Classification of Nature-Inspired Inventive Principles for Eco-innovation and their Assignment to Environmental Problems in Chemical Industry

Mas'udah[1][0000-0003-4335-7715], Pavel Livotov[2][0000-0001-8784-1117], Sandra Santosa[1], Akhmad Suryadi[1]

[1] Politeknik Negeri Malang, Jl. Soekarno Hatta No. 9, 65141 Malang, Indonesia
[2] Offenburg University of Applied Sciences, Badstr. 24, 77652 Offenburg, Germany
masudah@polinema.ac.id

Abstract. Eco-innovations in chemical processes should be designed to use raw materials, energy and water as efficiently and economically as possible to avoid the generation of hazardous waste and to conserve raw material reserves. Applying inventive principles identified in natural systems to chemical process design can help avoid secondary problems. However, the selection of nature-inspired principles to improve technological or environmental problems is very time-consuming. In addition, it is necessary to match the strongest principles with the problems to be solved. Therefore, the research paper proposes a classification and assignment of nature-inspired inventive principles to eco-parameters, eco-engineering contradictions and eco-innovation domains, taking into account environmental, technological and economic requirements. This classification will help to identify suitable principles quickly and also to realize rapid innovation. In addition, to validate the proposed classification approach, the study is illustrated with the application of nature-inspired invention principles for the development of a sustainable process design for the extraction of high-purity silicon dioxide from pyrophyllite ores. Finally, the paper defines a future research agenda in the field of nature-inspired eco-engineering in the context of AI-assisted invention and innovation.

Keywords: Eco-inventive Principles, Eco-innovation, Chemical Engineering, Process Design, AI-Aided Innovation.