,800
2019	90.0%	\$21,447,700		\$2,544,800	-\$18,730,100	-\$731,200		\$0	\$1,986,400	-\$735,000	\$1,251,400	\$3,796,200	\$1,625,500

6. Profitability Measures - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

**Profitability Measures**  
Monochlorobenzene Separation Process

May, 2003

The Investor's Rate of Return (IRR) for this Project is: **20.95%**

The Net Present Value (NPV) at 15% for this Project is: **\$1,625,500**

**ROI Analysis (Third Production Year)**

Annual Sales:	\$21,447,700
Annual Costs:	-\$19,461,300
Depreciation:	-\$196,900
Income Tax:	-\$662,100
Net Earnings:	\$1,324,300
Total Capital Investment:	\$5,300,800
ROI:	<b>25.0%</b>



7. Sensitivity Analyses - Part (b) – Purchase and Installation Costs Estimated by Aspen IPE

**IRR Analysis - Two Variable**  
**Monochlorobenzene Separation Process**

May, 2003

**Product Prices vs Variable Costs**

		Variable Costs											
		\$17,689,500	\$18,209,800	\$18,730,100	\$19,250,400	\$19,770,600	\$20,290,900	\$20,811,200	\$21,331,500	\$21,851,800	\$22,372,000	\$22,892,300	\$23,412,600
Product Prices	\$ 0.46	17.98%	12.43%	6.18%	-1.20%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.47	23.51%	18.52%	13.10%	7.04%	-0.04%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.49	28.55%	23.94%	19.04%	13.74%	7.86%	1.06%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.50	33.21%	28.88%	24.35%	19.54%	14.36%	8.64%	2.09%	Out of Range	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.51	37.58%	33.47%	29.21%	24.74%	20.03%	14.96%	9.39%	3.06%	Out of Range	Out of Range	Out of Range	Out of Range
	\$ 0.53	41.71%	37.78%	33.73%	29.52%	25.13%	20.50%	15.53%	10.10%	3.98%	Out of Range	Out of Range	Out of Range
	\$ 0.54	45.64%	41.86%	37.97%	33.98%	29.83%	25.51%	20.95%	16.09%	10.79%	4.86%	-2.05%	Out of Range
	\$ 0.55	49.39%	45.74%	42.00%	38.17%	34.22%	30.13%	25.87%	21.39%	16.62%	11.45%	5.69%	-0.95%
	\$ 0.57	52.99%	49.44%	45.83%	42.14%	38.35%	34.45%	30.42%	26.23%	21.82%	17.14%	12.08%	6.48%
	\$ 0.58	56.44%	53.00%	49.49%	45.92%	42.27%	38.53%	34.68%	30.71%	26.57%	22.24%	17.65%	12.70%
	\$ 0.59	59.77%	56.42%	53.01%	49.54%	46.01%	42.40%	38.71%	34.91%	30.98%	26.91%	22.64%	18.13%
	\$ 0.61	62.99%	59.71%	56.39%	53.02%	49.59%	46.10%	42.53%	38.88%	35.13%	31.26%	27.24%	23.04%
	\$ 0.62	66.10%	62.90%	59.66%	56.37%	53.03%	49.64%	46.19%	42.66%	39.05%	35.34%	31.52%	27.56%