EngBAM Excel Basics Worksheet

Excel is a very useful tool for a Chemical Engineer! Whether this is for performing a mass / energy balance on a process stream or for data analysis, excel is often the first step when handling large amounts of data. Therefore, for any scientist or engineer it is important to have a strong grasp on how to do the basics.

This worksheet is designed to lead you through some basic calculations with some example lab data. At the end of this worksheet, you will have performed calculations on a data set and will have produced a chart to display the link between the Reynolds number and velocity of fluid flow through a pipe.

If you get stuck with this worksheet watch the videos on the excel section on the EngBAM website (ww.engbam.com) which will take you through the task.

Background

As chemical engineers we are often interested in how a fluid flows through a pipe. The rate of flow through a pipe will determine how mixed the stream is, as well as the pressure drop that will occur in a process. The flow through a pipe can be characterised by a dimensionless number known as the Reynolds number.

$$Re = \frac{\rho U D}{\mu}$$

Re – Reynolds Number (dimensionless)

ρ – Density (kg/m^3)

U – Fluid Velocity (m/s)

D – Pipe Diameter (m)

μ – Fluid Viscosity (Pa s)

Within this exercise, we want to see what effect the fluid velocity will have on the Reynolds number. To do this we are going to take some raw experimental data, calculate the Reynolds number and plot this against the fluid velocity.

The velocity and volumetric flowrate are linked together, therefore we can convert between the two.

$$Q = UA$$

Q – Volumetric Flowrate (m^3/s)

U – Fluid Velocity (m/s)

A – Cross Sectional Pipe Area (m^2)

We can rearrange this equation to allow us to find the velocity of the fluid through the pipe. To find the velocity we will look to divide the volumetric flowrate by the cross-sectional area of the pipe.

Task

1. First freeze the column titles. To do this select cell B8 and then freeze panes.
2. Calculate the cross-sectional area of the pipe from the diameter (Hint: $A = \pi r^2$). In excel π can be entered into a formula as PI().
3. Next find the fluid velocity from the volumetric flowrate. Remember you can drag down the formula to each row of the table to save the need to repeatedly type the same formula. When dragging down the formula remember you need to use absolute cell referencing for the cell containing the cross-sectional area (Hint: Use the $ symbols).
4. The final column in the table is the Reynolds number. Use the equation shown above in the background section (Hint: Remember to use absolute cell referencing and ensure that your brackets are in the correct place).
5. Finally, we want to display this data in a scatter graph to see the trend between the fluid velocity and the Reynolds number. Add a scatter chart to the sheet, then right click to add the data. You can then improve the presentation of the data by adding a plot title and axis labels. Click the trendline button to add a trendline to the plot. Is this an appropriate trendline for this data? Does the data fit this trendline well?

As expected, there is a strong positive correlation between the fluid velocity and the Reynolds number. When the velocity increases so will the Reynolds number. In this case the trendline that we added to the plot is appropriate as there is a linear relationship between the two variables. However, this will not always be the case, so make sure to always check if the trendline is appropriate!

If you want to check your solution, watch the final video on the EngBAM website that shows an example of how to solve this worksheet.

Extension

To improve this data, we can take an average across the three experimental runs and use the average flowrates to find the Re. How does only plotting the average Re and velocity change the plot and the trendline? Have a go at trying to achieve this by adding in an extra column and explore using the average function.