GUJARAT TECHNOLOGICAL UNIVERSITY
(Established Under Gujarat Act No.: 20 of 2007)
ગુજરાત ટેકનોલોજીકલ યુનિવર્સિટી
(ગુજરાત અધિનિયમ ક્રમાંક : ૨૦/૨૦૦૭ દ્વારા સ્થાપિત)

Abstract of Thesis

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Title of the Thesis: Mathematical Modelling of the Groundwater Pollution Through Porous Media

Abstract

The main objective of the thesis is to study and develop the mathematical modelling of groundwater pollution through porous media. It becomes critical to address groundwater pollution in water bodies. People have discovered many sources of water as civilization has advanced and their water consumption has risen gradually. The slope of a graph showing the pace of groundwater usage has changed drastically and dangerously in the previous century. Along the same lines, the second component of the focus is groundwater quality, which is distinct from groundwater quantity. The quality of the groundwater has declined as a result of numerous factors. To protect the water and stop the excessive degradation process, the field of basic science is currently seeking the attention of researchers, engineers and other intellectuals. One of the most efficient preventative measures for reducing groundwater pollution is having a thorough understanding of the process of groundwater pollution. The present research describes the contamination of groundwater. Through the present theoretical research work, an attempt is made to mathematically elaborate on all the physical processes required to explain groundwater pollution. Well-behaved models are developed by creating appropriate one- and two-dimensional linear partial differential equations that regulate the specific groundwater conditions. The research work includes examining the impacts of variation in flow velocity on pollutant dispersal in various mediums of an aquifer. The mathematical models are developed to investigate groundwater pollution in homogeneous and heterogeneous media. The movement and transformation of pollutants are modelled by factoring in the advection-dispersion

equation, groundwater flow velocity, dispersion coefficient, reaction rate and other factors. The models that have been developed offer helpful tools for understanding pollutant transport processes, identifying the impact of the nature of pollution sources, formulating remediation actions and assessing associated risks. The findings of this study are meant to help in making well-informed decisions to protect groundwater resources and ensure human and environmental health. The finding may make it feasible to help society receive clean water from groundwater for a prolonged period. The research that has been provided aims to present a solution for this by predicting the pollutant concentration in groundwater.

The broad scope of the current study makes it possible to develop experimental methodologies for prevention and control measures. Researchers studying the expansion of contamination of groundwater from sources like industry zones, waste dumping sites, etc. may use this work. The governing bodies to control pollution like Central and State Pollution Control Boards, Environment Management institutes, and Government and private agencies doing environmental audits can also include these predictive models for various purposes. This research work may help in making advance decisions about the locations for collecting groundwater samples, the time of year, and the season. The research study offers a thorough breakdown of the extremely intricate process of groundwater pollution in a variety of natural physical settings.

List of Publications

1. R. R. Malan and N. B. Desai, Contaminant transportation modelling with time-dependent dispersion, *Computational Methods for Differential Equations*, **11** (3), (2023), 605–614 (Web of Science Indexed).
2. R. R. Malan and N. B. Desai, Two-dimensional mathematical modelling with continuously dumped pollutants in aquifer, *Mathematics in Engineering, Science and Aerospace*, **14** (2), (2023), 527–551 (Scopus Indexed).
3. R. R. Malan and N. B. Desai, An analytic solution of the one-dimensional solute transport equation for uniform unsteady flow in a homogeneous medium, *Advances and Applications in Mathematical Sciences*, **22** (1), (2022), 25–42 (UGC Care listed).
4. R. R. Malan and N. B. Desai, *"Study of groundwater pollution: Non-uniform unsteady flow"*, Book chapter, MMSPS-2022, CRC press (In press).