Integrated Project @ the University of Liège

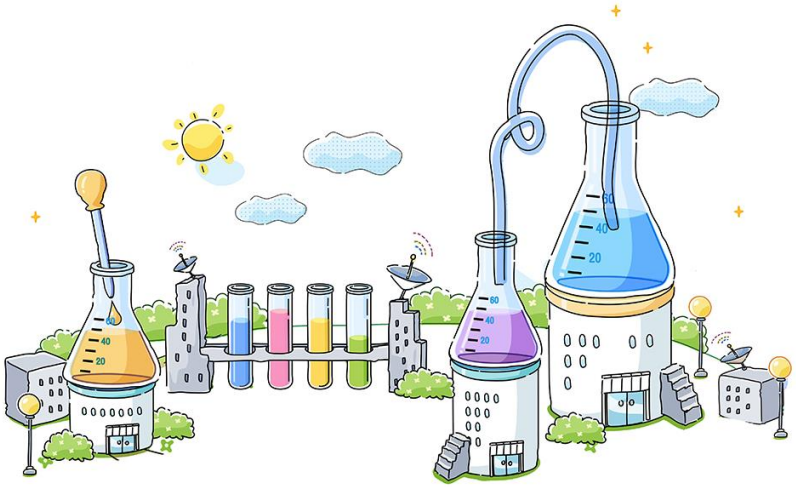
1st year of Master in Chemical Engineering and Materials Science

CHEMICAL ENGINEERING

LIÈGE université

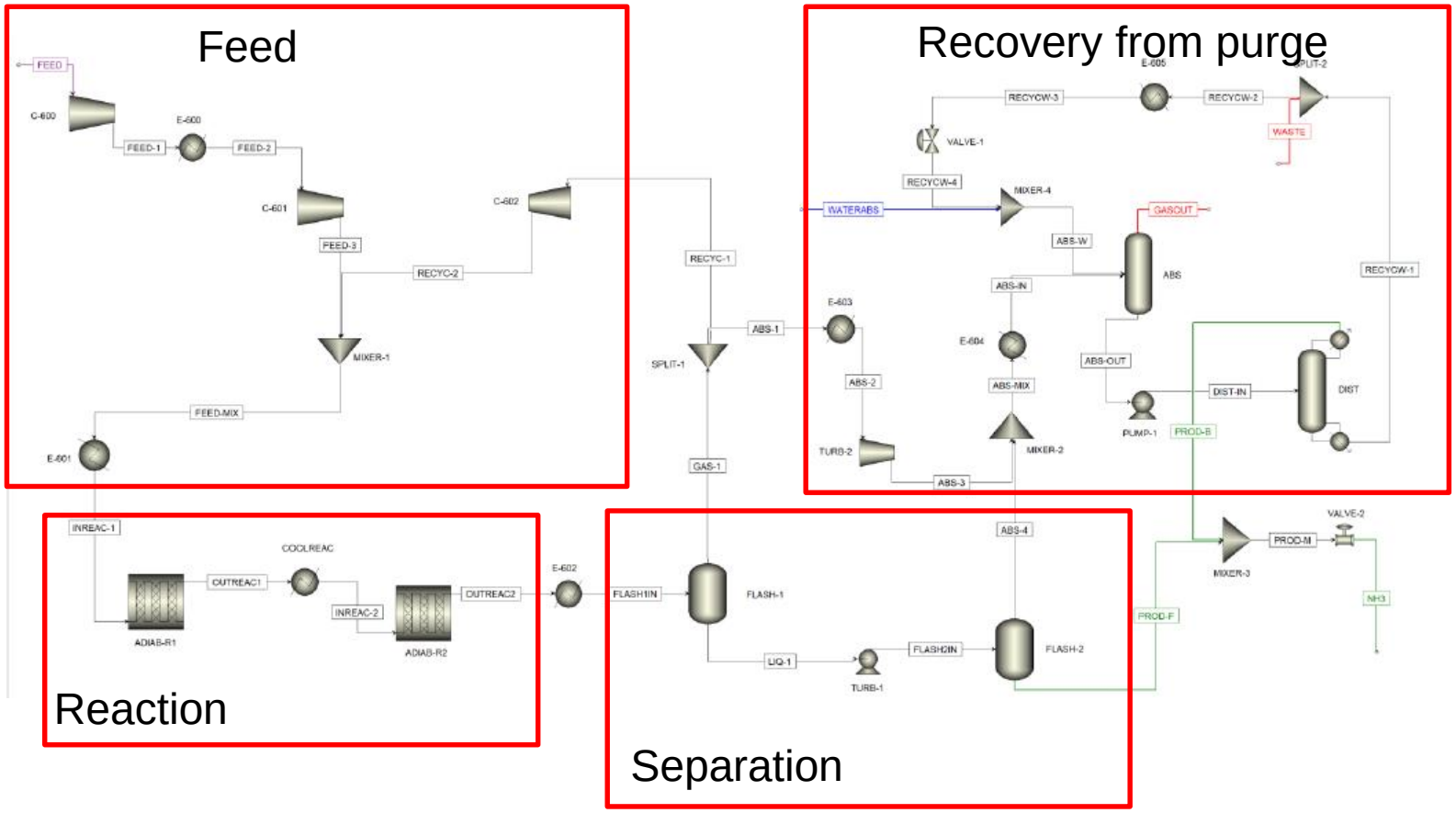
Key learning outcomes (KLO)

- The goal of the integrated project is
  - to consolidate technical knowledge and
  - to promote the acquisition of soft skills
  - by integrating and linking chemical engineering disciplines usually taught separately



Technical skills

- Make the link between chemical engineering classes



Soft skills

- Focus on:
  - Management of project and deadlines
  - Ability to work in large groups (6-11 students, random)
  - Written and oral communication in English (various audience)

Source: Iowa State University

General comments

- Verify and validate the approaches taken:
  - Does the code behave properly also in limiting cases?
  - Do the assumptions make sense?
  - Can the results be compared to independent data?

- Assignements are not perfect and are not supposed to be!

“Graduates should be able to use their powers of judgment as engineers in order to work with complex and possibly incomplete information, to recognize discrepancies and to deal with them."

(…) They should be able to recognize the need for information, to find and provide information

Source: EFCE Bologna Recommendations, 2010

Content: 5 parts

- Sep 15 – Oct 15: Mass balances, short literature review, consolidation of results in groups and project planning
- Oct 15 – Dec 15: detailed models for thermodynamics; kinetics & reactors; separation units
- Feb 1 – Mar 1: Exchange of topics between sub-groups and sensitivity studies on models
- Mar 1- April 20: Process integration into one model & process optimization
- Apr 20 – May 15: extended literature review and report for general audience

Output of the project

- Final deliverable: 15-page article + presentation
- www.chemeng.uliege.be/cms/c_4912130/en/integrated-project-m1

Liege University
PROJ0012-1, 2019-2020

Dimethyl ether, A review of production processes and a modeling of the indirect route

Cyril Fortin, Nicolas Gianfolcaro, Rachel Gonzalez, Justine Lohest, Antoine Lonneux, Pauline Mordant, Ariane Kesnelle Ndong Siliki, Thomas Peiffer, Romain Renson, Claire Schmitz

Abstract
Dimethyl ether (DME) can be considered as a potential substitute to traditional fuels and, thus, receives a great industrial interest. This paper exposes the two main DME production processes: the direct route, where DME is directly produced from syngas and the indirect route which involves the upstream methanol production. This paper also presents a modeled DME production plant (through indirect route) of a capacity of 116 kton/yr. This simulation was performed in Aspen Plus software using the UNIQUAC thermodynamic model. DME is produced tough the dehydration of methanol under $\gamma - Al_2O_3$ catalyst in a adiabatic fixed-bed reactor. The proposed model allows to reach a DME yield and purity of respectively 93.1 % and 99.6 mol %. A cost analysis was performed. OPEX and CAPEX are evaluated to 66,987 k$/yr and 3,780 k$. The economical balance shows that benefices of the production plant widely depend on the price of the methanol feed stream. A life cycle analysis of the process shows a good agreement between the modeled process and Ecoinvent data base.
A literature review was also performed to investigate other ways to produce DME. Improvements can be achieved within the indirect route. The literature review shows that using silica embedded $\gamma - Al_2O_3$ or zeolite catalyst can enhance the DME conversion up to 86% and 94% respectively. The process integration of the indirect DME production was also considered and more particularly the use of a reactive dividing-wall column. Direct DME production from syngas is also presented as well as a European associated project (FLEDGED) which targets to produce DME fuel from biomass.

Keywords
DME — Dimethylether — Methanol Dehydratation – Aspen Modeling – Process Intensification – FLEDGED

Methodology

- Part 1: Individual work + group consolidation

- Other parts:
  - Regular interaction with teachers
  - To be organized by students

- + Plenary meetings (~1/month)
- + Theoretical sessions (communication, process design, LCA…)
- + Office hours every week

- Interaction with industrial experts panel
- Coaching from ULiège lab: Psychology of groups and organization

Evaluation

- The grade will include technical and soft skills evaluations !

- Technical skills:
  - Only final reports (after each part) and final presentation (in May) are evaluated

- Soft skills:
  - Self-evaluation and peer evaluation

Global results (group grade)	Maximal note
General form	
Respect of assignment (on time, number of pages…)	2
Clear and consistent report structure (intro, conclusion, bibliography, unified presentation…)	4
Presentation, quality of figures and tables…	2
Style and respect of conventions (relevant vocabulary choice, bibliography…)	4
Context	
Presentation of the context and objectives	4
Identification and mobilization of resources (eg literature…)	4
Results	
Importance and validity of obtained results (quantity and quality of results)	6
Discussion of results (clarity of the explanations, rational and evidence-based argumentation…)	6
Global integration of the results: links between sub-tasks, links with lectures	4
Conclusion and perspectives (usability of results, critical overview…)	4
Total	40

Results

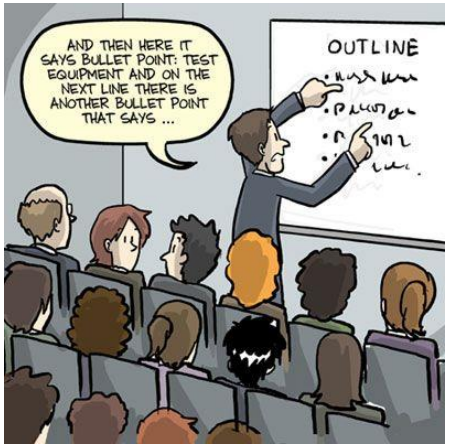
- Initial framework needs to be very clear, otherwise, may be frustrating for students and teachers!

- Soft skills learnings are as important as technical learnings!
  - Difference between successful groups and less successful ones clearly appears!
  - Eg: Sections of varying quality, non-uniformised report
  - Eg: inconsistent results or assumptions
  - Next steps: co-working with electromechanical engineers

- PSGO coaching very useful for students to get a reflexive view over their work

Results

PSGO coaching very useful for students to get a reflexive view over their work



- Eg: Typical project week
  - Monday 14.00: presentation
  - Monday 14.30: Prof. XX yells at us…
  - Tuesday, Wednesday: ….
  - Thursday: I should start working at it
  - Friday: For sure, I'll work on the week-end
  - Saturday, Sunday: we work
  - Sunday night: as usual, we're late…
  - Monday morning: emergency finishing the presentation, we'll definitely start earlier next week

Good luck… and enjoy!