THE APPLICATION OF INTEGRATED SUSTAINABILITY TOOL FOR PRODCUTION OF CYCLOHEXANONE

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INTRODUCTION

The sustainability problem for reactor systems which is consists of simultaneous calculation of the three sustainability index (one-dimensional index, two-dimensional index, three-dimensional index) in one single analysis and is shown in Figure 1. 1D sustainability analysis is developed according to Shadiya and High (2012), in which a one by one index is calculated for all three indicators. The environmental indicator is divided into two different indexes, which are environmental metric and resource usage metric. Economic indicator is evaluated by using a set of metrics for the cost effectiveness. Whereas, the social indicator is measured by using total inherent safety index and also health risk. Then, for 2D sustainability analysis is developed by referring to Ulhman and Sailing (2010), in which a 2D sustainability indicator is introduced by simultaneous assessment of two criteria out of three. The categories involved are economic-environmental, socioeconomic and socio-environmental which are expressed in term of mass, water and energy intensity index. Furthermore, 3D sustainability analysis is based on Martins et. al. (2007). Here, the indexes used are energy intensity, material intensity, potential chemical risk and potential environmental impact. In this case, those four indexes are located inside a 3D index that complies all aspects in sustainability.

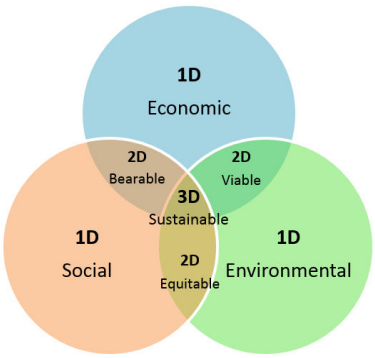

Figure 1. Venn diagram of sustainability criteria.

This paper is used to shown the application of the developed tool in assessing the simultaneous assessment of sustainability index (1-D, 2-D, and 3-D) of reactor systems.

The tools have been developed by (Nordin et. al, 2014) and the developed sustainability calculator is been tested by the production of cyclohexanone in continuous-stirred tank reactor (CSTR).
The framework of the developed integrated sustainability tool consists of four parts: introduction, components selection, data input and analysis. The objective of the first part is to introduce the user to the process on the reactor systems. Then, the users have to select components which are involved in the process in the second part. Next, in the third part the users need to key in the necessary data, such as feed and product flowrates and composition, energy, and others required data. Lastly, is the analysis part which objective is to analyze and display the calculated values.

MAIN RESULTS

The production of cyclohexanone has been used in the application for this developed tool. All the data needed is being key-in into the integrated tool and then, in one single analysis, all the required index has been calculated simultaneously in an easy, systematic and efficient way. All the sustainability index value is shown in Table 1.

Table 1. Simultaneous sustainability index get from the analysis by using Sustainability Calculator.

		Full Index	Scale Index	Index
1D	Social Index	26105.1227	0.0148	0.3385
	Economic Index	1768863.8503	1.0000	
	Environmental Index	1160.3613	0.0007	
2D	Mass Intensity Index	0.1700	1.0000	0.4029
	Water Intensity Index	0.0338	0.1988	
	Energy Intensity Index	0.0017	0.0100	
3D	Potential Environmental Impact	0.5913	0.0103	0.2577
	Potential Chemical Impact	57.4522	1.0000	
	Material Intensity	1.1700	0.0204	
	Non Renewable Energy Intensity	0.0017	0.0000	

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