LIFE CYCLE ASSESSMENT OF AN ELECTROLESS NICKEL PLATING WASTEWATER TREATMENT PLANT

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May Allah give you the best reward and may the blessings of Allah be upon you.

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ABSTRACT

Electroless nickel plating industry has been a well-known industry compared to other types of electroplating industry. This method of coating practice yields better coating properties. Life Cycle Assessment (LCA) is being proposed to assess and quantify the environmental impacts of the treatment processes which include physical, chemical and biological treatments to identify the hotspot (weak point) in the treatment processes. The methodology of this study followed the basis of International Organization for Standardization (ISO) 14040 - series framework. Life Cycle Inventory (LCI) table was completed by data collection from a plant and added with chemical analysis. The assessment was conducted using GaBi software and Life Cycle Impact Assessment (LCIA) method is referred to ReCiPe method (RIVM, Radboud University, CML and Pré Consultants). Both problem-oriented and damage-oriented methods were assessed and chemical treatment process showed higher impacts in important categories like climate change, acidification and human toxicity. This caused the process to be the hotspot in this wastewater treatment plant. The results for problem-oriented are 1553 kg CO_2 equivalent, 5.8 kg SO_2 equivalent, and 5.4 kg 1,4 dichlorobenzene (1,4-DB) equivalent respectively and results for damage-oriented are 2.17 x 10^{-3} DALY (Disability Adjusted Life Years), 3.36 x 10^{-8} species.yr and 3.80 x 10^{-6} DALY respectively when compared to the other treatment processes. This was due to the usage of chemicals in the chemical treatment which is significantly higher than in other processes. Hence, two different scenarios were suggested and assessed in order to reduce the environmental impacts of this conventional wastewater treatment. The scenarios include using the chitosan in chemical treatment process and replacing the chemical treatment process with wet air oxidation process. Both processes showed less environmental impacts than the conventional chemical treatment process in the wastewater treatment plant.

ABSTRAK

Industri penyaduran nikel secara tanpa elektrik merupakan industri yang terkenal berbanding industri penyaduran elektrik yang lain. Kaedah penyaduran ini menghasilkan ciri-ciri saduran yang lebih bagus. Penilaian Kitar Hayat (LCA) dicadangkan untuk menilai dan mengukur kuantiti impak alam sekitar kepada proses rawatan termasuklah rawatan fizikal, kimia dan biologi untuk mengenalpasti titik panas (titik lemah) dalam proses rawatan. Cara kerja untuk kajian ini mengikuti asas Organisasi Antarabangsa untuk Piawaian (ISO) 14040 – rangka siri. Jadual Inventori Kitar Hayat (LCI) dilengkapkan dengan pengumpulan data daripada loji dan ditambah dengan analisis kimia. Penilaian ini dijalankan menggunakan perisian GaBi dan kaedah Penilaian Impak Kitar Hayat merujuk kaedah ReCiPe (RIVM, Universiti Radboud, CML dan Perunding Pré). Kedua-dua kaedah orientasi-masalah dan orientasi-kerosakan dinilai dan didapati proses rawatan kimia menunjukkan impak yang paling tinggi dalam kategori yang penting seperti perubahan iklim, keasidan dan ketoksikan manusia. Ini menyebabkan proses rawatan tersebut merupakan titik panas dalam loji rawatan air sisa ini. Keputusan untuk orientasi-masalah masing-masing adalah 1553 kg CO_2 setara, 5.8 kg SO_2 setara, dan 5.4 kg 1,4 diklorobenzena (1,4-DB) setara dan keputusan untuk orientasi-kerosakan masing-masing adalah 2.17 x 10^{-3} DALY (kecacatan terlaras tahun hayat), 3.36 x 10^{-8} spesies.tahun dan 3.80 x 10^{-6} DALY bila dibandingkan dengan proses rawatan yang lain. Ini disebabkan oleh penggunaan bahan kimia dalam proses rawatan kimia yang mana lebih tinggi dengan ketaranya berbanding proses yang lain. Oleh itu, dua senario yang berbeza dicadangkan dan dinilai untuk mengurangkan impak alam sekitar dari rawatan air sisa lazim ini. Senario-senario tersebut termasuklah menggunakan kitosan dalam proses rawatan kimia dan menggantikan proses rawatan kimia dengan proses pengoksidaan udara basah. Kedua-dua proses menunjukkan impak alam sekitar yang kurang berbanding proses rawatan kimia lazim dalam loji rawatan air sisa.