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Reliability and efficiency of pollution removal during long-term operation of a one-stage constructed wetland system with horizontal flow

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ABSTRACT

The paper presents the results of a study of the reliability and efficiency of pollutant removal during long term operation of a one-stage constructed wetland system with horizontal flow. The flow rate of the wastewater treatment plant was $1.2 \text{ m}^3 \cdot \text{d}^{-1}$ during the research period. Physical and chemical analyses of raw wastewater and treated effluent were carried out in the years 1997–2010 (14 years). During this study period, 56 series of analyses were performed and 112 wastewater samples were collected. The average efficiencies of BOD₅ (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand) and TSS (Total Suspended Solids) removal in the investigated facility during the 14 years of its operation were respectively: 84.7%, 80.9%, and 62.4%. The average values of these parameters in the treated wastewater were significantly lower than the values deemed acceptable by relevant regulations in Poland. The reliabilities of the wastewater treatment plant, based on the Weibull reliability theory for acceptable values of pollution parameters in the effluent of the treatment plant, were as follows: BOD₅ – 92%, COD – 98%, TSS – 90%. The conducted analysis showed that the operational reliability of the one-stage horizontal subsurface flow constructed wetland (HSFCW) over the operation period was insufficient according to the Polish standards. Improvement of the reliability of the analyzed system by introduction of additional purification elements, such as irrigated biological beds or a constructed wetland with vertical wastewater flow, was recommended.

Keywords: reliability; pollution removal; wastewater treatment; constructed wetland; horizontal flow

1. Introduction

Constructed wetlands (CWs) have been used for wastewater treatment in Poland for over 25 years [1] and for more than 60 years worldwide [2, 3]. The first experiments on the viability of constructed wetland wastewater treatment systems were carried out in Germany in the second half of the 20th century by Seidel [4]. In her later works, Seidel [5] presented multi-stage wetland systems with vertical (VF-CWs) and horizontal flow (HF-CWs), in which she used filtering substrates of high hydraulic conductivities such as gravel, planted with

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