Problem 3-65, Engineering Economy, 12th Edition • Revised 0945 hours on 28/02/03
Solution *Lexcie Lu* • MIT Center for Transportation Studies

The refinery needs filters every year for six years. Those filters are priced $175,000 at the beginning of the first year. The price of filters grow by 8% in each year. Thus,

- The filter required at the beginning of next year would cost $175,000*(1.08).
- The filter at the beginning of the 3rd year would cost $175,000*$(1.08)^2$.
- The filter at the beginning of the *n*th year would cost $175,000*$(1.08)^{(n-1)}$.

The spreadsheet in Exhibit 1 calculates the costs of the filters:

	A	B
1	Year	Cost
2	0	*(no filter)*
3	1	175
4	2	189
5	3	204.12
6	4	220.4496
7	5	238.0856
8	6	257.1324

Exhibit 1: Spreadsheet to calculate cash flows due to filter liability.

The refinery is evaluating its capital programme with an assumed cost of capital of 18% per year. This means the refinery is able to borrow money or raise money from the stock market at an average interest rate of 18% per year. The bankers may offer loans for less than 18%, while the stock market may be expecting more than 18% annual return, but the weighted average is 18%. In other words, if the refinery need to invest in some kind of capital project, it should ensure that it will generate at least an 18% return.

Supposing that the oil refinery had $100 now, and it chooses to invest it in some known aspect of its business, it could earn a return of 18%. Let's say it invests the $100 in its own stock, the dividend paid at the end of this year would be $18. Therefore, if it chooses to invest in something other than its own stock (i.e. the expensive heat exchanger system (HXS) that avoids the need for filters), then the return had better be more than 18%.

If we choose to invest in the HXS, we are effectively avoiding liabilities. The liability of the filters required at the end of the present year is $175,000 -- but we need to discount this back to the beginning of the present year, in order to compare it with the investment required in the HXS *today* (which would avoid the liability in a year's time).

So what is the discount rate? If instead of investing in the HXS, we invest in our own stock, we expect to earn 18% dividend at the end of the present year. Thus, $100 today will be worth $118 at the end of the present year. In other words, the discount rate is 18%.

We plug the numbers from Exhibit 1 into our universal Net Present Value Calculator spreadsheet (available from the course website), we get the results shown in Exhibit 2. Thus, the HXS would only be worthwhile if it costs less than $721,300 to install, operate and maintain.

	A	B	C	D	E
1	**1.011 Assignment 3**, Spreadsheet Solutions				
2	*Lexcie Lu*, MIT Center for Transportation Studies				
3					
4			Effective %	Nominal %	
5	Effective to Nominal:		12.7497%	12.0000%	
6					*(Manually e*
7		Nominal Interest Rate i% =		18%	*Nominal va*
8					
9	**Year**	**Cash flow**	**Factor**	**Present V**	**Cumulati**
10	*(t)*	*(Ct)*	*(1+i)^t*	*(Ct)/(1+i)^t*	*Intgrt[PV]*
11	0	0	1	0	0
12	1	175	1.18	148.3051	148.3051
13	2	189	1.3924	135.7369	284.0419
14	3	204.12	1.643032	124.2337	408.2757
15	4	220.4496	1.938778	113.7055	521.9811
16	5	238.0856	2.287758	104.0694	626.0505
17	6	257.1324	2.699554	95.24996	721.3005
18	7		3.185474	0	721.3005
19	8		3.758859	0	721.3005
20	9		4.435454	0	721.3005
21	10		5.233836	0	721.3005
22	11		6.175926	0	721.3005
23	12		7.287593	0	721.3005
24	13		8.599359	0	721.3005
25	14		10.14724	0	721.3005
26	15		11.97375	0	721.3005
27	16		14.12902	0	721.3005
28	17		16.67225	0	721.3005
29	18		19.67325	0	721.3005
30	19		23.21444	0	721.3005
31	20		27.39303	0	721.3005
32		INPUT			
33		Net Present Value =		721.3005	
34					

Exhibit 2: Calculating the Net Present Value of oil filter liabilities