CHEMICAL ENGINEERING EDUCATION FOR DEALING WITH THE NEW CHALLENGES: FROM ONE-WAY LECTURES TO PROJECT BASED COGNITIVE LEARNING

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SUMMARY

There are three main distinguished characteristics of our age which should be considered for the education of the new generation of Chemical Engineers:

1. Short life cycle of the new knowledge: The knowledge production rate was accelerated significantly during the last decades thanks to the info-, bio- and more recently nano-technology revolutions. Although the solid background basic scientific knowledge is always necessary, the chemical engineering portfolio should include specific skills which will facilitate their access to the new knowledge and to the innovation production mechanisms;

2. Need for multidimensional sustainability: The more traditional techno-economic studies carried out for any chemical engineering process, nowadays, should be also coupled by the eco-societal sustainability studies;

3. From process to product design: The saturation of process engineering needs asks for an example shift in the global chemical engineering market, where the product design skills can give the desired outlet, especially in the developed economies.

In this view, this study will present the experience of our research group, BTU, within the frame of 3 successive undergraduate specialization courses; i.e. Petrochemical Engineering, Design of Organic Industries and Biological Resources for Organic Industries; provided in the 4^{th} and 5^{th} year of NTUA, Chemical Engineering Curriculum. The innovations integrated to the teaching methodology in order to provide the necessary tools to the students for dealing with the above mentioned challenges are summarized below:

i. project based learning; ii. team work; iii. multi-disciplinary approach through interactive(?) lectures and experts tutoring on specific project related topics; iv. three consecutive semesters for an in depth optimization of sustainable solutions; v. from process to product design; vi. integration of the new concept of “molecule domestication”; vii. use of multiple research techniques from desk research to experimental data production; viii. design of a student experiment according to the needs of each specific project; ix. an overview of the specific scientific field, further to the specific student project needs, provided through experimental lab work from a wide spectrum of applications from organic chemical industries; x. Student feedback through evaluation questionnaires, the outcomes of which are announced to the class and used in the continuous improvement process of the courses.

Within the framework of this study, highlights from a selected student project, the "production of butadiene" will be provided as an example of the outcome produced through the above described educational process.

- First phase (7th semester): Desk research for mapping the state of the art - chemistry, thermodynamics, kinetics, production technology (alternative routes), fundamental economics, environmental impact, market/uses of butadiene.
- Second phase (8th semester): Conversion of butenes (feedstock) into butadiene via oxidative dehydrogenation (ODH). Plant design with Aspen HYSYS. Plant output 270000 t/a. Economic analysis to assess feasibility, along with a sustainability analysis for environmental and social impact. Suggestions for further research.
- Third phase (9th semester): "Greening" of the whole production and supply system. Syngas (refuse) fermentation-to-2,3-butanediol followed by catalytic conversion of 2,3-butanediol to 1,3-butadiene via dehydration. Data collection (capacity, feedstock requirements, product analysis). Process design with Aspen HYSYS. Sustainability comparison between the petrochemical and biological pathways using 24 predefined "greening" criteria.