Appendix G

Internal Rate of Return (IRR) Calculation Method

1. Determine the estimated erected cost (EEC) for the complex. The EEC is composed of two factors:

   a. The inside-battery-limits costs (a.k.a. ISBL EEC - the costs for the process units). Calculate from the unit feed rates and the information in Table 7.1 (Base Case) and Table 7.2 (Alternate Case).

   b. Add an allowance for offsites of 50% of the ISBL EEC. The value of 50% is rather arbitrary and will depend on many factors such as the site, existing utility structure, etc.

   $$EEC = 1.5*(ISBL\ EEC)$$

2. Calculate the total investment (INV). INV contains the capital spent during the construction period and the interest on the capital already spent. Capital expenditures occur over a three year construction period: 20% of EEC in the first year, 50% in the second year, and 30% in the third year. The interest on the capital is assumed to be 10% per year. The erected cost and the interest are summed to arrive at the total investment figure.

$$INV = [0.2*EEC*(1.0)\char94 3] + [0.5*EEC*(1.10)\char94 2] + [0.3*EEC*(1.10)]$$

3. The cash flow calculations are calculated over a 20 year period. Depreciation is calculated using a straight-line method at 10% per year. The income tax rate was assumed to be 33%. The calculations use two simplifying assumptions: 100% equity basis (no interest charges in the pre-tax income calculation), and constant dollar basis (no inflation).

These assumptions will not affect the conclusions because conclusions are drawn by comparing rather than by looking at absolute dollar values.

P   = Product revenue
F   = Feedstock cost (or value)
FE   = Fixed expenses (utilities, labor, maintenance, catalyst, local taxes)
DEP   = Depreciation (ISBL + offsite @ 10% of EEC per year)
PTI   = Pre-tax income
ATI   = After-tax income
CF(t) = Cash flow for year t

$$PTI = P - F - FE - DEP$$

$$ATI = (1 - 0.33)*PTI$$

$$CF(t) = ATI + DEP$$

The cash flows for the first 10 years will be the same, but the cash flows for the second 10 years will be different because there is no depreciation.

4. The discounted cash flow equation to be solved for the internal rate of return (IRR) is:

$$\sum_{t=1}^{20} \frac{CF(t)}{(1 + IRR)^t} = INV$$

The calculation method to determine an IRR is straight-forward. However, the method to find the correct F to give a 20% IRR requires an iteration:

a. Pick F
b. Calculate all CF(t)
c. Solve the above equation to find IRR
d. Iterate until the value for F is found so that IRR = 20%