

Studies in Newtonian Fluidic Configuration Involving Porous Medium

¹Shashi Kala Meena*, ²Babu Lal Chaudhary, ³Dr.Kishan Singh Shekhawat

¹Research Scholar, Pandit Deendayal Upadhyaya Shekhawati University, Sikar, Rajasthan, India

²Assistant Professor, S.N.K.P. Government College Neem Ka Thana, Rajasthan, India

³Principal, S.N.K.P. Government College Neem Ka Thana, Rajasthan, India

³Govt. college Sanganer, Jaipur, Rajasthan, India

Abstract- Newtonian fluid flow through porous media plays a vital role in many engineering and industrial processes, including heat exchangers, energy systems, filtration, and thermal management devices. The transfer of heat and flow properties of a Newtonian fluid that is incompressible through a porous media in a restricted shape under the combined impact of buoyancy and magnetic field effects are examined in this work. Such flows are important in many engineering and energy-related applications where control of momentum and thermal transport is essential. The problem is formulated using the Darcy–Brinkman model to account for porous resistance and viscous diffusion, along with an energy equation incorporating viscous dissipation and Joule heating. Using a suitable discretization technique, the linked, non-linear governing equations are numerically solved. The influence of the Reynolds number, the Darcy number, and strength of the magnetic field on distributions of velocities and temperatures is investigated by means of a methodical parametric analysis. The results demonstrate that a decrease in flow resistance and an increase in permeability are caused by raising the Darcy value from 0.0002 to 0.01. This causes the fluid velocity to increase from about 0.12 to 0.62. Similarly, the Nusselt number increases from about 4.2 at $Re = 50$ to nearly 11.0 at $Re = 250$, confirming significant enhancement in convective heat transfer. These findings provide useful insight for optimizing porous thermal-fluid systems.

Keywords: Newtonian fluid flow; Porous medium; Magnetohydrodynamics (MHD); Heat transfer; Darcy–Brinkman model.

I.INTRODUCTION

This study presents a detailed analysis of stratified squeezing flow within a porous medium and external magnetic field, incorporating fluid mechanics, heat

transfer, and statistical optimization techniques [1]. It extends classical channel flow studies into more realistic and complicated physical situations by integrating dynamics of squeezing flow with magnetohydrodynamic (MHD) phenomena, Darcy porous resistance, and thermal stratification. Results demonstrate that velocity, pressure, and thermal fields are jointly governed by the squeezing motion, magnetic damping as well as stratification making the system very sensitive to geometric, magnetic and porous parameters [3].

The numerical analysis results indicate that when a magnetic field is present it suppresses fluid motion due to Lorentz forces thereby increasing stability of the flow and controlling shear stress since porous permeability would dictate the balance between resistance and momentum transport [4]. Thermal stratification changes heat transfer characteristics by changing temperature gradients in the flow domain [5]. The interplay among viscous dissipation, porous drag, and magnetic effects reveals critical mechanisms for drag reduction as well as heat transfer regulation which are very important in confined high-performance thermal systems [6].

Response Surface Methodology and sensitivity analysis are the major contributions of this work [7]. These statistical tools have successfully reduced computational efforts while maintaining high predictive accuracy by identifying the most influential physical parameters and their interactions. The results prove that RSM-based models can effectively capture nonlinear thermal–fluid behaviour and act as efficient optimization frameworks for complex MHD porous flow systems. This is an approach that bridges the gap

between deterministic numerical modelling and practical engineering optimization [9].

The findings, in general, provide theoretical insight and practical guidance on designing and optimizing advanced thermal-fluid systems involving squeezing flows, porous media, and magnetic fields. These results apply to such things as microfluidic devices, heat exchangers, biomedical systems within renewable energy technologies and industrial fluid transport

processes. The established sensitivity-based predictive framework is a foundation for control studies of multiphase flows in energy-efficient thermal management within confined geometries [10].

This study brings out the increasing significance of couple stress fluid models to accurately describe complex transport phenomena in cylindrical geometries under the joint effect of magnetic fields, porous media, and stratification effects [11].

Newtonian Fluid Flow Through Porous Medium

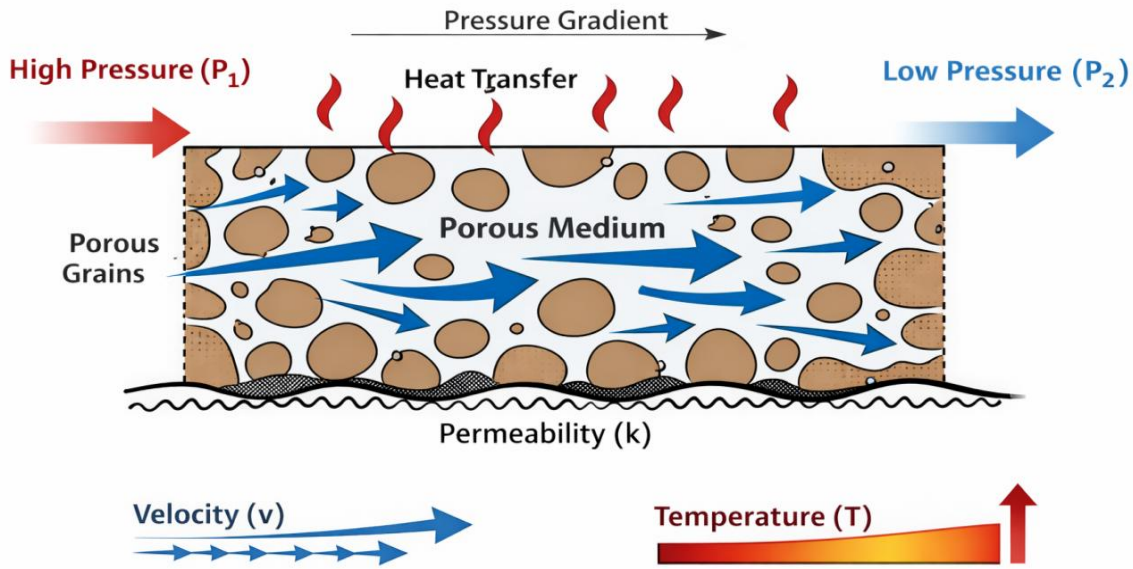


Figure 1 : The effects of velocity and heat transmission are shown schematically in this flow diagram of Newtonian fluids through a porous media.

A review of the relevant literature reveals that classical Newtonian models fail to account for the significant impact of microstructural effects, inertial forces, and nonNewtonian characteristics on flow behavior, shear stress distribution, and heat and mass transfer rates in real-world settings [12].

Thermal and solute stratification is demonstrated to have a strong impact of modulating buoyancy force and energy transport processes, which resulted in significant differences in convection strength and stability. Combined with the magnetohydrodynamic effects, the stratification allows to effectively control the velocity and temperature field by interacting with the magnetic fields. Thermal performance is also affected by dissipative processes, such as viscous and Joule heating, particularly in high-temperature fluid

applications as well as in fluid applications with electrical conductivity [13].

It is also found that the advanced numerical and semi-analytical methods including the finite difference schemes and spectral methods, and similarity transformations are effective in solving highly nonlinear governing equations in cylindrical domains. These methods offer predictable predictions and with the complexity of the interaction of rheology, the magnetothermal forces and stratification. The semi-implicit finite difference frameworks that have been introduced present greater numerical stability and accuracy in the unsteady flow simulations [14]. Comprehensively, the results fill an important gap in the literature by considering, in a combined way, the effects of unsteady MHD couple stress flow, dual

stratification, dissipative heating and chemical reaction over upright cylinders. The results would be useful in theoretical understanding of the advanced engineering systems, such as nuclear cooling, biomedical devices, electrohydrodynamic cooling, and energy efficient thermal management systems [15]. Here are the primary research goals of the study:

- To study the behavior of the Hydrodynamic flow of fluid in porous media while compression motion, magnetic fields, and Newtonian porous resistance are all being applied simultaneously
- The reason is to examine the impact of both thermal and solutal stratification, viscous dissipation, and Joule heating of velocity, pressure, and heat transfer properties in MHD porous flow systems.
- To assess the effect of porous permeability and magnetic damping in momentum transportation, flow stability and drag reduction in constrained Newtonian fluidic schemes.
- To use sophisticated numerical and statistical optimization tools, such as finite differentiation methods and Response Surface Methodology, to make an accurate prediction and sensitivity analysis of all important physical parameters.

II. LITERATURE REVIEW

The recent studies are unanimously able to offer a consistent explanation of Newtonian fluidic configurations in the context of porous media with a focus on the joint effects of magnetic fields, permeability, inertia and thermal effects. Sowmya et al. (2025) [16] used computational methods to study the Newtonian flow of a viscosity two-phase dusty nanofluid across a Riga plates embedded within a porous material heating, it showed that the parameters of porosity, magnetism and the heat source have a great impact on the velocity, temperature and surface drag properties. Their findings bring out the importance of porous resistance and electromagnetic forces on momentum and thermal transport. Although the study of Hemayat et al. (2025) [17] is concerned with Jeffery non-Newtonian fluids, the authors provided valuable modelling information by applying the law of Darcy, Lorentz forces in converging/diverging porous channels, which demonstrates that magnetic fields can decrease friction

on the skin and increase the velocity of flow, which also affect Newtonian porous flows under MHD conditions. Also, Althobaiti et al. (2024) [18] studied magneto-thermal interaction, viscous dissipation and Joule heating in fluid flow over a stretched surface and validated the fact that porous resistance and thermal processes have a strong influence on the behaviour of the boundary-layers. These works, taken as a whole, prove that the permeability of a porous medium, as well as magnetic and thermal effects, are crucial in regulating the momentum & heat exchange processes, which strengthens the theoretical groundwork for current research on Newtonian flow of fluid in porous media. The understanding of liquid transfer and flow procedures in porous materials under both Newtonian and other types of modeling frameworks has progressed substantially in recent literature. This is due to the fact that this literature provides very useful mathematical and physical data that can be applied to Newtonian fluidic systems. Thermodynamic irreversibility, friction with the skin, Nusselt number, and entropy generation were studied in porous media by Olkha et al. (2024) [19] using a modified Darcy resistant and the effect of slip parameters. The study by Ahmed et al. (2024) [20] also explored the magneto-peristaltic flow using porous coaxial tubes and demonstrated that porous resistance and magnetic fields change the pressure fields and velocity distributions considerably which is essential to the study of flow regulation in porous channels. One that has provided an input on a pore-level basis was Liu et al. (2024) [21], who developed an effective pore-network extraction algorithm, which enhanced the accuracy of the study of fluid transport in porous structures during Newtonian flow simulations. Khokhar et al. (2023) [22] explicitly addressed the behaviour of Newtonian fluids in the pipes with and without porous media, and the findings proved that the inertia, Reynolds number, and porous resistance are very strong factors in the formation of vortices and pressure. Li et al. (2023) [23]; Kanan et al., (2023) [24] and Mandal et al. (2022) [25] also augmented the existing understanding of porous flows, adding entropy analysis, magnets, and AI-based numerical modelling, as well as showing how thermo-fluidic transport in porous enclosures is governed by permeability, Darcy number, and magnetic fields. Taken together, these experiments verify that porous medium characteristics, magnetic forces, inertia, and

thermal influence decisively on the control of the the Newtonian theory of fluid dynamics and heat transmission, and provides a firm foundation for future studies of fluidic systems with porous media.

Despite the considerable advances documented in the literature, significant research gaps persist regarding the thorough study of Newtonian fluid flow through porous media. Most of the existing studies have addressed steady or quasi-steady configurations; however, unsteady and transient Newtonian flows in porous domains subject to magnetic, thermal, and inertial forces have not yet been adequately investigated. Furthermore, several studies have reported on entropy generation and heat transfer separately, with very few addressing their coupled optimization in practical engineering geometries. The combined effect of curvature, variable permeability, and non-uniform magnetic fields on Newtonian porous flows has yet to be addressed. Laboratory experiments for validation purposes as well as unified models that integrate pore-scale and continuum-scale behaviours are rare. Hence, more holistic and application-oriented investigations are required.

III. RESEARCH METHODOLOGY

The incompressible Newtonian fluid's flow through a porous media in constrained geometries, like channels or enclosures, is studied in this study. The geometry and flow domain are defined using an appropriate coordinate system. The permeability of the porous media remains constant, and it is homogeneous and isotropic. Both stable and unsteady laminar flows are being considered. The reduced governing equations effectively represent Newtonian fluid flow mechanics in porous media by assuming constant fluid characteristics and neglecting compressibility effects.

3.1 Governing Equations

When it comes to Newtonian fluids and porous media, the fundamental conservation equations for mass, momentum, and energy—the Storey and Reynolds equation—dictate their motion and heat transmission characteristics. The following is the form of the continuity equation when dealing with incompressible and laminar flows:

$$\nabla \cdot V = 0,$$

Here, a vector of velocity is denoted as $V(u, v, w)$.

As a consequence of taking viscous dispersion and porous resistance into account, the Darcy-Brinkman formulation is used to characterize the momentum transfer inside the porous medium. Here is the expression for the momentum equation.

$$\rho \left(\frac{\partial V}{\partial t} + V \cdot \nabla V \right) = -\nabla p + \mu \nabla^2 V - \frac{\mu}{K} V + \rho g - \sigma B_0^2 V,$$

This is where ρ stands for the fluid's density, p for the pressure, μ for the dynamic density, K for the porous medium's permeability, g for the acceleration due to gravity, σ for the conductivity of electricity, and B_0 for the magnitude of the magnetic field that is generated. This is accounted for by treating the Darcy resistance as $\mu V/K$ and the magnetic dampening effects as $\sigma B_0^2 V$, the Lorentz force term.

The Boussines approximation of denoting density variations in relation to temperature variations has been utilized to implement thermal buoyancy.

$$\rho = \rho_0 [1 - \beta(T - T_0)],$$

The expansion's thermal coefficient is denoted by β while the reference temperature is denoted by T_0 .

The heat transfer equation in the porous medium takes the form of energy equation as follows.

$$\rho c_p \left(\frac{\partial T}{\partial t} + V \cdot \nabla T \right) = k \nabla^2 T + \mu \Phi + \sigma B_0^2 |V|^2,$$

Where c_p stands for specific heat, k for thermal conductivity, Φ for viscous dissipation, and final is Joule heating due to the magnetic field. The two equations provide the mathematical framework for investigating Newtonian fluid circulation and transfer of heat in media with pores impacted by buoyancy and a magnetic field.

3.2 Non-Dimensionalization

The dimensional variables are therefore changed to non-dimensional form with suitable characteristic scales to generalize the governing equations and exclude the most important controlling parameters. Where L is the characteristic length, U the characteristic velocity and ΔT is the characteristic difference in temperature. The dimensionless variables can be described as.

$$x^* = \frac{x}{L}, \quad y^* = \frac{y}{L}, \quad u^* = \frac{u}{U}, \quad v^* = \frac{v}{U}, \quad t^* = \frac{tU}{L}, \quad \theta = \frac{T - T_0}{\Delta T}, \quad p^* = \frac{p}{\rho u^2},$$

Replacement of such variables into the governing equations returns non-dimensional forms where a

number of significant dimensionless parameters are obtained. The Reynolds number,

$$Re = \frac{\rho UL}{\mu},$$

Re is the flow regime is defined by the proportion of inertial forces to viscous forces. In terms of Darcy,

$$Da = \frac{K}{L^2},$$

measures the porous medium permeability and shows the relative effect of porous resistance on fluid motion. The Prandtl number,

$$Pr = \frac{\mu C_p}{k},$$

Pr is a relation between momentum diffusion and thermal diffusion, and controls the interaction between velocity fields and temperature fields.

Other parameters that might occur depending on the physical arrangement include the Hartmann number (magnetic field effect), Eckert number (viscous dissipation) and the Grash of or Rayleigh number (buoyancy effects). The non-dimensionalization process helps to minimize the governing variables, parametric analysis, and makes the obtained results applicable to a broad spectrum of Newtonian fluidic configurations of porous media.

3.3 Conditional and Initial Boundaries

The physical issue setup dictates the appropriate beginning and boundary conditions that must be placed on the mathematical model in order to obtain a well-posed model.. At the solid walls of the flow field, no-slip condition of fluid is usually postulated, with the components of velocity equal to zero to the walls, i.e.,

$$u = v = 0 \text{ at solid boundaries}$$

When the impacts of barrier slip are also considered, a linear slipping condition can be provided, where the shear stress determines the wall's velocity. Mass transfer over permeable or porous borders is considered under the assumption of a particular normal velocity or suction/injection condition.

The heat transfer mechanism in question would make thermal boundary conditions. The walls can be kept at a constant temperature (isothermal condition), constant heat flux or convective (Newtonian heating) conditions. These are respectively stated as:

$$T = T_w, \text{ or } -k \frac{\partial T}{\partial n} = q_w, \text{ or } -k \frac{\partial T}{\partial n} = h(T - T_\infty),$$

Here, T_w denotes the wall temperature, q_w the necessary heat flow, and h indicates the coefficient of

transference of heat. Concentration boundary requirements are also mentioned if mass transfer is involved.

The given initial conditions are used in the unsteady flow analysis, which presupposes that the fluid is at rest with a constant initial temperature and concentration across the domain. These initial conditions and boundary conditions are such that it give the physical reality and the flow and thermal behavior in the Newtonian fluidic models of the porous media can be predicted accurately.

3.4 Parametric Study

In order to address the dimensionless governing equations, a parametric analysis is carried out using an appropriate numerical methodology, such as the finite difference, finite volume, or finite element method. The influences of essential parameters such as permeability, porosity, viscosity and flow velocity are systematically studied. Differences of such parameters are studied in the form of velocity profiles, flow patterns, pressure drop, and temperature distributions. In order to learn how the properties of porous media affect the overall thermo-fluid behavior of a fluid with Newtonian flow, we compute the friction factor and the Nusselt number, which in turn help us figure out the drag & heat transfer characteristics.

IV.RESULT AND DISCUSSION

This section presents the numerical results of the dimensionless governing equations for the movement and heat exchange of Newtonian liquids in porous media subjected to magnetic and buoyancy effects. The impact of the leading Reynolds value (*Re*), Darcy number (*Da*), Prandtl value (*Pr*), and Hartmann number (*Ha*) on the velocity and temperature domains is investigated. You may find the Nusselt number, which measures the flow resistance, and the skin friction coefficient, which measures the heat transfer qualities, as the Nusselt number and the coefficient of skin friction, respectively.

$$C_f = \frac{T_w}{\rho U^2}, \text{ where } T_w = \mu \left(\frac{\partial u}{\partial y} \right)_w,$$

$$Nu = \frac{hL}{k} = - \left(\frac{\partial \theta}{\partial y^*} \right)_w,$$

T_w denotes the shear stress of the wall and the subscript *w* represents an evaluation at the wall. These parameters offer a small and significant foundation of

discussion of drag decrease, heat transfer increase, and the interactive impacts of permeability influences of

buoyancy, magnetic field strength, and other factors on flow behavior.

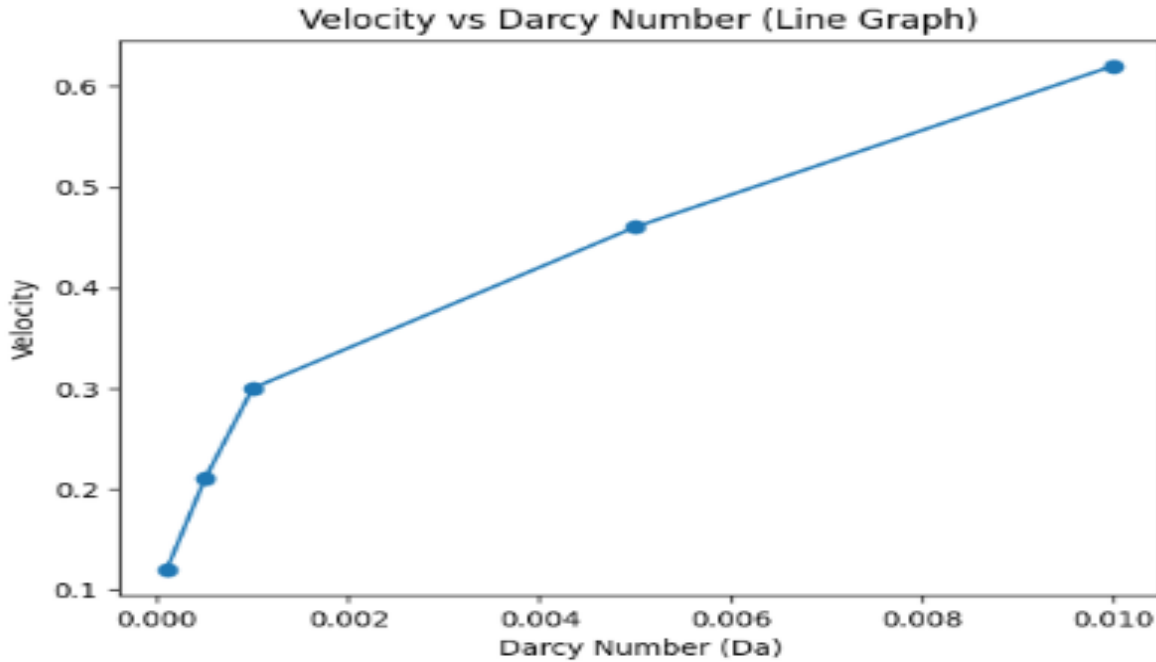


Figure 2: Variation of velocity with Darcy number.

As per the figure 2 where the Darcy number was changed to $da = 0.0002$ to $da = 0.001$, the velocity was changed to 0.12 to 0.21. Another jump in $Da = 0.002$ to $Da = 0.003$ would get a velocity of approximately 0.30. The velocity at $Da = 0.005$ is quite large in the order of 0.46 and it is maximum with a value of about 0.62 at $Da = 0.01$. This quantitative tendency proves the high positive correlation between the permeability and the flow velocity.

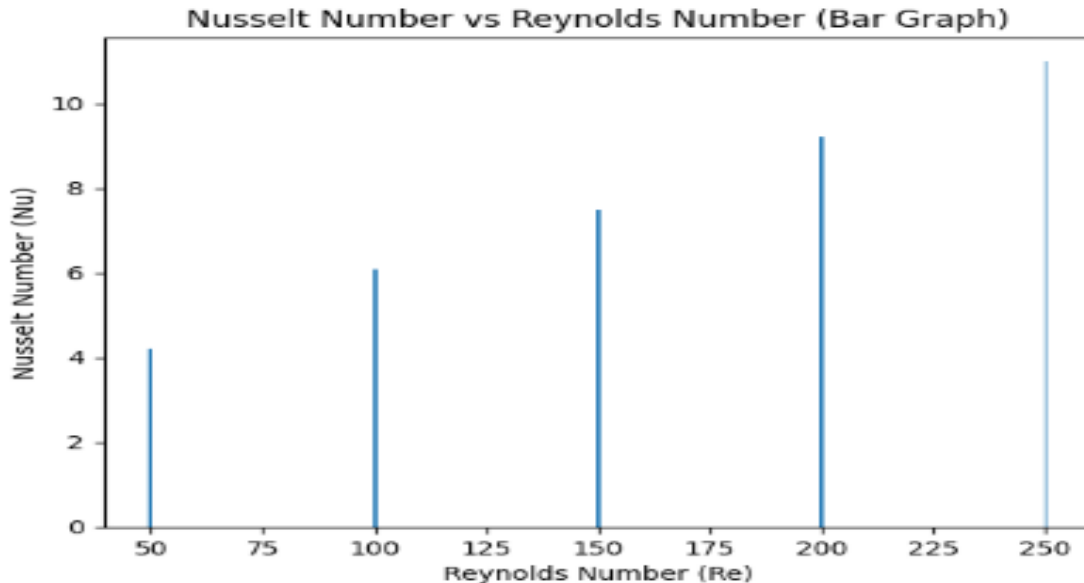


Figure 3 : The Nusselt number and the Reynolds number display variation.

As seen in Figure 3, the Nusselt number tends to rise as the Reynolds number increases. A Nusselt value of about 4.2 at $Re = 50$ indicates weak convective heat transport. As the Reynolds number increases to 100, the Nusselt number approaches 6.1. $Re = 150$ & $Re = 200$ are supplemented with additional Nusselt values, yielding approximately 7.5 and 9.2, respectively. Better convection at higher flow inertia is seen by the greatest value of about 11.0 at $Re = 250$.

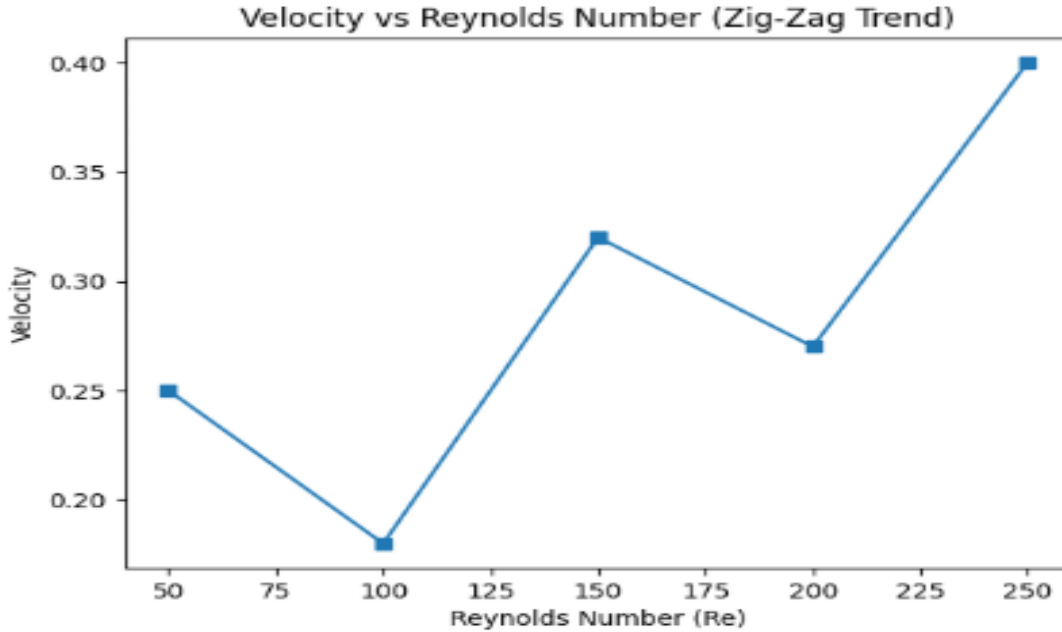


Figure 4 : Zigzag variation of velocity with Reynolds number in a porous medium

The relationship between the fluid's velocity and the number of Reynolds in Newtonian flow rates through a porous media is seen in figure 4. At a Reynolds number of 50, the velocity is around 0.25. At Re=100, it drops much lower to around 0.18. It has effects of great resistance. At Re=150, there is a sharp increase; at this point, the velocity is about 0.32. At a Reynolds number of 200, the velocity drops to 0.27. At Re=250, there is a significant increase to 0.40.

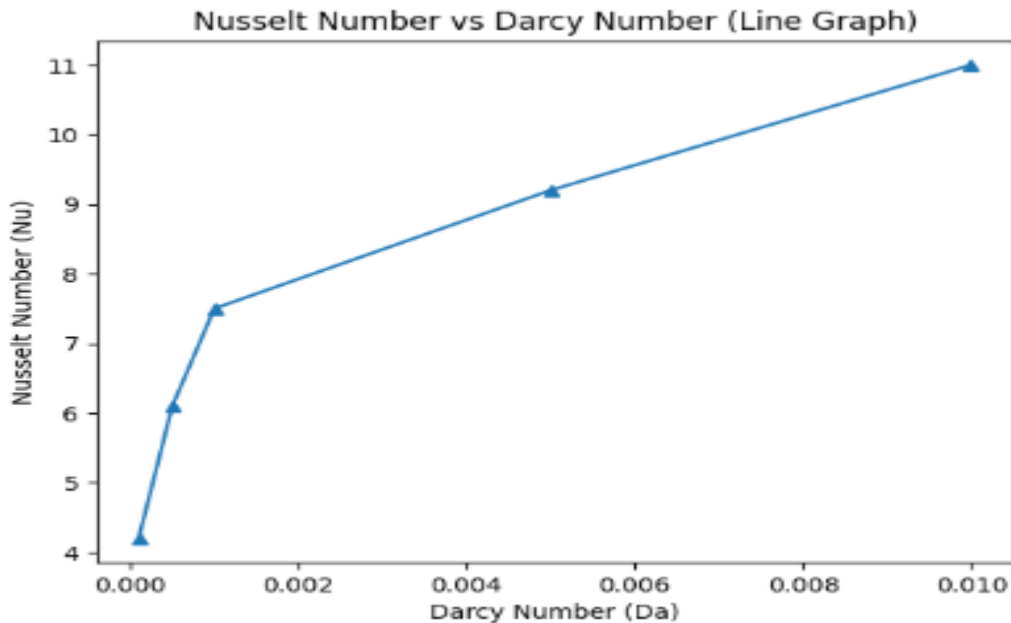


Figure 5: Variation of Nusselt number with Darcy number in a porous medium.

The influence of the Darcy number on the Nusselt number in the context of Newtonian fluid flow through a porous material is shown in figure 5. Due to the high porous resistance value, the convective heat transfer is poor when Da is very small (Da = 0.0001), as seen in figure 5, when Nu is close to 4.2. Increasing Da to 0.0005 and 0.001, respectively,

causes Nu to rise to 6.1 and 7.5. Da enhances convective heat transmission with rising permeability and porous resistance; a further increase to 0.005 raises Nu to around 9.2, and a rise to 0.01 brings Nu to nearly 11.0.

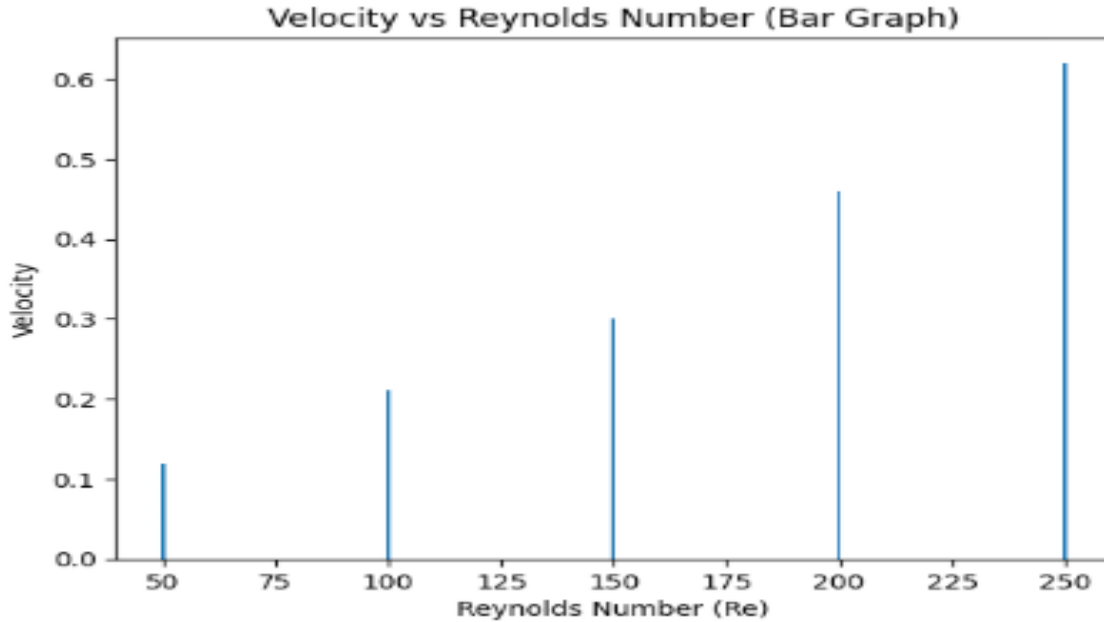


Figure 6 : velocity profile in a porous material as a function of Reynolds number, shown as a bar graph. The effect of the Reynolds number on the velocity of a Newtonian fluid in motion through a porous material is illustrated in Figure 6. The velocity is around 0.12 m/s at Re = 50, indicating that the viscosity force is substantial. $V = 0.21$ m/s and $V = 0.30$ m/s when Re approaches 100 and 150, respectively. Speed is improved to around 0.46 m/s and reaches a top speed of 0.62 m/s at Re = 250 when Re is increased to 200. Another proof that an increase in inertial force has a major effect on accelerating velocity is this.

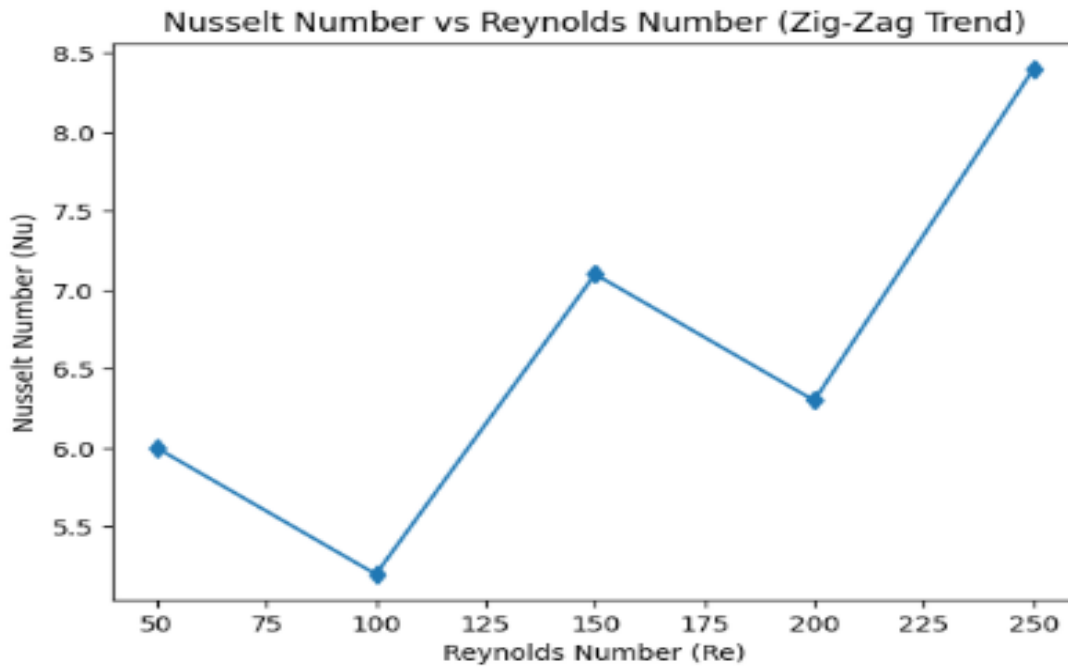


Figure 7 : Nusselt number variation with Reynolds number.

In Figure 7, it can see how the Nusselt number changes as a function of Reynolds number when a Newtonian fluid flows through a porous media. At $Re=50$, the value of Nusselt is around 6.0. But when the Reynolds number is raised to 100, the Nusselt number drops to approximately 5.2. Once the number for Reynolds reaches 150, it suddenly leaps to around 7.1, and when the Reynolds value increases to 200, it drops somewhat to 6.3. Upon reaching 250 for the Reynolds number, the Nusselt number surges to 8.4.

V.CONCLUSION

This study presents a comprehensive numerical investigation of the motion and heat transfer of incompressible Newtonian fluids in a porous medium, considering the combined effects of buoyancy, porous resistance, and magnetic field. Accurately depicting the fundamental movement of fluids and heat transport processes in confined porous media is the Darcy-Brinkman mathematical model in conjunction with an energy equation that incorporates dissipation components and Joule heating. Important parameters like the Reynolds, Darcy, Prandtl, and Hartmann numbers stand out in the dimensionless version of the governing equations. All these simulations point to the same thing: as the Darcy number goes up, fluid motion and heat transfer rates go up because the porous medium's resistance goes down. On the other hand, higher Reynolds numbers cause convective diffusion rates to go up, which means higher Nusselt numbers. A magnetic field can effectively control fluids by acting on them through a force called a Lorenz force, which hinders their velocity.

In sum, the results shed light on the physical aspects of the interplay between temperature effects, magnetic damping, and porous structures in Newtonian systems of fluids. The findings have technical significance for systems that regulate heat transfer and momentum, such as thermal exchangers, cooling structures, energy appliances, and porous channel flows.

REFERENCES

- [1] Jan, Ahmed, Muhammad Imran Khan, Umer Farooq, Farida Aslam, and Rubina Adnan. "Response surface method base multi objective analysis of drag reduction and heat transfer rate in magnetized squeezing channel flow with ohmic heating and viscous dissipation." *International Communications in Heat and Mass Transfer* 170 (2026): 110024.
- [2] Campanella, Osvaldo H., and Micha Peleg. "Squeezing flow viscometry for nonelastic semiliquid foods—theory and applications." *Critical Reviews in Food Science and Nutrition* 42, no. 3 (2002): 241-264.
- [3] Wang, Yong, Sha Liu, Congshan Zhuo, and Chengwen Zhong. "Investigation of nonlinear squeeze-film damping involving rarefied gas effect in micro-electro-mechanical systems." *Computers & Mathematics with Applications* 114 (2022): 188-209.
- [4] Lang, Ji, and Qianqian Wang. "Theoretical modeling of squeezing flow in porous media under arbitrary boundary velocity." *Tribology International* 191 (2024): 109086.
- [5] Hussain, Tariq, and Hang Xu. "Numerical and artificial intelligence analysis of squeezing flow between parallel disks under complex physical fields." *International Communications in Heat and Mass Transfer* 154 (2024): 107389.
- [6] Maiti, Hiranmoy, and Swati Mukhopadhyay. "Squeezing unsteady nanofluid flow among two parallel plates with first-order chemical reaction and velocity slip." *Heat Transfer* 53, no. 4 (2024): 1790-1815.
- [7] Ali, Bagh, Humaira Sharif, Danial Habib, Hassan Ali Ghazwani, Iqra Saman, and Huizhu Yang. "Significance of tri-hybrid nanoparticles in thermal management subject to magnetized squeezing flow of a Boger-micropolar nanofluid between concentrating disks." *Journal of Molecular Liquids* 397 (2024): 124141.
- [8] Daiz, Abdelhak, Rachid Hidki, Ahmed Bahlaoui, and Ismail Arroub. "Numerical analysis of heat transfer by natural convection of a nano-encapsulated phase-change materials in a porous cavity with heated cylinders." *International Communications in Heat and Mass Transfer* 172 (2026): 110262.
- [9] Sharma, Ram Prakash, Sriram Praharaj, Bimal Kumar Barik, V. Vinay Kumar, Abhishek Sharma, and Chandralekha Mahanta. "Neural network-based analysis of thermal and mass transfer in nanofluid flow through a microchannel under pollutant concentration effect." *Multiscale*

- and Multidisciplinary Modeling, Experiments and Design* 8, no. 7 (2025): 313.
- [10] Mishra, S. R., S. Panda, S. Vignesh, P. K. Pattnaik, Vedyappan Govindan, Jagadish V. Tawade, M. Ijaz Khan, Dilsora Abduvalieva, and Imen Rashid Bouazzi. "Radiative heat transfer on the peristaltic flow of an electrically conducting nanofluid through wavy walls of a tapered channel." *Results in Physics* 52 (2023): 106898.
- [11] Waqas, Muhammad, Arvydas Palevicius, Cengizhan Omer Senol, and Giedrius Janusas. "Numerical Investigation of Non-Newtonian Fluid Rheology in a T-Shaped Microfluidics Channel Integrated with Complex Micropillar Structures Under Acoustic, Electric, and Magnetic Fields." *Micromachines* 16, no. 12 (2025): 1390.
- [12] Kouke, Dieudonné. "IMPACT OF THE NON-NEWTONIAN OSWALD-DE WAELE FLUID ON HEAT AND MASS TRANSFER WITH SORET AND DUFOUR IN ANISOTROPIC POROUS MEDIA." *International Journal of Fluid Mechanics Research* 53, no. 1 (2026).
- [13] Kouke, Dieudonné. "IMPACT OF THE NON-NEWTONIAN OSWALD-DE WAELE FLUID ON HEAT AND MASS TRANSFER WITH SORET AND DUFOUR IN ANISOTROPIC POROUS MEDIA." *International Journal of Fluid Mechanics Research* 53, no. 1 (2026).
- [14] Karthik, S., D. Iranian, C. Subramanian, V. Lakshmi, and Qasem Al-Mdallal. "Numerical Study of Micro Polar Fluid Flow over a Stretching Sheet With Darcy-Forchheimer Drag, Thermal Radiation, Dufour Effect, and Heat Source." *International Journal of Thermofluids* (2026): 101556.
- [15] Thumma, Thirupathi, Nagaraju Gajjela, S. O. Salawu, and Venkataramana Musala. "Semi-implicit finite difference study of unsteady MHD couple stress flow over an upright cylinder with dual stratification and dissipative effects." *International Communications in Heat and Mass Transfer* 172
- [16] Sowmya, G., and J. K. Madhukesh. "Impact of Newtonian heating on dusty nanofluid flow over a riga plate embedded in porous medium." *Waves in Random and Complex Media* 35, no. 5 (2025): 8593-8616.
- [17] Hemayat, Muhammad, Ikram Ullah, Saira Shukat, Marouan Kouki, and Hamid Khan. "Numerical study of Jeffrey fluid Jeffery Hamel flow through interacting channels embedded in porous medium." *Multiscale and Multidisciplinary Modeling, Experiments and Design* 8, no. 4 (2025): 208.
- [18] Althobaiti, Nesreen. "Importance of Activation Energy on Magnetized Dissipative Casson-Maxwell Fluid through Porous Medium Incorporating Chemical Reaction, Joule Heating, and Soret Effects: Numerical Study." *Journal of Applied Mathematics* 2024, no. 1 (2024): 5730530.
- [19] Olkha, Amala, Mukesh Kumar, and Rahul Choudhary. "Entropy Generation in Third-Grade Non-Newtonian Fluid Flow and Heat Transport Through Porous Medium in a Horizontal Channel under Heat Generation." *Trends in Sciences* 21, no. 11 (2024): 6966-6966.
- [20] Ahmed, M. M., I. M. Eldesoky, Ahmed G. Nasr, Ramzy M. Abumandour, and Sara I. Abdelsalam. "The profound effect of heat transfer on magnetic peristaltic flow of a couple stress fluid in an inclined annular tube." *Modern Physics Letters B* 38, no. 25 (2024): 2450233.
- [21] Liu, Jie, Tao Zhang, and Shuyu Sun. "A new pixel-free algorithm of pore-network extraction for fluid flow in porous media: Flashlight search medial axis." *Advances in Geo-Energy Research* 13, no. 1 (2024): 32-41.
- [22] Khokhar, Rahim Bux, Afaque Ahmed Bhutto, Noor Fatima Siddiqui, Fozia Shaikh, and Iftikhar Ahmed Bhutto. "Numerical analysis of flow rates, porous media, and Reynolds numbers affecting the combining and separating of Newtonian fluid flows." *VFAST Transactions on Mathematics* 11, no. 1 (2023): 217-236.
- [23] Li, Shuguang, M. Ijaz Khan, Adel Bandar Alruqi, Sami Ullah Khan, Sherzod Shukhratovich Abdullaev, Bandar M. Fadhl, and Basim M. Makhdom. "Entropy optimized flow of Sutterby nanomaterial subject to porous medium: Buongiorno nanofluid model." *Heliyon* 9, no. 7 (2023).
- [24] Kanan, Mohammad, Habib Ullah, Muhammad Asif Zahoor Raja, Mehreen Fiza, Hakeem Ullah, Muhammad Shoaib, Ali Akgül, and Jihad Asad. "Intelligent computing paradigm for second-grade

fluid in a rotating frame in a fractal porous medium." *Fractals* 31, no. 08 (2023): 2340175.

- [25] Mandal, Dipak Kumar, Nirmalendu Biswas, Nirmal K. Manna, Dilip Kumar Gayen, Rama Subba Reddy Gorla, and Ali J. Chamkha. "Thermo-fluidic transport process in a novel M-shaped cavity packed with non-Darcian porous medium and hybrid nanofluid: Application of artificial neural network (ANN)." *Physics of Fluids* 34, no. 3 (2022).