TECHNICAL SCIENCE RESEARCH IN UZBEKISTAN
ISSN (E): 2992-9148 SJIF 2024 = 5.333
ResearchBib Impact Factor: 9.576 / 2024
VOLUME-2, ISSUE-6

UDC. 532

SOLVING RESEARCH PROBLEMS OF FLOWS IN CHANNELS USING NUMERICAL METHODS

Abdukhamidov Sardor
Institute of Mechanics and Seismic Stability of Structures of the Academy of Sciences of the Republic of Uzbekistan,
Chorshanbiyeva Lobar
Doctoral student of Tashkent State Technical University

ABSTRACT:

The study of fluid flow in channels is fundamental in various fields of engineering and environmental sciences. Traditional analytical methods often fall short in handling complex geometries and varying boundary conditions. Numerical methods have thus become indispensable in understanding and predicting fluid dynamics in channels. This paper explores the application of numerical methods in the study of flows in channels, focusing on the Finite Difference Method (FDM), Finite Element Method (FEM), and Computational Fluid Dynamics (CFD). Case studies and simulations are presented to illustrate the effectiveness of these methods in solving real-world problems.

Keywords: Numerical methods, fluid dynamics, channel flows, Finite Difference Method, Finite Element Method, Computational Fluid Dynamics, Flow.

РЕШЕНИЕ ЗАДАЧ ИССЛЕДОВАНИЯ ТЕЧЕНИЙ В КАНАЛАХ ЧИСЛЕННЫМИ МЕТОДАМИ

АБСТРАКТНЫЙ:

Исследование течения жидкости в каналах имеет фундаментальное значение в различных областях техники и наук об окружающей среде. Традиционные аналитические методы часто не справляются со сложной геометрией и различными граничными условиями. Таким образом, численные методы стали незаменимыми для понимания и прогнозирования динамики жидкости в каналах. В этой статье исследуется применение численных методов при исследовании потоков в каналах с упором на метод конечных разностей (FDM), метод конечных элементов (FEM) и вычислительную гидродинамику (CFD). Тематические исследования и моделирование представлены для иллюстрации эффективности этих методов в решении реальных проблем.

Ключевые слова: Численные методы, гидродинамика, русловые течения, метод конечных разностей, метод конечных элементов, вычислительная гидродинамика, поток.

INTRODUCTION

The behavior of fluid flow in channels is a critical area of research in hydrodynamics, environmental engineering, and other applied sciences. Understanding these flows is essential for the design and management of water resources, predicting natural phenomena, and optimizing industrial processes. Traditional analytical solutions to flow problems are limited to simple geometries and conditions. In contrast, numerical methods provide the flexibility to model complex systems and are increasingly used to simulate fluid flows in channels.

Numerical Methods Overview

Finite Difference Method (FDM)

The Finite Difference Method (FDM) is one of the simplest and oldest numerical techniques used for solving differential equations. It involves discretizing the domain into a grid and approximating the derivatives in the governing equations using difference equations. For fluid flow in channels, the Navier-Stokes equations, which describe the motion of fluid substances, can be discretized using FDM.

Implementation Steps:

1. Grid Generation: Divide the channel into a finite number of grid points.
2. Discretization: Approximate the derivatives in the Navier-Stokes equations using finite differences.
3. Solving the Equations: Use iterative solvers like Gauss-Seidel or Successive Over-Relaxation (SOR) to solve the resulting algebraic equations.

Finite Element Method (FEM)

The Finite Element Method (FEM) is a powerful numerical technique particularly suited for complex geometries and boundary conditions. It divides the domain into smaller sub-domains called elements and uses variational methods to derive a system of equations.

Implementation Steps:

1. Mesh Generation: Create a mesh of the channel, dividing it into finite elements.
2. Formulation: Derive the weak form of the governing equations (e.g., Navier-Stokes) and approximate the solution using shape functions.
3. Assembly and Solution: Assemble the global system of equations from the element equations and solve using numerical solvers.

ISSN (E): 2992-9148 SJIF 2024 = 5.333
ResearchBib Impact Factor: 9.576 / 2024
VOLUME-2, ISSUE-6

Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) encompasses a variety of numerical methods, including FDM and FEM, to solve fluid flow problems. CFD involves the simulation of fluid flow by solving the governing equations of fluid dynamics numerically.

Implementation Steps:

1. re-processing: Define the geometry, create a mesh, and specify boundary and initial conditions.
2. Solving: Use CFD software to solve the Navier-Stokes equations iteratively.
3. Post-processing: Analyze the results using visualization tools to interpret the flow characteristics.

Case Studies

Case Study 1: Laminar Flow in a Rectangular Channel

A rectangular channel with a simple laminar flow is modeled using FDM. The flow is governed by the steady-state Navier-Stokes equations. The velocity profile and pressure distribution are computed and compared with analytical solutions to validate the numerical method.

Case Study 2: Turbulent Flow in an Irregular Channel

A more complex case involving turbulent flow in an irregular channel is simulated using FEM. The k-ε turbulence model is employed to account for the turbulent effects. The results provide insights into the velocity distribution and turbulent kinetic energy across the channel.

Case Study 3: Sediment Transport in a River Channel

CFD is used to model sediment transport in a river channel, considering both the fluid flow and sediment dynamics. The interaction between the fluid and sediment phases is analyzed, and the results help in predicting sediment deposition patterns.

Results and Discussion

The numerical simulations provide detailed insights into the flow characteristics in various channel configurations. The accuracy and computational efficiency of FDM, FEM, and CFD are compared. The advantages and limitations of each method are discussed, highlighting their suitability for different types of flow problems.

CONCLUSION

Numerical methods have revolutionized the study of fluid flow in channels, providing robust tools to handle complex geometries and dynamic conditions. FDM,

ISSN (E): 2992-9148 SJIF 2024 = 5.333
ResearchBib Impact Factor: 9.576 / 2024
VOLUME-2, ISSUE-6

FEM, and CFD each offer unique advantages and are suitable for different types of flow analyses. Future research should focus on improving the accuracy and efficiency of these methods, as well as their application to more complex and coupled flow problems.

LIST OF REFERENCES:

1. Anderson J. D. (1995). Computational Fluid Dynamics: The Basics with Applications. McGraw-Hill.

2. Ferziger J. H., Perić, M. (2002). Computational Methods for Fluid Dynamics. Springer.

3. Patankar S. V. (1980). Numerical Heat Transfer and Fluid Flow. Hemisphere Publishing Corporation.

4. Versteeg H. K., Malalasekera, W. (2007). An Introduction to Computational Fluid Dynamics: The Finite Volume Method. Pearson Education.

5. Abduxamidov S. K., Omonov Z. J., Chorshanbiyeva L. T. issues of calculating the transverse force and bending moments for various types of fences imposed by external forces //Archive of Conferences. – 2021. – C. 63-66.

6. Abdukhamidov S. K. Using the finite element method to study flows in channels //Journal of Science-Innovative Research in Uzbekistan. – 2023. – T. 1. – №. 9. – C. 475-488.

7. Abduxamidov S. TWO-STEP IMPLICIT PISMAN-RICKFORD SCHEME FOR SOLVING THE LAPLACE EQUATION //Eurasian Journal of Mathematical Theory and Computer Sciences. – 2022. – T. 2. – №. 7. – C. 29-30.