Book of Abstracts
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Sustainability Integration in Chemical Process Engineering

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1. Summary

The global nature of the Environment demands global environmental thinking but many decisions are taken at a local scale combining in different ways economic, social and environmental issues. Integration of Sustainability criteria in Chemical Process Engineering is an emerging task, which needs to be based on: (a) Sustainability Metrics, and (b) Previous Lessons from Case Studies in order to develop a suitable methodology to be applied for an operating unit, which can correspond to a functional unit in a process plant, a process plant (or a group) , the supply chain (or a part) or other process system . The Aluminium Fluoride Manufacture has been taken as a Case Study, in order to describe the identification of the operating unit and the selection of indicators and weight factors for the objective functions.

Keywords: Sustainability, Life Cycle Assessment, Environmental Management

2. Extended Abstract

The world economy globalizes as national economies integrate into the international economy through trade, foreign direct investment, short term capital flows; international movement of workers and people in general and flows of technology.
As economies open up, more people become involved in the processes of knowledge integration and the deepening of non-market connections, including flows of information, culture, ideology and technology.
The global nature of the environment demands global environmental management and designing more sustainable processes and products is one of the key challenges, for a sustainable development of the chemical process industry. This is not a trivial task as it requires translating the principles of sustainable development into processes and products. Taking into account the long-term constraints imposed by the finite carrying capacity of the Earth is the main challenge
At present, there is not any established methodology to guide sustainable chemical process engineering and almost no practical experience. The management of complex systems involving material and energy flows will be essential and system-based tools for environmental management based on chemical engineering principles are common.

In an attempt to contribute to this emerging area, new methodologies for integrating sustainability considerations into chemical process engineering are necessary. Two main guidelines have to be considered:

(1) Life Cycle Thinking, this methodology guides the chemical engineer through different stages to enable integration of technical, economic, environmental and social criteria. The objectives seem to be how to assess the level of sustainability and how to use the obtained information to make the company, chemical processes and products more sustainable.

(2) The sustainability metrics. Many frameworks of sustainability assessment that focus on the performance of companies, processes and/or products have been suggested by now. They propose an evaluation based on numerous sustainability, indicators, which are generally measured in very different units.

The keynote presents a sustainability analysis based on Life Cycle Thinking and the Metrics and Harmonization of the different sub-systems taking part in the chain supply.

Chemical Process Engineering has undertaken significant progress over the last twenty years in order to improve the efficiency of production and in the last ten years in order to introduce the environmental performance but, sustainability needs to examine and improve other aspects, which have not received much attention in the past: (a) global environmental responsibility, (b) a broader scope of economic return, considering wealth creation and, (c) social development.

It can be translated to the technical language in the way from one dimension optimization problems based only on the benefit for investors to "at least" a thee dimensions optimization problem based on an objective function which should be able to weight the three components of sustainable development.

In order to apply the Life Cycle Thinking the first important technical question to be clarified is the identification of the OPERATING UNIT. Three main scales are identified for the operating unit: (1) The operation unit scale, which corresponds to the equipment and facilities units where physico-chemical changes take place, (2) The Process Plant (or plants), which combine unit operations and reactors in order to achieve the transformation from raw materials to final products and, (3) The Supply Chain, which considers all the steps from the raw materials supply to the final destination of the products in the Environment.

The second important question to be answered is the selection and harmonization of the environmental, economic and social indicators to be used in the operating unit and the weight factors to be applied in the definition of the objective function to be optimized. Three different scenarios can be envisaged corresponding to the maximum and minimum values of the weight factors. A GREEN scenario, where the weight factor for the environmental indicators is 1, being 0 and 0 the weight factors for the economic and social aspects a RED scenario where the social aspects are of main concern and a BLACK scenario taking only economic aspects.

An analysis of sensitivity using different weight factors is recommended in order to achieve the best results.

A sustainability analysis of the operating units related to the chemical, aluminium fluoride will be developed as case study showing the application of the two main steps:

(1) Identification of the operating unit.

(2) Selection and application of indicators and weight factors in an objective function.

Results will be discussed to integrate sustainability in Chemical Process Engineering.

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