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Bio-based targeted chemical engineering education; role and impact of bio-based energy and resource development projects

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Abstract

Avans University of Applied Sciences is redrafting its courses and curricula in view of sustainability. For chemical engineering in particular that implies a focus on 'green' and bio-based processes, products and energy. Avans is situated in the Southwest region of the Netherlands and specifically in that region much development occurs towards 'a bio-based economy'. There is much agriculture based business, small and large companies, important chemical industry and it is situated between major industrial and chemical industry centers and leading international ports. Chemical companies see many opportunities in bio-based products and processes. Connecting the chemical and agro-food sector will lead to unexpected new innovation opportunities. Biomass has quite other characteristics than oil and gas, in composition, availability, and offers new options with respect to compounds that can be derived from it. So there is a strong need to develop and introduce novel processes, products and production routes based on biomass resources. It requires other technologies and equipment, another approach and another mindset than those chemical engineers are being taught at present. Process design, modeling, and optimization will have to be adapted to the new circumstances. Chemical engineering in its basic knowledge won't be different but in practice students will need other and extra knowledge and therefore get other cases to study in projects. That transition will be gradually but it starts now. The bio-based economy already asks for new approaches in education, in particular in chemical engineering. Already now we observe an increasing need for personnel with knowledge of biobased issues on site and for a more bio-based oriented chemical engineering curriculum.

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To acquire that new knowledge and to observe what is needed by industries involved in that bio-based economy Avans University of Applied Sciences is actively participating in projects with local companies, other universities and research institutes. For this paper we have taken the international (Interreg) cooperation project 'Energy Conversion Parks' (ECP) in which we partake as example how such projects can and must contribute when developing a 'bio-based chemical engineering curriculum'. Besides attention for the specific types of equipment, processes and compounds involved, it shows that crucial knowledge also concerns the complexity of energetic optimization and the need for economic synergy when using different biomass streams and conversion technologies. Aspects involved are also bio-refinery, bio-cascading (implying use of all biomass components for products with the highest possible value) and optimizing input and output for seasonal variations in availability and demand. It shows the need for special mathematical models to calculate mass and energy balances for integrated bio-based installations, as well as the economical profitability of the different possible combination of biomass inputs and conversion techniques. The cooperation with industrial partners shows which the important technologies and knowledge for the bio-based oriented chemical engineer are. Students work on cases derived from the projects. The research results increase the knowledge we can teach. Representatives of the various project partners, from industry and research institutes, contribute with lectures based on practice information. In this manner it is possible to develop curricula that are useful for industry and society as a whole and at the same time attractive for the much needed new students.

*Keywords: C*hemical engineering; biobased economy; biobased education

1. Introduction

1.1. A changing economy

Bio-based economy concerns the transition from production of materials, chemicals and energy based on fossil oil and gas towards one that is based on renewable biological resources. Factors as climate change, dependence on politically unstable regions, and strong price fluctuations of fossil fuels are the driving forces for this. According to the Dutch Green Raw Materials Platform [1], in 2030 30% of the Dutch raw materials and energy needs can and should be supplied by biomass.

The bio-based economy is beneficial for both the agro-food sector and the chemical industry because it leads to new products and markets at the one hand and offers profitable uses for biomass waste streams at the other. Additionally, the transition to a bio-based economy is driven by their need to come to a more sustainable way of production and green image. Examples of some bio-based processes and products are for instance: oil from pyrolysis of waste wood, chemical products from carbohydrates (C6 chemistry), biomass based polymers (e.g. poly-lactic-acid and cellulose derivates), and biogas production via fermentation of manure and green household waste.

People working in the companies that will make this transition will need a different training and knowledge than those which are presently working in the chemical industry. To some extent, that will also be the case for companies that supply for instance equipment, and industries further in the chain using the new products and materials. Engineers, operators and managers alike must understand the complexities and variability of biomass production, and yet can recognize and help advance promising new technologies utilizing biomass as feedstock. Besides, the new type of compounds, processes and equipment used and produced ask for people knowledgeable with these. Workforce development and creative linkages with new sources of human and technological capital are essential to the success of the