Education
Special Interest Group Newsletter

IChemE Education Special Interest Group

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Welcome….

… to the September/October 2017 Education Special Interest Group Newsletter. The newsletter cannot be produced without examples of your good work, so if you have an example of good practice in chemical engineering education (whether in an academic or industrial setting) please send us an email to let us know.

On the last page you will find information on events and other news from IChemE.

Past Newsletters are available as a resource to all EdSIG Members on the IChemE EdSIG webpage and you are free to download them and share them with your colleagues, students (and even your friends and family) should you wish to.

Prof Jarka Glassey, EdSIG Chair

Good Practice Exchange

Effective Teaching for Process Simulation

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Steady-state process simulation is commonly taught in many chemical engineering undergraduate programmes worldwide. Many students also make use of process simulation software to perform mass and energy balances for their final year design project. Mastering good simulation skills will be an added advantage for graduates who wish to join a design and consultancy company. Note, however, that teaching of simulation is a challenging task, especially when the class is big, and with students of different levels of understanding and learning speed.

In this article, we offer a few suggestions on how simulation can be taught effectively.

Integrated flowsheet vs individual units

It is often important to teach students in simulating an integrated flowsheet rather than single unit operations; not only to prepare students for their final year design projects, but also to mimic the actual operating plant. Hence it is always good to start the simulation for an individual unit, then converge it and link it with the subsequent units. This is formally referred to as the *sequential modular* approach in simulation literature (Westerberg et al., 1979). For an integrated flowsheet, a convenient way of converging it is to make use of some conceptual process design tools. One such tool is the Onion model (Figure 1), originally proposed by Linnhoff et al (1982). Foo et al (2005) demonstrated how it may be used to guide the simulation of an integrated flowsheet, using the *n*-octance case study.

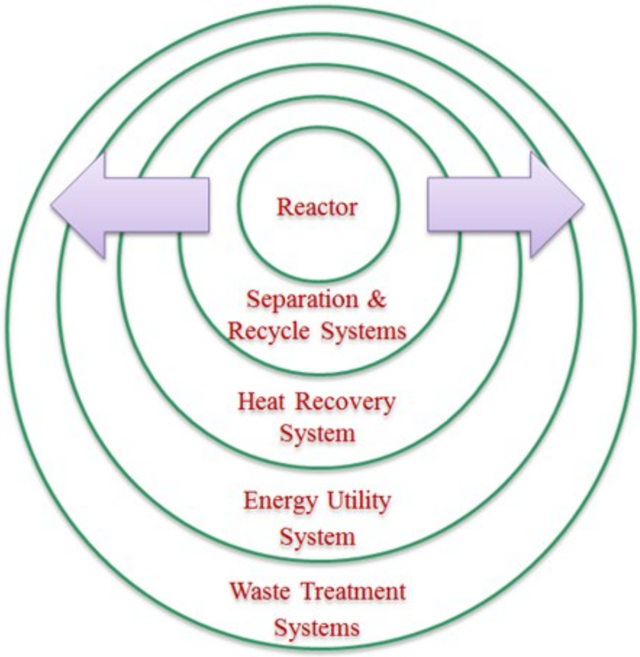

Fig 1. The Onion model (Foo et al, 2017)

As shown in Figure 2, the *n*-Octane case study involves a reactor where ethylene and *i*-butane are reacted to form *n*-octane. Following the concept of the Onion model, one would first simulate and converge the reactor model (i.e. the core of the Onion model), before moving to the distillation and recycle systems (second layer of the Onion; see Figure 2(a)). Next the material recycle system is converged, in most cases using the *tear stream* concept (Figure 2(b)). We then move on to simulate and converge the heat recovery system (third layer of the Onion), which is considered as *energy recycle system* from the simulation perspective (Figure 2 (c)). Performing the simulation in this step-by-step approach enables the flowsheet to converge in a relatively short time and with fewer mistakes.

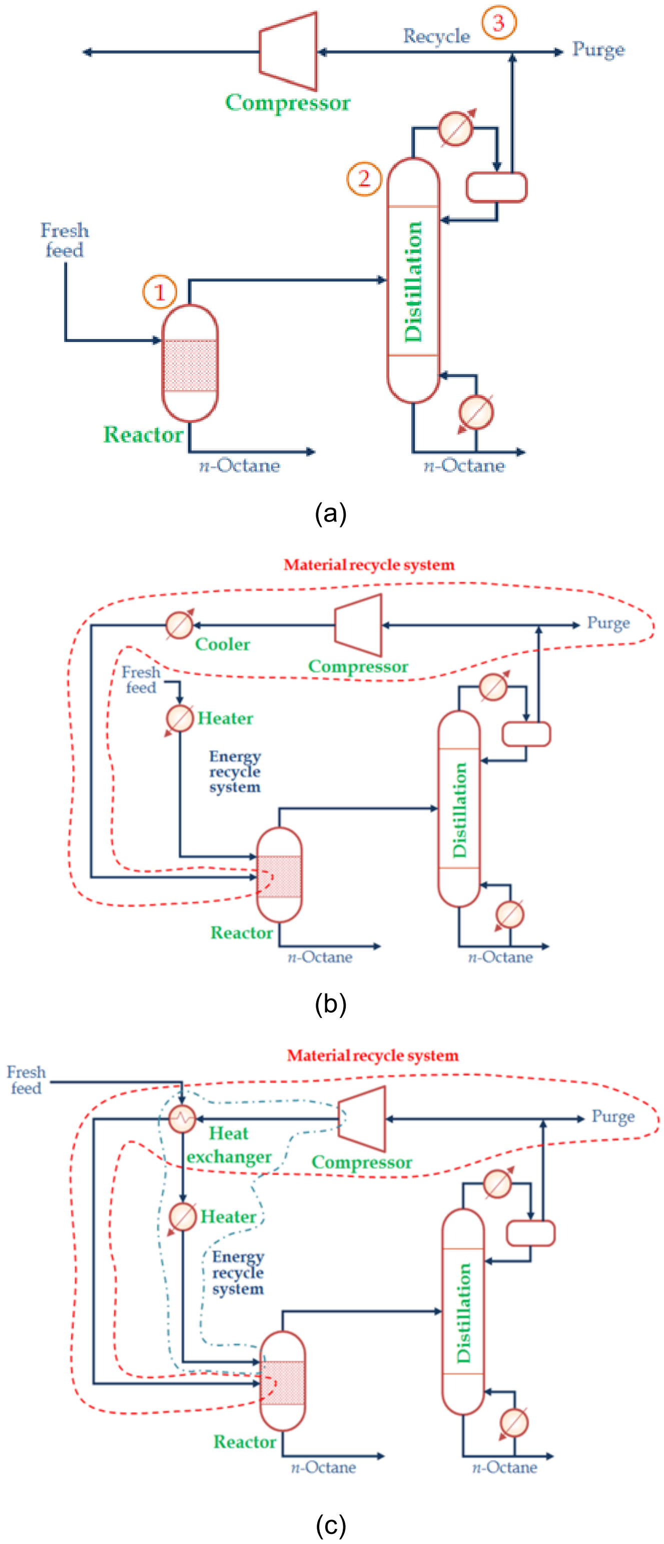

Fig 2 Simulating an integrated flowsheet: (a) start simulation for reactor (①) distillation (②)and material recycle system (③); (b) material recycle system; (c) energy recycle system

Good lecture material

Typically, a hands-on simulation class can be highly effective when the number of students is kept below 20, or even 10! However, this is often not possible for an undergraduate programme in the university. Hence, extra efforts are needed in order to make good learning material for the class. An example is shown in Figure 3, where step-by-step guides are included in the lecture handout for the simulation class.

Effective classroom teaching

During the simulation class (which lasts for typically 2 to 3 hours), it is always good to start with some simple examples before moving on to more complicated cases. The lecturer should first explain the underlying principles and concepts and then demonstrate how to solve a simulation case step-by-step. The students can then try out the exercises following the steps outlined in their lecture notes. If time permits, more advanced problems can be introduced in the latter part of the session.

For hands-on simulation classes, a sufficient number of instructors is important. It is recommended to maintain the ratio of students to instructors to max 30:1 to ensure good interactions. In most cases, the instructors consist of the lecturer and some teaching assistants; the latter are normally postgraduate students with a good understanding of the process simulation concept and who will help to troubleshoot whenever the students face difficulties in their simulation exercises.

Online learning material

One of the main challenges for a hands-on simulation class is that students have different levels of knowledge and learning speeds. One can easily observe that about 20-30% of the students perform relatively fast in completing an exercise, while others are struggling with basic exercises and concepts. For this reason the *blended classroom approach* offers a good solution to overcome such problems, especially for classes with a large number of students. The blended classroom approach is a mix of traditional face-to-face teaching and technology-based learning. There has been a lot of evidence on successful blended classroom teaching experience from elementary schools through to colleges and universities.

For a successful blended classroom approach, online learning materials are important. These include PowerPoint slides as well as instructional videos that illustrate the step-by-step approach in performing a simulation study (see an example here: https://youtu.be/-YAw1xHYtAk), To assist the students with their self-guided learning, instructional videos may be posted on a virtual learning environment so that students can effectively learn and revise at their own pace outside of lectures and tutorials. These resources are very useful for revision before tests and examinations. More information about the blended classroom approach can be found in Chong (2017).

Final words

Teaching of process simulation has always been a challenging task for university instructors, especially those with high student numbers. Many innovative ideas may also be useful for effective teaching, e.g. online

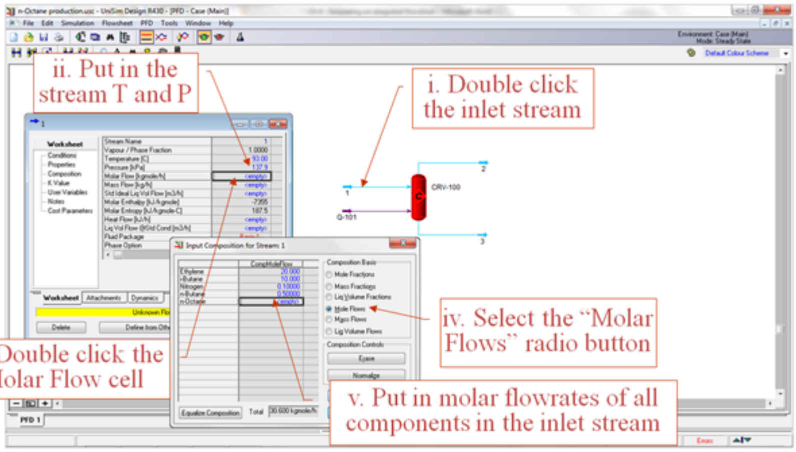

Fig 3 Lecture handout with step-by-step guide

discussion, expert group investigations, linkage to industrial projects, etc. These efforts are certainly time-consuming, but are useful to enhance student engagement and passion for learning, which eventually prepares them for better employment opportunities.

References

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We are grateful to those who take the time to contribute to the EdSIG Newsletter. Please note that content and opinions are those of the contributor(s) named above (or in resources accessed online) and do not necessarily reflect the views of the Education Special Interest Group Committee or the Institution of Chemical Engineers.

EdSIG News & Events

Chemical Engineering Design Project Workshop - London, UK - 8 November 2017
This full day workshop will examine the chemical engineering design project from IChemE accreditation, industrial, academic and student perspectives. Education and Accreditation Forum (EAF) and industrial speakers will outline their viewpoints followed by academics presenting three different approaches to delivering the design project with students on hand to add their views. Focus group sessions will enable attendees to discuss with different stakeholders the design project from a variety of perspectives.. For more information or to register for this workshop please visit the website at http://www.icheme.org/communities/special-interest-groups/education/events.aspx

Process Synthesis and Design using P-graphs - Webinar
This webinar will be delivered by Kathleen B Aviso, a full professor of chemical engineering and current Assistant Dean for Research and Advanced Studies of the Gokongwei College of Engineering at De La Salle University, Manila. For more information and to register for the webinar visit the website at http://www.icheme.org/communities/special-interest-groups/education/events/2017/pgraphs-webinar-15nov.aspx#.WeDRWPlSxpg

For up to date information on EdSIG workshops and webinars visit the events pages at http://www.icheme.org/communities/special-interest-groups/education/events.aspx

Elsewhere in IChemE

IChemE Safety Centre
Membership of the IChemE Safety Centre is FREE to universities delivering Chemical Engineering degree programmes. By signing up to the Safety Centre you will have access to the excellent Case Study teaching resources that have been developed (there are currently four with a fifth in production) - http://www.ichemesafetycentre.org/managing-safety/isc-case-studies.aspx To find out more please contact the IChemE Safety Centre at safetycentre@icheme.org

IChemE Events
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