Life Cycle Assessment for the Activated Carbon Production by Coconut Shells and Palm-Oil Shells

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Abstract

Activated carbon, also called activated charcoal or activated coal is a form of carbon that has been processed to make it extremely porous and thus to have a very large surface area available for adsorption or chemical reactions. In this research studies environmental impacts of activated carbon production processes which produced from two types of agricultural by-products namely : coconut shells and palm-oil shells . SimaPro software is applied to evaluate the environmental impacts of both processes. The results have shown that the environmental impacts for the process using coconut shells as raw material is higher than that using palm –oil shells as raw material.

Key words: coconut shells , palm-oil shells , activated carbon

1. Introduction

Activated carbon, also called activated charcoal or activated coal is a form of carbon that has been processed to make it extremely porous and thus to have a very large surface area available for adsorption or chemical reactions. Activated carbon has the ability to adsorb various substances both from the gas and liquid phases. It is widely used for adsorption of pollutants from gaseous and liquid steams, for recovery of solvent and as a catalyst or catalyst support. In the nuclear industry, activated carbon is used for adsorption of iodine and noble gases from gaseous effluent. To obtain these activated carbons from cheap and readily available precursors become an interesting objective[1].

The world demand for activated carbon in the year 2005 is 970,000 tons which can be divided for each region as follows: 52% in Asia/Pacific, 26% in North America, 13% in Western Europe and 9% for other regions. It is forecast to expand around 5% per year through 2009 to over 1.2 million tons in 2010 (Freedonia Group, 2006)[2]. The principal properties of manufactured activated carbons depend on the type and properties of the raw material used. Any cheap substance with a high carbon and low content can be used as raw material for the production of activated carbon[3]. Coal , coconut shell , palm-oil shell , corn-cob and wood have been the most frequently used precursors to manufacture activated carbon[4].

A life cycle assessment (LCA, also known as life cycle analysis, ecobalance, and cradle-to-grave analysis) is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence. The goal of LCA is to compare the full range of environmental and social damages assignable to products and services, to be able to choose the least burdensome one[5]. This work, Life Cycle software is SimaPro 7.1.

2. Materials and Methods

The activated carbon production processes using coconut shells and palm-oil shells as raw material are studied.. Mass balances of each process are derived and simulation has been carried out to obtain data used in the SimaPro software. SimaPro software is applied to evaluate the environmental impacts of both processes.

Table 1 The input and output of the activated carbon production processes from coconut shells.

Input	**Amount(kg)**
Coconut shells	1000.0
Oxygen	12.8
Water	120.0
Output	**Amount(kg)**
Carbondioxide	525.6
Carbonmonoxide	240.9
Methane	204.9
Hydrogen	38.6
Nitric oxide	30.0
Sulfer dioxide	12.8
Activated carbon	80.0

Table 2 The input and output of the activated carbon production processes from palm-oil shells.

Input	**Amount(kg)**
palm-oil shells	1000.00
Oxygen	6.7
Water	163.5
Output	**Amount(kg)**
Carbondioxide	566.8
Carbonmonoxide	233.5
Methane	184.4
Hydrogen	41.0
Nitric oxide	37.5
Activated carbon	109.0

3. Results and discussion

The environmental impacts for activatedcarbon production process from coconut shells and palm-oil shells are shown in Table3, Fig.1 , Table4 and Fig.2, respectively.

Table 3. Environmental impacts of the activated production from coconut shells

Impact category	Total	Activated Carbon	O_2	water
Total	1.63	1.63	0.00197	3.97E-5
Resp.organics	8.55E-4	8.54E-4	7.99E-7	2.07E-8
Ozone layer	5.75E-7	0	5.4E-7	3.55E-8
Minerals	1.02E-5	0	1.00E-5	1.79E-7
Radiation	4.03E-5	0	3.96E-5	6.33E -7
Ecotoxicity	3.99E-5	0	3.89E-5	1.03E-6
Acidification/ Eutrophication	0.18	0.18	5.64E-5	1.15E-6
Carcinogens	7.26E-5	0	7.10E-5	1.55E-6
Land use	1.53E-4	0	1.50E-4	2.73E-6
Climate change	0.355	0.355	2.58E-4	4.62E-6
Resp.inorganics	1.09	1.09	6.73E-4	1.30E-5
Fossil fuels	6.91E-4	0	6.76E-4	1.48E-5

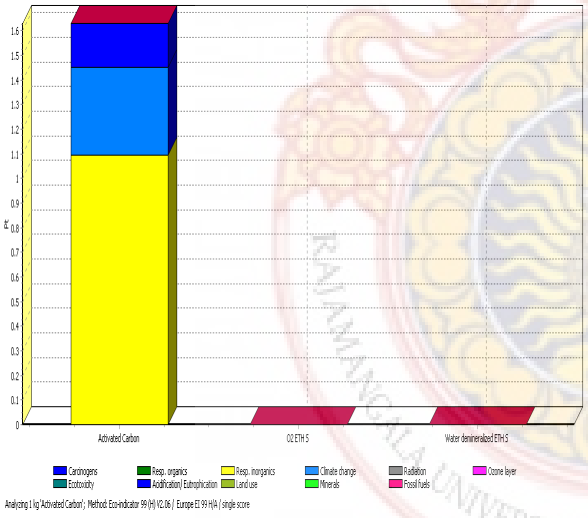

Fig. 1 Environmental impacts of the activated carbon production process of coconut shells.

Table 4. Environmental impacts of the activate production from palm-oil shells

Impact category	Total	Activated Carbon	water	O_2
Total	1.19	1.19	3.97E-5	7.59E-4
Carcinogens	2.88E-5	0.00	1.55E-6	2.73E-5
Resp.organics	5.58E-4	5.58E-4	2.07E-8	3.07E-7
Resp.inorganics	0.795	0.795	1.30E-5	2.59E-4
Climate change	0.238	0.238	4.62E-6	9.93E -5
Radiation	1.59E-5	0.00	6.33E-7	1.52E-5
Ozone layer	2.43E-7	0.00	3.55E-8	2.07E-7
Ecotoxicity	1.60E-5	0.00	1.03E-6	1.50E-5
Acidification/ Eutrophication	0.153	0.153	1.15E-6	2.17E-5
Climate change	0.355	0.355	2.58E-4	4.62E-6
Land use	6.04E-5	0.00	2.73E-6	5.77E-5
Fossil fuels	2.75E-4	0.00	1.48E-5	2.60E-4
Minerals	4.03E-6	0.00	1.79E-7	3.85E-6

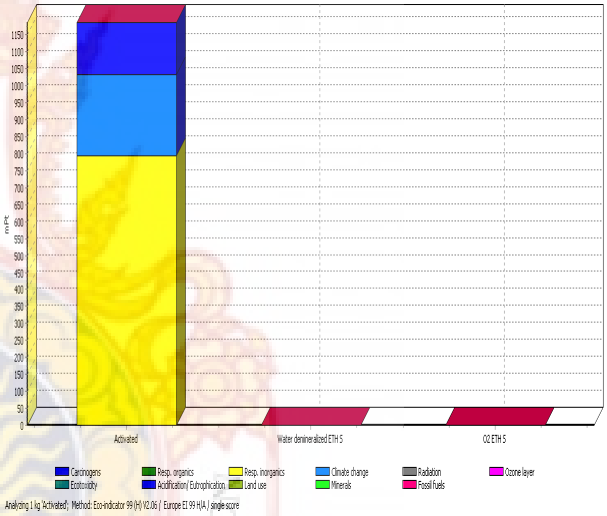

Fig. 2 Environmental impacts of the activated carbon production process of palm-oil shells.

4. Conclusions

The environmental impact of activated carbon production processes are studied. It was found that the environmental impact of the activated carbon production process using coconut shells as raw material is higher than that using palm-oil shells as raw material ; the main cause are respiratory inorganics , climate change , acidification/eutrophication and fossil fuels.

In this research, benefits of the life cycle assessment are strategy for improving the activated carbon production process as well as decreasing the environmental impacts corresponding to the production.

5. References

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