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ORIGINAL ARTICLE

Optimization of Industrial Wastewater Treatment Using Intuitionistic Fuzzy Goal Geometric Programming Problem



Payel Ghosh · T.K. Roy · Chanchal Majumder

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Abstract This paper describes a design of industrial wastewater treatment plant, operating on pulp and paper manufacturing waste. The main objective is to formulate cost effective biological treatment process on industrial wastewater. In terms of the percent of five-day bio-chemical oxygen demand removed, the required final effluent quality has been maximized. Also, the cost involved has been minimized in five-day bio-chemical oxygen demand removal. To optimize remaining five-day bio-chemical oxygen demand in wastewater spending minimum money, a goal geometric programming is used here. Moreover, goal geometric programming is described incorporating imprecision in it. A model of intuitionistic fuzzy goal geometric programming problem is given in this paper. We have solved intuitionistic fuzzy goal programming model using geometric programming technique. The algorithm of the approach is discussed in this paper. It is also shown that the usefulness of intuitive fuzzy environment in goal geometric programming is compared to fuzzy goal geometric programming

Payel Ghosh (✉)

Department of Mathematics, Adamas Institute of Technology, North 24-Parganas-700126, West Bengal, India

email: ghoshpayel.math@gmail.com

T.K. Roy (✉)

Department of Mathematics, Indian Institute of Engineering Science and Technology, Shibpur, Howrah-711103, West Bengal, India

email: roy_t.k@yahoo.co.in

Chanchal Majumder

Department of Civil Engineering, Indian Institute of Engineering Science and Technology, Shibpur, Howrah-711103, West Bengal, India

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using a numerical example.

Keywords Goal programming · Geometric programming · Intuitionistic fuzzy optimization · Wastewater treatment

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1. Introduction

Nowadays environmental pollution is a headache to scientists, engineers, environmentalists, stake holders as it interferes with our daily lives as well as our health, directly or indirectly. Water pollution takes one of the biggest roles among them. In the activities of water pollution control, optimization of wastewater treatment process has become an important topic for industrial manufacturer as it involves huge amounts of investment.

Goal programming is very commonly used tool for solving multi-objective programming problem. But goal geometric programming is new in this sector. We use this method in solving a non-linear goal programming problem. This method gives better results than the other non-linear programming method, which is already described in Ghosh, Roy [1, 2]. The algorithm of intuitionistic fuzzy goal geometric programming problem is described here. In this paper, we have described this algorithm on a numerical example. Later it is applied in fuzzy environment considering some condition. Further designing of industrial wastewater treatment process is considered as real life application to show the efficiency of intuitionistic fuzzy goal geometric programming problem.

Here, we have worked on a serial multi-stage treatment plant of industrial waste treatment operating on pulp and paper manufacturing waste. Earlier Shih and Krishnan [3], Evenson [4] discussed the same matter. They both used dynamic programming to find the optimum combination and efficiencies of processes at the minimum total annual cost. Later Ecker, McNamara [5] and Brightler, Philips [6] used geometric programming in one of the designs of industrial wastes treatment plant. Cao [7] discussed fuzzy geometric programming on the same problem. We have presented a new approach intuitionistic fuzzy goal geometric programming problem based on weighted sum method on the same problem. It is also shown here that the proposed approach can remove more five-day bio-chemical oxygen demand from the waste water than other approaches [8] of intuitionistic fuzzy goal geometric programming problem.

2. Intuitionistic Fuzzy Goal Geometric Programming Problem

Intuitionistic fuzzy goal geometric programming problem is an extension of fuzzy goal geometric programming problem in which the degrees of rejection of objective(s) and constraints are considered together with the degrees of satisfaction. This paper describes fuzzy goal geometric programming problem with more generalization considering non-membership function along with membership function. An intuitionistic fuzzy goal programming model can be written as

$$\text{Find } X = (x_1, x_2, \dots, x_n)^T \quad (1)$$

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