LIFE CYCLE ASSESSMENT COMPARISON BETWEEN PEPFACTANT® AND CHEMICAL SURFACTANT PRODUCTION

MASTER THESIS

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April 2008

Declaration

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04/2008

Acknowledgements

During this 18-month research study period, I have obtained the support and assistance from many people. Firstly, I would like to express the sincerest appreciation to my supervisors, Dr. David Lewis, Prof. Anton Middelberg and Dr. Peter Ashman, for offering me academic supervision, technical assistance, financial support and enthusiastic encouragement. My principal supervisor Dr. David Lewis has spent much time on reviewing my thesis and helping me correcting my English writing as English is not my first language. My external co-supervisor Prof. Anton Middelberg has provided me with collaborative support within his research team, at the Australian Institute for Bioengineering and Nanotechnology, University of Queensland.

The other people I also would like to thank are the research team of Prof. Anton Middelberg, in particular Dr. Robert Falconer. He has supplied me the most important technical information for this project and assisted me in solving the technical problems for this study. Without his help, this project wouldn't be completed as what it is like today. Additionally, Dr. Annett Dexter, Mr. Andrew Malcolm, Ms. Belinda Hartmann and Miss Mirjana Dimitrijev have given me valuable suggestions relating to the research methods and have facilitated the completion of experimental activities.

Last but not least, I will forever be grateful to my parents who support me both financially and mentally to complete this study and pursue a Masters Degree from overseas.

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Abstract

Recently designed Pepfactants® are an innovative type of nano-technological products, which could potentially replace conventional surfactants in broad-ranging applications. Currently, Pepfactants® technology is still in an initial design period at the laboratory scale. In order to develop the industrial-scale production of Pepfactants®, the design group has proposed simulated strategies for industrial-scale Pepfactants® manufacture and a desire to improve these strategies with regards to sustainability.

This project aimed to assist Pepfactants® designers to understand the environmental footprint of simulated Pepfactant® AM1 manufacturing process, using the methodology of Life Cycle Assessment (LCA) – a comprehensive tool to quantify the environmental impacts from products and processes. To find the environmental shortcomings of the proposed manufacturing process for Pepfactant® AM1, the LCA outcomes were compared with published life cycle information of traditional chemical surfactant Lineal Alkylbenzene Sulphonate (LAS) production. Following LCA methodology, a life cycle inventory was compiled based on the simulated AM1 manufacture, which determined the environmental impact assessment for both AM1 and LAS production. In the LCA boundaries disregarding the usage of both surfactants, the quantitative LCA comparison results indicated that raw material and energy requirements of AM1 manufacture were much higher than LAS production, estimated to be 3,186 t/t AM1 against 31.1t/t LAS and 1,564,000MJ/t AM1 against 69,870MJ/t LAS respectively. Additionally, compared with LAS production, enormous water consumption (2,651 t/t AM1) and CO_2 emission (522 t/t AM1) were also shown to be severe environmental problems for AM1 manufacture. Furthermore, the AM1 manufacture presents apparent problems with environmental impacts of nutrification, human toxicity, photochemical oxidant formation and acidification in comparison with LAS production.

Other than providing the optimisation point in the view of environmental impacts for Pepfactant® AM1 manufacture, the results of experimental work in this project

showed that as the surfactant concentration increases a greater foam height of Pepfactant® AM1 was achieved than when (from 7mm to 52mm between 15μM and 100μM) compared with LAS (from 8mm to 53mm between 31.3μM and 2,000μM) in the same aeration duration. This result demonstrated the great potential of AM1 to replace LAS based on the LCA functional unit – 1 tonne of products. The experiments results implied that 1 tonne of AM1 is able to have the same foaming ability as approximate 25 tonnes of LAS. Consequently, the environmental impacts from Pepfactant® AM1 manufacture are reduced by 25 times in the extended LCA boundaries linked to the quantitative usage comparison of these two surfactants.