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# Measurement of Residence Time Distribution of Wastewater in a Constructed Wetland System Using Radiotracer Technique

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**1. Background of the study:**
Constructed Wetlands (CW) are human engineered systems that utilize natural process for treatment of wastewater. They have been highly applicable in developing countries, due to their characteristics like utilization of natural processes, simple construction, operation and maintenance, process stability, and cost effectiveness. The design of constructed wetland requires multidisciplinary inputs involving biological and ecological sciences, aquatic chemistry, engineering hydrology and flow hydrodynamics. The CW are heterogeneous in nature. Thus, they are prone to show deviation in the designed flow pattern and residence time for the treatment of wastewater. The aim of the present study is to measure mean residence time (MRT) and flow patterns of CWs using radiotracer technique.

**2. Methodology employed:**
The wetland is 13.0 m long, 3.0 m wide and 0.7 m deep. The geometric volume of the system is 27.3m3. The system walls and bottom were lined to prevent leakage. The wetland has slope of 1% at the bottom and an average porosity of 52%. About 100 MBq of of Tc-99m (Half life: 6.6 h, Gamma energy: 139 KeV) as sodium pertechnatate used in each run. The radiotracer concentration monitored at different planes across the width and outlet using NaI(Tl) scintillation detectors were connected to a computer controlled data acquisition system (DAS) was set to record tracer concentration at an interval of every one minute at outlet and across the bed of the system.

**3. Data analysis and Results**
The RTD data was treated and analyzed using a RTD analysis software. The data treatment includes background subtraction, tail correction, radioactive decay correction, zero shifting, smoothing and normalization. The data was used to calculate MRT, dead volume of system and hydraulic efficiency of the plant. A four-parameter model i.e. tank in series exchanging with dead volume model prefixed with plug flow component was used to simulate the RTD data.

**4. Conclusions:**
Radiotracer experiments were successfully conducted in an artificially constructed wetland system and mean residence times and dead volumes were determined at different operating conditions. No bypassing/short-circuiting was observed in the CW. The proposed four parameter model was found suitable to describe hydrodynamics of wastewater in the wetland. The hydrodynamic parameters were indicating that CW works efficiently at bed height=0.6m, wastewater flow rate=2.3 m3/s and two point distributor geometry. However, the results of the study also indicate that on increasing the no of injection points, the efficiency of the CW will increase.

## Country/Organization invited to participate

India

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