Engineering Economics and Problem Solving, 4N4, 2014

Tutorial/Assignment 4

Tutorial date: 02, 03 October 2014; due date: **07 October 2014, 16:30!** (please note the date and time)

AIM: *To confirm your understanding of capital cost estimation.*

For capital cost estimation using correlations, we always follow this approach:

1. Look up the correlation to estimate the capital cost. Is it the one that applies to your case?
2. Does the range match the situation we are dealing with?
3. Read of the value of the base cost and base year for the correlation.
4. It's unlikely the capacity matches your case. Inflate for capacity, using the exponent n.
5. Calculate the bare module cost, using the bare module factor.
6. Adjust the price, if required, for materials of construction, pressure, and temperature.
7. The last calculation is to inflate the price into today's dollars.
8. Finally, report the value as a range, rather than a point estimate. Note, these are just estimates, so they have error.

The correlations in this assignment are from Woods, "Cost Estimation for the Process Industries", 1993 [30 Mb PDF]. You will also require access to the various indexes used to inflate costs to different points in time, which are on the course website.

Question 1

1. What is a typical annual salary of an operator in a plant? (give sources)
2. How much does a chemical engineering supervisor (potentially *you*) earn? (give reputable sources from actual salary surveys)

Question 2

Why should the MARR be used as the time value of money rate, i_{TVM} when doing NPV calculations?

Question 3

Estimate the capital cost for a Chinese plant selling propylene pellets with annual sales of CNY 185 million.

Question 4

A heat exchanger that your company purchased in 2000 cost $145,000 to buy and install. What is the cost today to repeat this purchase and installation of a similar exchanger that has 1.8 times the heat transfer area?

Question 5

This question breaks down the 8 step approach into sub steps for you. All dollar figures are in 1970 value, except for the last part of the question.

1. Estimate the actual cost of a floating head, carbon steel, floating head exchanger. It has an area of 400m^2. The exchanger operates at ambient conditions. [steps 1 to 4]
2. What is the installation cost of the exchanger? [step 5]
3. What is the bare module cost of the exchanger? [step 5]
4. If the exchanger is to operate at a maximum pressure of 6800 kPa:
   - how much *extra* will we pay the supplier (the vendor), on top of the base price calculated in part 1, for the exchanger?
   - how much *extra* will we pay internally, for unpacking, installation, foundations, electrical and utility connections, sensors, *etc*?
5. We have to upgrade most of the piping components in the bare module so that we can operate at these higher pressures. For heat exchanger's this a number that is roughly \$0.46 for every \$1.00 spent on the actual cost of the exchanger. But, not every pipe in the bare module has to be upgraded:
   - which pipes would need to be upgraded?
   - which pipes don't need to be upgraded? (look at pictures online of installed heat exchangers)
   - a good estimate is that 70% of the pipes in the bare module need to be upgraded; so calculate the *extra* cost we have to pay to upgrade 70% of the piping?
6. Report the total bill for this exchanger as broken down into 4 parts, as follows:
   - Base cost of the exchanger
   - Installation cost
   - Extra cost we have to pay the supplier for an exchanger that can safely operate at higher pressure
   - Extra costs we have to pay on our side for piping that safely operates at the higher pressure
7. How much will you pay the supplier, in total, for the heat exchanger (called the purchase cost)?
8. Take the total cost from part 6, and convert it to a dollar figure in 2013; report your answer as a range. [steps 7 and 8]

Question 6

The following graph is from a textbook, "Chemical Engineering, volume 6", by Sinnott, published in 1983, p 189. It is for costing a heat exchanger.

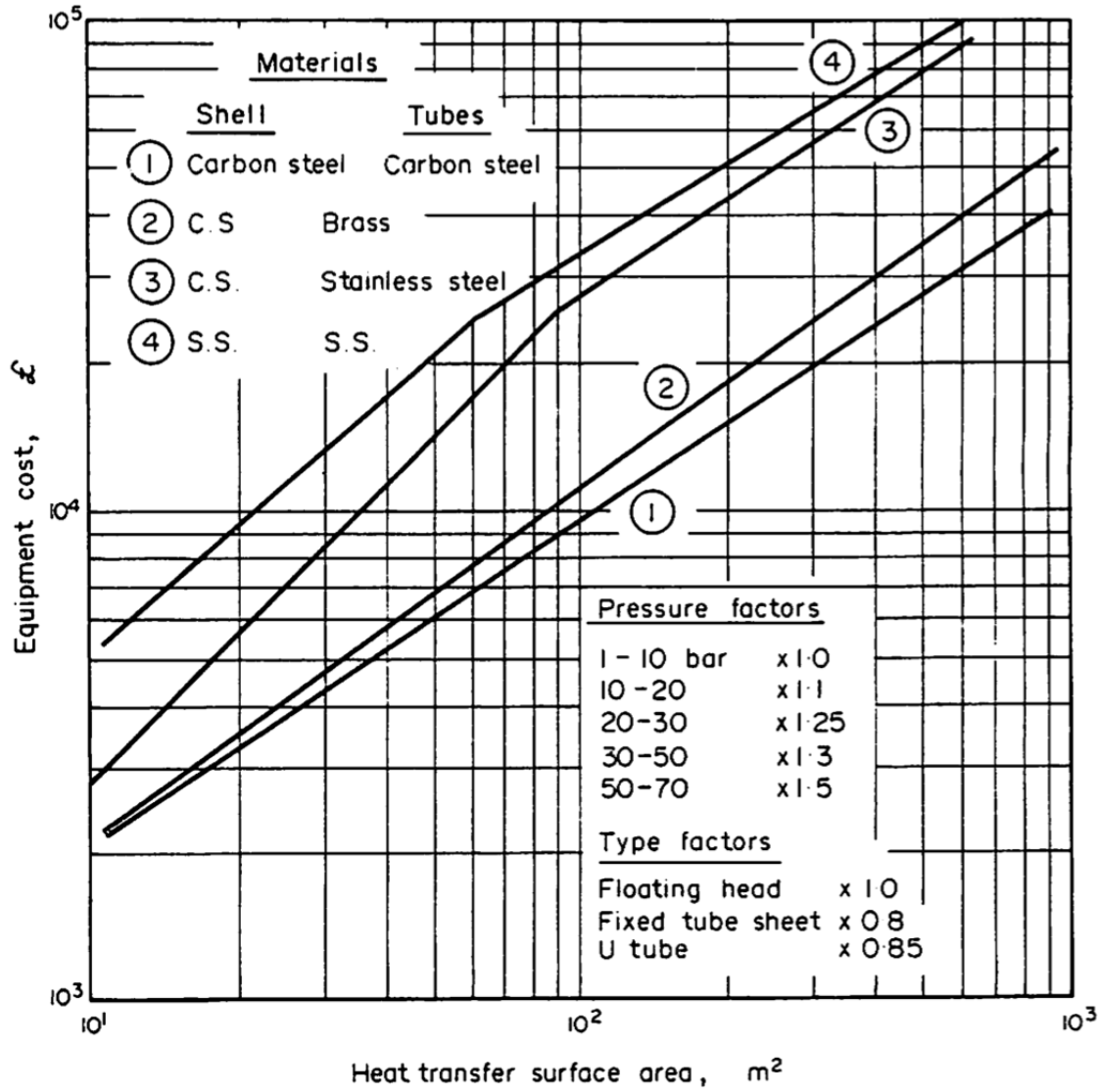

FIG. 6.3. Shell and tube heat exchangers. Time base mid-1979
Purchased cost = (bare cost from figure) × Type factor × Pressure factor

Use it to calculate the purchase cost of the exchanger calculated in the prior answer.

How does that estimated purchase cost compare to the one from the prior question (part 7)? What assumptions do you make when trying to make the comparison?

Question 7

1. What is the purpose of a flash vessel?
2. You need to purchase a vertically-oriented flash vessel, made from carbon steel. What is the estimated bare module costs if the vessel has height of 2.2 meters, and a diameter of 0.5 m? It operates close to ambient conditions.

Cite the correlation used, and the parameters in it.

Question 8

This graph is from the same textbook, "Chemical Engineering, volume 6", by Sinnott, 1983, p 190. It is for costing pressure vessels.

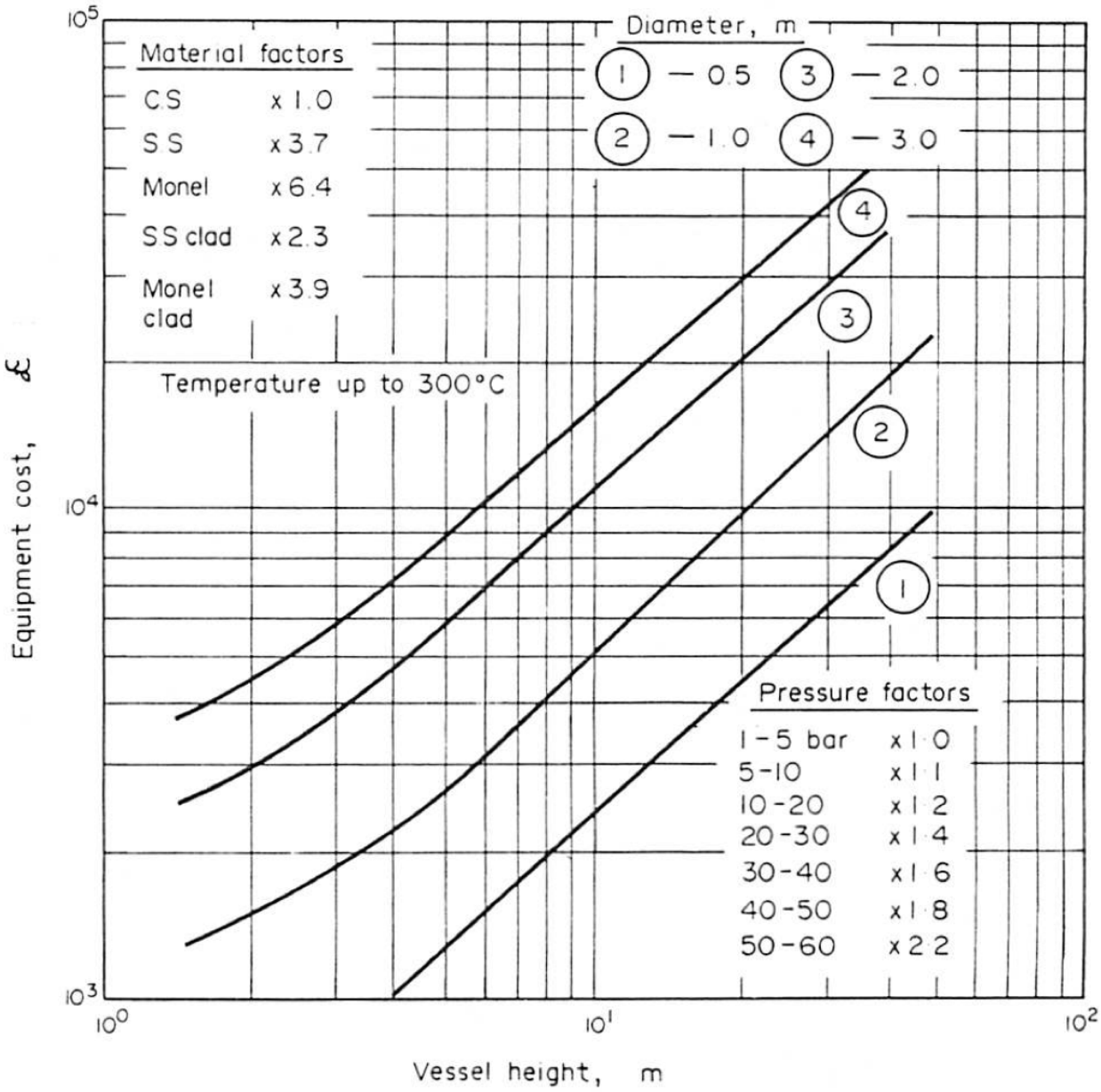

FIG. 6.4. Vertical pressure vessels. Time base mid-1979
Purchased cost = (bare cost from figure) × Material factor × Pressure factor

Use it to calculate a cost estimate of the prior flash vessel, and again, compare your answers.

Question 9

Quote a typical, accurate, and reputable price for the following commodities:

- natural gas [which units are typically used for natural gas?]

- electricity [assume it is in Ontario]
- municipal water [assume it is in the GTA region of Ontario again]

Question 10

Which components go into making up the composite CEPCI index (find the source for the information, read it, and interpret it, and write an answer in your own words please).

Question 11

In the upcoming course project you can use the capital cost estimation tool in Aspen. But, we should not use these tools without understand how they work.

- Which sources of information does Aspen's software use to determine the capital costs?
- How does Aspen account for different capacity units?
- How does Aspen inflate for prior/future years?
- What is the level of error associated with the Aspen estimates?

Cite your sources, ensuring they are credible.

END