Sustainability Infusion Project

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Title of Module/Activity

Module 10: Sustainable Process Design

Course Name and Course Number

Chemical Engineering Process Design and Safety- CHME 453/853

Length of Module/Activity

Module 10 is integrated to my capstone design course of "Chemical Engineering Process Design and Safety." I will use Module 10 for about three to four weeks during spring semester in 2020. Module 10 emphasizes the methodology for assessment of sustainable process design and encourages the use of sustainability analysis within the 'feasibility assessment' of chemical engineering design projects.

Primary Learning Outcomes

At the completion of the Module, students will have:

1. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

2. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

3. an ability to communicate effectively with a range of audiences

Resilience and/or Sustainability Connections

Module 10 addresses:
1) System thinking competency in sustainability analysis,
2) Elements of sustainability,
3) Metrics/indicators of sustainability,
4) Cause-effect chains,
5) Feasibility analysis with sustainability metrics/indicators.

Module 10 activity undertakes sustainability analysis in chemical process designs. Module 10 emphasizes system thinking competency approach in sustainability analysis and estimation of sustainability metrics by using design tools. Model 10 teaches how to construct a multi-criteria decision matrix compromising of all economic, environmental and societal indicators toward comprehensive feasibility analysis of chemical process designs.

Identify One or More of the Key Sustainability Competencies Addressed

Module 10 emphasizes system thinking by analyzing the sustainability with respect to the design parameters, such as capacity, type of process, type of utilities, and type of materials and energy. Module 10 will teach how to estimate the sustainability metrics based on CO_2 equivalent emissions data source and ultimate fuel source. Based on how much renewable energy and material are used in the process, the students will be able to estimate material and energy intensity, emission impact, and toxic material release, as well as process safety. The students will be able to quantify the sustainability analysis and use these in their feasibility analyses.

Instructional Strategies

Students use a design & simulation package to design the process to understand material and energy balance, equipment list, and utilities necessary. Later the students perform economic analysis to determine fixed and operating costs, job creation, and profitability. Students analyze sustainability in their industrial scale chemical process design projects by estimating the metrics of sustainability to quantify the use of renewable material and energy, GHG emissions, global warming potential, and toxic emissions. Students prepare a multi-criteria decision matrix by combining economic analysis, sustainability analysis, as well as process & public safety to compare the feasibility of their projects with a base design.

Assessment Strategy:

Formative Assessment

- 'Documented Problem Solutions' in every class activity
- 'Documented Discussions' in every class activity

Summative Assessment

- Assessment of Final Design Project Posters by the Alumni during "Design Showcase' presentations
- 'Performance Indicators of Student Outcomes' based on student outputs by the Alumni
- 'Student-Self Assessment' of Performance Indicators of Student Outcomes