Chemical Engineering: Background Reading

What is Chemical Engineering?

Shawn, a chemical engineer in industry, has made a short video on chemical engineering, including an overview of the key topics covered. It's a brilliant video and we recommend you watch it for a better idea of what you will study in the next three years: https://youtu.be/ifUgW2DJO14

The IChemE

The Institution of Chemical Engineers, or IChemE, is the key accreditation body in the UK. They exist to advance chemical engineering contribution to benefit society. They also play a key role in ensuring Chemical Engineering courses contain all the relevant information required to become a successful graduate chemical engineer – all our courses at Surrey are accredited by the IChemE.

To help prospective and current students get a better idea about chemical engineering, they have prepared the webpage "Why not Chem Eng?" which contains an introduction to this subject. You may have found this page already while applying for the course, but if you haven't, then have a read for some background information.

Key topics in Chemical Engineering

The points below give a brief overview of some key technical aspects of chemical engineering. Many, if not all, of these topics are interrelated and impact each other. A fundamental understanding of each aspect is crucial to become a well-rounded chemical engineer – and this is what you will learn during your time at Surrey. This list is not exhaustive and you may wish to add to it as you continue through your studies!

If there are any words or phrases you are unfamiliar with, this is a good opportunity to look them up.

- **Mass and energy balances**
  The conservation of both Mass and Energy are fundamentals on which all chemical processing is based. This topic involves being able to properly formulate and solve material and energy balances. It also involves integrating and interpreting physical property data from different sources and in a variety of different units.
- **Fluid dynamics**
  It is a crucial skill as a chemical engineer to understand how fluids flow and behave in different systems, whether they are static or dynamic. Fluid properties such as density, viscosity and surface tension are key aspects to understand. Flow regime i.e. laminar and turbulent flow is another crucial concept. Pumps and system pressure are also considered in this topic.
- **Heat transfer and thermodynamics**
  This covers aspects such as work, energy consumption/generation, system efficiency. The laws of thermodynamics are key concepts to understand as chemical engineers. Further to this, how heat is transferred and the mechanisms by which this happens is of fundamental importance in many aspects of process design (heat exchangers in particular). Fouling and heat transfer coefficients are also important parameters in this topic.

- **Process design**
  This covers the design of chemical processes, from the development of engineering drawings and representation of processes, to the large-picture timeline of a project. Chemical processes need to be optimised for performance and cost, and costing analyses is a crucial aspect of chemical engineering as well as design work. Safety, operability, flexibility, profitability and sustainability are key aspects in process design.
- **Reaction engineering**
  Chemical reactions are the heart of many chemical processes and it is important to understand how they can be represented mathematically so their outcome can be predicted. A sound understanding of a reactor is crucial for design work. Different types of reactor, mixing, continuous-v-batch processes, are all aspects to consider. Heat transfer is also important to understand, and exothermic and endothermic reactions must be treated differently in process design.
- **Separation processes**
  Separations are the most common operation in chemical plants and cover aspects such as distillation, adsorption, filtration, absorption, etc. Typically this is because when a reaction occurs, the reactants do not convert 100% to products, and often side-products or waste components are produced. To obtain a pure product for sale, separation processes must be employed to isolate the desired product from the rest.
- **Process control**
  This is a crucial aspect for the operation of a chemical process. Process control allows manufacturers to keep operations running within specified limits, and enables them to optimise profitability. It is also a key aspect in ensuring safe operation and in maintaining product quality. As chemical engineers you will learn how to apply control to process designs, and also understand the fundamentals of how controllers operate.
- **Engineering materials**
  Understanding the limitations of different materials is incredibly important in the safe design of chemical process equipment. It is often the task of a chemical engineer to determine the material a pipe or equipment item should be constructed from, accounting for pressure, temperature, and the process fluid contained inside. Aspects such as corrosion, embrittlement, stress/strain, creep, fatigue, viscoelasticity, oxidation etc are important to understand for key classes of materials.
- **Sustainability**
  A key aspect of chemical engineering, even more so as the years go on. Sustainability improves the quality of our lives, protects our ecosystem and preserves natural resources for future generations. Developing more efficient processes plays a crucial role in this topic. Businesses have a crucial role to play in the diverse and increasingly complex agenda of environmental and social management. Evaluating the degree of influence that these issues have on business activities is an important aspect to consider in chemical engineering.
- **Engineering management**
  Company accounting and reporting, project evaluation and project management are all crucial aspects of working in a professional engineering environment. Legal responsibilities of companies and employees to the health and safety of all in the workplace are considered in this topic. Chemical engineering is not just design and calculations – in fact, having people in management positions who understand the engineering aspects is incredibly important when it comes to schedule and organisation of large projects as they can set realistic timelines leading to a smoother-run project.

Exercise 1: Chemical Engineering Design and Safety

The Engineering Design Process

Watch this YouTube video: https://youtu.be/MAhpfFt_mWM. This gives a nice overview of the engineering design process from the perspective of a taco party. Do you already apply this design process to other aspects of your life without realising it?

Safety in Engineering Design

You may have heard of the Deepwater Horizon explosion in April 2010, but perhaps don't know why it happened or how the incident could have been prevented. This video, from the Chemical Safety Board, is a great summary of what happened: https://youtu.be/FCVCOWejlag

Another aspect we need to carefully consider is that most processes are designed at a pressure much different to atmospheric – so designing vessels to withstand this pressure is really important. Have a look at this video: https://youtu.be/uo7H_ILs1qc. It talks through the 2009 pressure vessel explosion at NDK Crystal in Illinois.

For both of these cases, think about:

- What could have been improved in the design
- What could have reduced the impact of the accident
- What take-away lessons can we learn as chemical engineers?

Exercise 2: The history and future of Chemical Engineering

Using the following links as a starting point, do some research to answer the following question:

"Based on the history of Chemical Engineering, where do you see its future?"

Use this opportunity to practice your referencing and research skills, along with your critical analysis of the sources. Have a look at the resources provided by the library to help guide you on this.

Think about the following:

- Do you agree with the predictions on the future of Chemical Engineering?
- What do you think the future holds for Chemical Engineering, and what interests you most about Chemical Engineering as a career?
- How reliable are these sources, and how much do you trust the information provided?
- Who or what do you think was responsible for the development of Chemical Engineering as a profession?

Here are some references to get started:

- A post from NewEngineer: https://newengineer.com/blog/the-history-of-chemical-engineering-1506258
- A magazine article from Chemical Processing: https://www.chemicalprocessing.com/articles/2016/chemical-engineers-face-favorable-future/
- This article from the AIChE magazine: https://www.aiche.org/resources/publications/cep/2018/october/revisiting-future-chemical-engineering