



# DESIGN FOR ENVIRONMENTAL EXCELLENCE: A HYBRID REVERSE OSMOSIS

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## ABSTRACT

Design for Environment is an approach to design where most of the environmental impacts of a product are considered over the entire life cycle of a product. Aim of DfE is to address environmental impacts at all stages of the product life cycle by developing a methodology to analyze, design and develop a product with low environmental impact during its cradle-grave life cycle processes. To support this a review was carried out as the first step to achieve this aim. A problem of Reverse Osmosis was considered and analyzed using a complete life cycle assessment tool called GaBi-ts. The life cycle assessment for the water treatment process using RO was modelled.

**Keywords**— Design for Environment (DfE), Life Cycle Assessment (LCA), GaBi, Sustainability, Reverse Osmosis(RO)

## I. INTRODUCTION

Design for Environment (DfE) is an approach to design where most of the environmental impacts of a product are considered over the entire life cycle of a product. Design for environment (DfE) is originally coined by the United States Environmental Protection Agency (EPA) in 1992. Current product design is leaned towards ensuring consistent performance life cycle of the product. Aim of DfE is to address environmental impacts at all the stages of the product life cycle. The ratio of product mass to waste mass, directly or indirectly produced as a result of the product during its life cycle is about one to twenty. There are many tools to support DfE. Most DfE tools are conceptual in nature, and there is little adoption of this in industry [1] due to: Organizational inertia, corporate organization, Markets for recycled materials, Limited database, Resource limitation, Government regulations etc. Products make a substantial impact on environment. It is characteristic of the human nature to develop tools that help carry out daily activities in an easier and optimal way. It began with the invention of the wheel, and continues with the aid of computers [2]. Aim of DfE is to develop a methodology to analyze, design and to develop a product with low environmental impact during its 'Cradle-Grave' life cycle processes. In this study, a reverse osmosis process of treatment of water is considered. GaBi-ts, a complete lifecycle assessment tool was used for the study of the RO process and improving the

## II. Methodology

### A. Objectives of the project

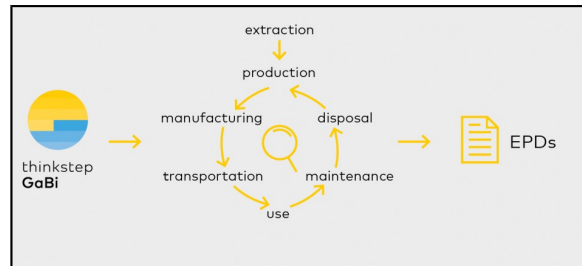
To improve the environmental friendliness of Reverse Osmosis process in terms of reduction in RO rejects along with removal of iron with respect to water or any wastewater.

### B. GaBi- think step: A complete lifecycle assessment module

GaBi-ts – Complete Life cycle assessment software used to measure the environmental impacts due to the materials used in the production. Complete inputs for a product to be manufactured from its material extraction to the end of life.

The GaBi think step is a complete lifecycle assessment module which helps us to evaluate our product at every step throughout its lifecycle phases. The GaBi-ts requires you to give the inputs like the material required, wastage every step, energy consumption etc., and outputs like expected emissions or wastage at every stage of

the lifecycle phase. Once the flows are connected, the balances give you the environmental impacts caused due to the product.



**Figure 1: Use of GaBi in the workflow**

GaBi is the next generation product sustainability solution with a powerful Life Cycle Assessment engine to support the following business applications:

- Life Cycle Assessment : Design for Environment, Eco-efficiency, Eco-design, Efficient value chains
- Life Cycle Costing: Cost reduction
- Life Cycle Reporting: Sustainable Product Marketing, Sustainability Reporting, LCA knowledge sharing
- Life Cycle Working Environment: Responsible manufacturing



**Figure 2: Advantages of using GaBi**

### III. RESULTS AND DISCUSSION

GaBi-ts was used to determine the life cycle assessment of the RO process. Initially the basic RO process was modelled by providing the inputs like the average amount of plastic used in the unit, the type of membrane material used, water input, electricity input and the treated water as output.

Inputs like plastic usage, membrane material, quantity of water used, electricity used were given in the flowchart. Expected output of the process were suggestion on reuse of plastic, amount of treated water and also the environmental impacts due to the different materials used, water wastage and electricity usage.

The flowchart for the water treatment using reverse osmosis, was modelled as shown in the figure

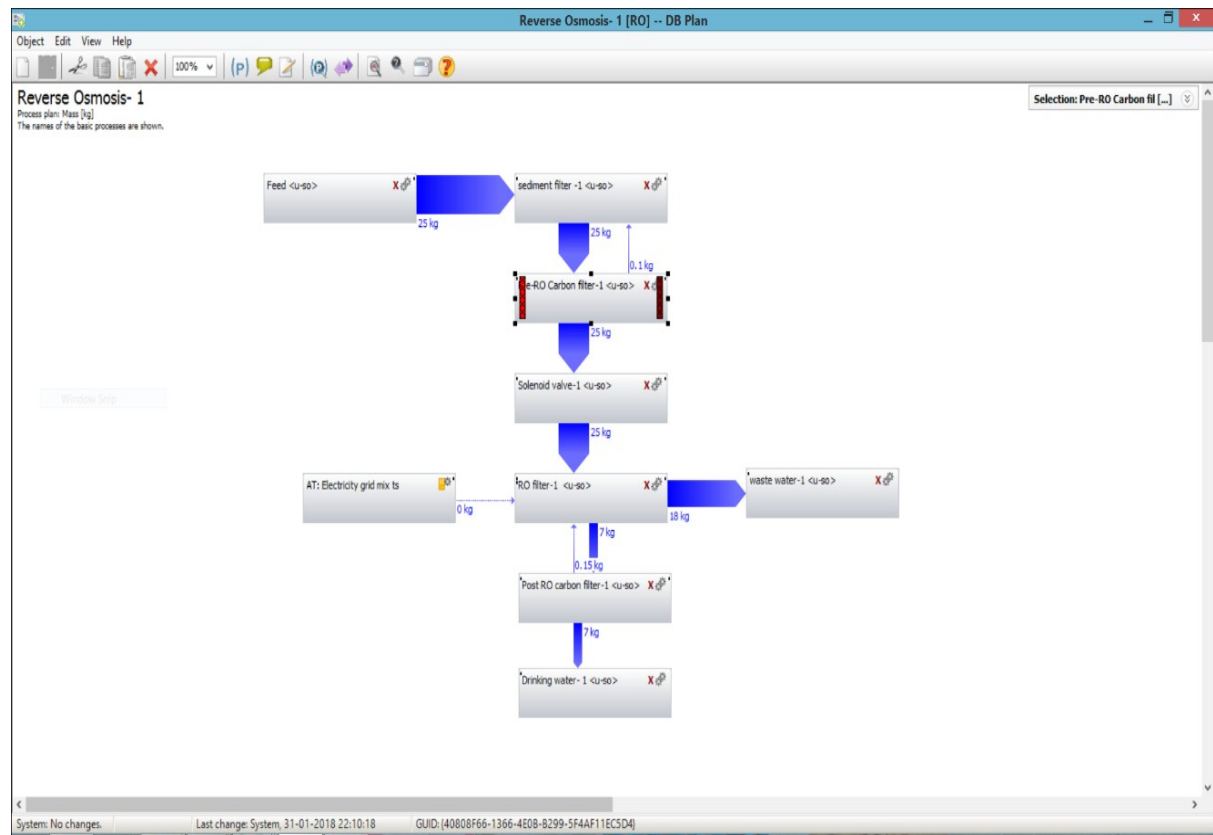


Figure 3: Flowchart of RO process in GaBi

#### IV. CONCLUSION AND WAY FORWARD

The results obtained from GaBi assessment were very minimal. Results for only electricity consumption were shown which was not as per our expectations. The results did not show the impact due to the materials used in the RO unit. The GaBi lifecycle assessment is suitable for the product lifecycle assessment but not for the process lifecycle assessment. The study was a failure when RO process was considered.

The future scope of the work is to study the working of different RO units for pre summer, summer and post summer seasons. The study of quality and quantity of the treated and reject water for the different RO units should be carried out for better understanding of the process. An attempt to retreat the reject water will be done in terms of increasing the efficiency of the RO unit.

#### REFERENCES

- [1] Srinivas Kota and Amaresh Chakerabarti, *ACLODS- A holistic framework for environmentally friendly product lifecycle design*, CIRP Design Conference, 2009
- [2] Dr. Bert Bras, *Incorporating environmental issues in product design and realization*, Industry and Environment, Special issue on product design and the environment, United Nations Environment Programme Industry and Environment (UNEP/IE), Vol. 20, No. 1-2 (double issue), 1997 Invited contribution.
- [3] Fabrice Mathieus et al., *Connecting CAD and PLM systems with ecodesign software: Current experiences and future opportunities*, International Conference on Engineering Design, ICED'07, Paris, France
- [4] Arun Subramani, Joseph G Jacangelo (2014), *Treatment technologies for reverse osmosis concentrate volume minimization: A review, Separation and Purification Technology*, 472–489.
- [5] Balasubramanian. P, Centre for Energy & Environmental Science and Technology, Tiruchirappalli (2013), *A brief review on best available technologies for reject water (brine) management in industries*, International journal of environmental sciences Volume 3, No 6.
- [6] GaBi-ts- <http://www.gabi-software.com/international/index/>