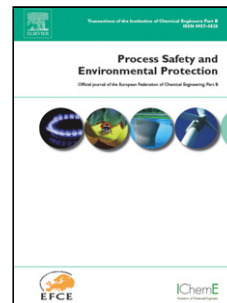


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Optimal selection of Iron and Steel wastewater treatment technology using integrated multi-criteria decision-making techniques and fuzzy logic

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Abstract

Selecting the optimal wastewater treatment technology (WTT) is one of the biggest challenges in the sustainable management of industrial wastewaters. In Iran's economy, the strategic role of the steel sector highlights its importance in sustainability assessments. Using Iran's steel industry as a case study, this paper develops an integrated methodology for determining the most appropriate WTT. Since, the most common approach for technology evaluation, in both developed and developing countries, is expert judgment, this issue is studied by means of a multi-dimensional approach that considers the sector characteristics; the interaction of the technical, environmental and economic aspects; and the specific preferences in developing countries. The proposed modelling framework presents a rational decision-making process based on two multi-criteria decision-making (MCDM) techniques including the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) in combination with fuzzy logic to make use of the combined benefits of several methods. The methodology is carried out as a stepwise procedure and the fuzzy concept is introduced in both the weighting and ranking procedures. The most commonly used industrial WTTs in the steel industry are identified and ranked with respect to the six evaluation criteria and their thirty associated indicators. Finally, the results from different models, with crisp and fuzzy values, are compared to propose a straightforward and pragmatic operational decision tool. The study indicates that a hybrid model of AHP, TOPSIS and Fuzzy logic offers better results and provides a higher degree of confidence for sophisticated judgments. According to the findings, the experts largely prefer the more advanced treatment systems, such as "electrolytic splitting with reverse osmosis and evaporation in addition to the conventional technologies" because of their high system efficiency and compatibility with environmental impact criteria. This approach can be applied for other sectors at any industry level of decision-making – from the level of individual plants to national.

Key words: Optimal technology; Wastewater treatment; Iron and Steel industry; AHP; TOPSIS; Fuzzy logic.

1. Introduction

The steel industry is a fundamental sector, and, hence, has a vital role in a country's industrial development. Furthermore, its production and consumption rate can be used as an index for measuring the level of development. It is the second biggest industry in the world after oil and gas with an estimated global turnover of 900 billion USD (World Steel Association, 2015). According to the latest figures released by the World Steel Association, Iran was the top steel producer in the Middle East in 2014. It was ranked 14th among the major steel producing countries and, also, as the second steel producer by Direct Reduction (DRI) in the world. About 20 years ago, the steel industry was limited to three or four big government plants. However, more recently, many small and medium sized plants have been established, and, nowadays, more than 130 plants with capacities from 30 thousand tons to several million tons are active throughout the country. It has been predicted that, during the next few years, Iran's ranking will rise to 11 or 12, and its annual steel production volume will reach 55 million tons. Regarding this increasing growth and

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