What is magnetohydrodynamic power generation. Mhd power generation seminar report pdf. Power generation explained. Power generation methods.

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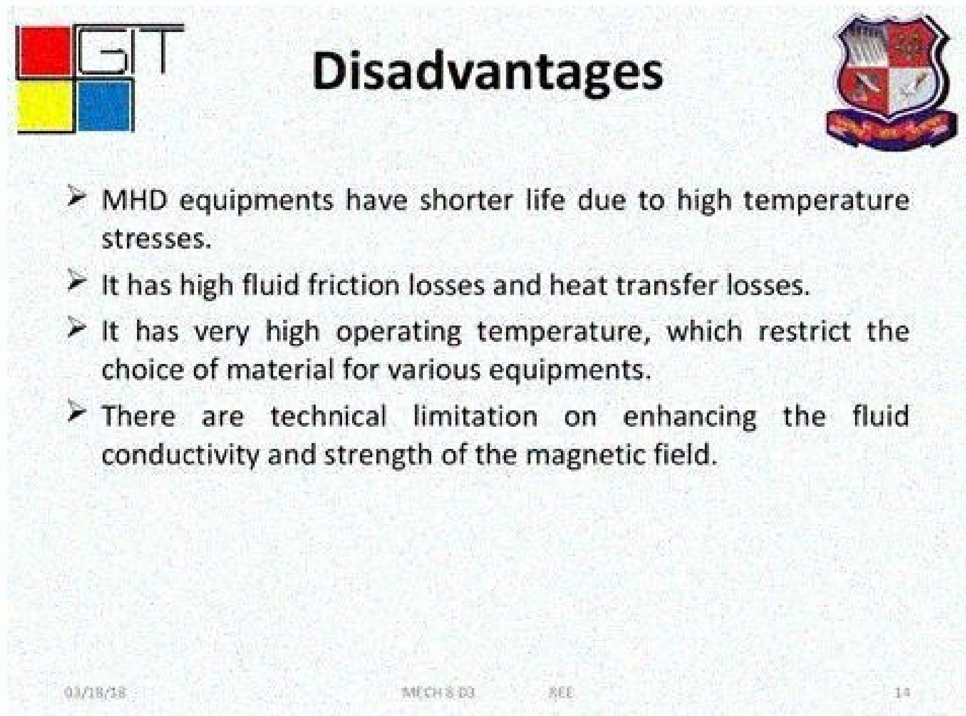
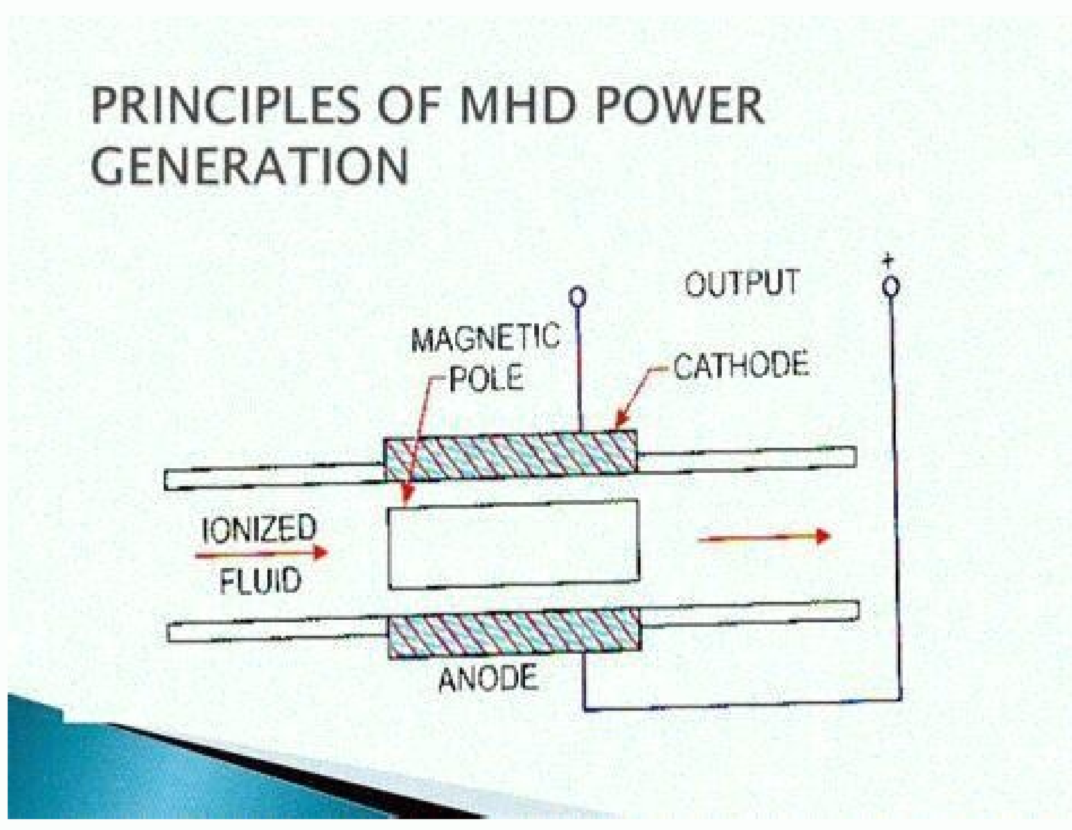


The open cycle is simpler, but the closed cycle has some benefits such as higher efficiency and lower environmental impact. There are also three different geometries for MHD generators: Faraday, Hall, and Disc. Each one has its own characteristics and challenges. A closed-cycle MHD generator using a Faraday geometry was developed by NASA in the 1970s. It used argon gas with cesium seed vapor and a magnetic field of up to 1.8 T. It was able to generate about 300 W of power, but it also suffered from Hall currents that reduced its performance. A similar design using coal-fired gas was also tested. A more recent study used a Hall geometry for an MHD generator, which produced a voltage difference and a current in a load. The results from experiments and simulations were consistent, as shown in Figure 9.10.. The article discusses the importance of digital literacy programs in education, as technology advances rapidly. It argues that such programs are necessary for students to prepare for the changing job market and to participate in the digital world. It also provides some guidelines for writing clear and factual content, using a specific keyword for search engine optimization. The keyword is 'mhd power generation pdf'. The article then gives an overview of magnetohydrodynamic (MHD) power generation, which is a process of converting the kinetic energy of a conductive gas into electric energy, using a magnetic field.

It describes the basic principle of MHD power generation, the advantages of using coal as a fuel, and the challenges of dealing with turbulence in liquid metal MHD generators. It also cites some sources and figures to support its claims. MHD power generation is a process that converts thermal energy into electrical energy by using a plasma and a magnetic field. The plasma is a hot, ionized gas that can conduct electricity. The magnetic field induces an electric current in the plasma, which can be extracted by electrodes. MHD power generation has several advantages over conventional power plants, such as higher efficiency, lower emissions, and simpler design.

However, it also faces some challenges, such as high construction costs, material degradation, and plasma instability. MHD power generation has been studied for a long time. In 1832, Faraday tried to measure the electric voltage generated by the water flow in the Thames river and the earth's magnetic field. The author of this article began his career working on MHD power generation at AERE Harwell about 50 years ago. He learned about the importance of using a superconducting magnet to make the process more economical. MHD power generation can be seen as a generalization of the dynamo and the motor effects. If a fluid that can conduct electricity flows through a magnetic field, it generates an electric voltage. If an electric current is applied to the fluid in a magnetic field, it produces a force. This principle can be used to propel a boat by using salt water as the fluid and a superconducting magnet on the boat. MHD power generation is a complex phenomenon that requires a detailed understanding of the physics involved. Some good references are given by Witte, Hales, and Davidson. There have been some experiments with MHD boats using superconducting magnets. The first one was Yamato - 1, which was tested in Kobe harbour in 1992. The only HTS MHD boat so far was made by Hales at the Clarendon Laboratory in collaboration with Space Cryomagnetics Ltd. It was a small-scale model that used the 'open field' design, which was proven to work well for a non-superconducting MHD submersible by Way and Devlin. The magnet shape was 'racetrack', which was different from the usual circular shape. This was done to maximize the thrust by accessing the largest mass of water. Mamatha S. Upadhya and C.S.K. Raju discuss the applications of MHD power generation for micro and nanofluid convection with magnetic field effects.

They use MATLAB to solve the coupled nonlinear equations that describe the fluid dynamics and heat and mass transfer in MHD systems. They also provide examples of MHD power generation for different geometries and boundary conditions.. The numerical solution of Eqs. (7.12)–(7.15) with boundary conditions (7.16) is obtained by using Runge-Kutta based shooting technique. The flow and heat transfer features are studied by taking $l=0.5,\phi=0.05,\beta v=0.2,\beta T=0.2,M=0.5,Pr=7.10,\phi d=0.01,A=0.5,Ec=0.1, R=0.5,\Gamma=0.3,\lambda 1=0.3,\lambda 1=0.3,\gamma=0.2$ as constant values, except for the variations shown in the figures and tables. Figs. 7.2–7.11 show the fluid, dust, nanofluid (graphene+water) and dusty nanofluid (graphene+dust particle) profiles of velocity and temperature, with solid green, dashed, solid blue and dashed red lines, respectively. Table 7.1 gives the properties of water and graphene nanoparticles. The present results agree well with Abel and Mahesha (2008) and Krishnamurthy et al. (2016) (Table 7.2).Figure 7.2. Effects of M on velocity profiles.Figure 7.3. Effects of M on temperature profiles.Figure 7.4. Effects of R on temperature profiles.Figure 7.5. Effects of A on velocity profiles.Figure 7.6. Effects of A on temperature profiles.Figure 7.7. Effects of Γ on temperature profiles.Figure 7.8. Effects of $\lambda 1$ on velocity profiles.Figure 7.9. Effects of $\lambda 1$ on temperature profiles.Figure 7.10. Effects of Ec on temperature profiles.Figure 7.11. Effects of ϕd on velocity profiles.Table 7.1. Thermo physical properties of base fluid water (H_2O) and nanoparticles (Graphene) Babu et al. (2017).Thermo physical propertiesWaterGrapheneρ (kg/m3)997.12250cp (J/(kg K))41792100k (W/(m K))0.6132500Table 7.2. Validation of the obtained local Nusselt number ($-\theta'(0)$) with reference to the available literature in some limited case $\Gamma=\gamma=l=M=A=\phi=\phi d=\lambda 1=\lambda 2=0$.PrPresent studiesAbel and Mahesha (2008)Krishnamurthy et al.



Power generation methods.

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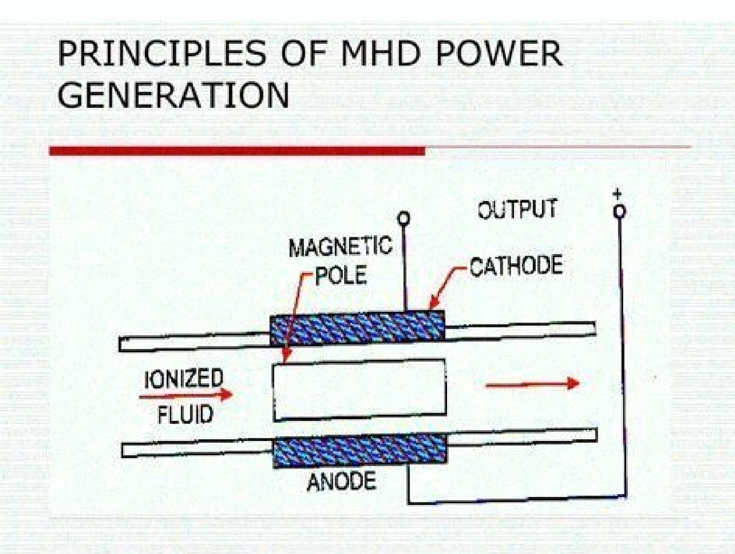

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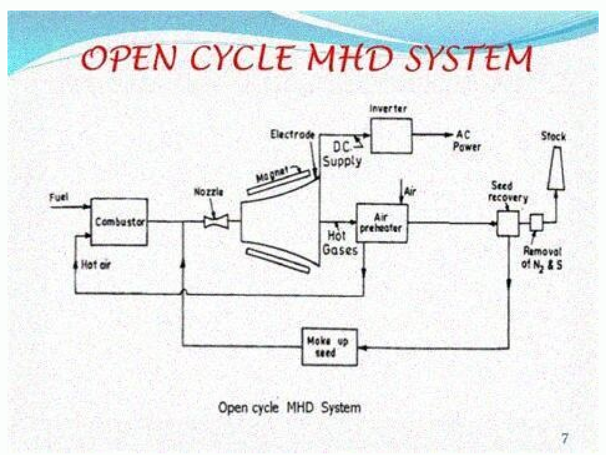

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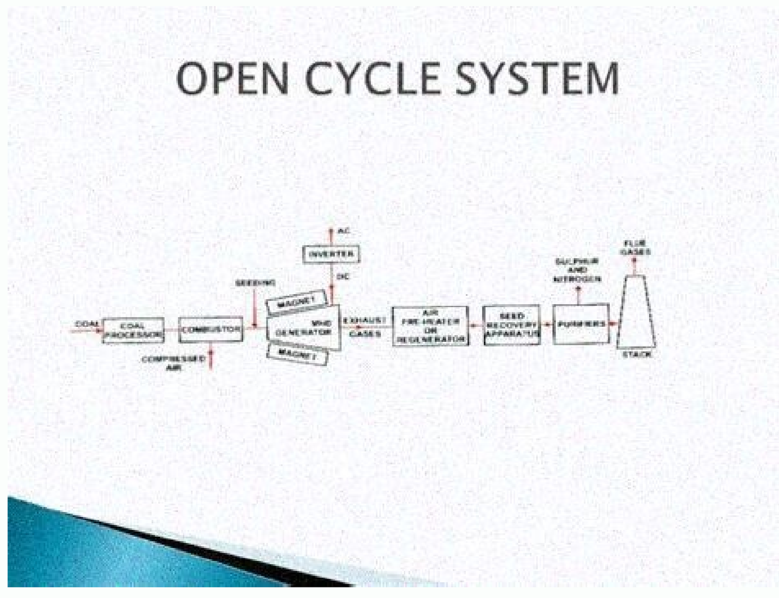

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The thermal boundary layer is higher for dusty fluid and dusty nanofluid with low Stephan number.

Thermal radiation dominates over conduction or convection when R is large, so more heat energy is transferred to the flow. Fig. 7.5 shows that unsteadiness parameter (A) reduces the stretching rate and the velocity of dusty fluid and dusty nanofluid. Nanoparticles also lower the velocity boundary layer compared to $\phi=0$ case.

Fig. 7.6 shows that thermal boundary layer increases with unsteadiness parameter A. Nanofluid and dusty nanofluid have higher thermal boundary layer than fluid and dusty fluid. This is because A enhances the particle interaction and thermal conductivity. The thermal relaxation effect is shown in Fig. 7.7. Thermal relaxation parameter Γ increases the temperature distribution in the flow. Higher thermal relaxation stimulates the movement of nearby particles, which improves the thermal boundary layer. Nanofluid and dusty nanofluid have higher temperature distribution than fluid and dust particle. Fig. 7.8 shows that buoyancy parameter (λ1) decreases the momentum boundary layer of all cases. Buoyancy usually increases the velocity of the flow, but in this study, unsteadiness and graphene nanoparticles reduce the velocity profiles. This is seen in Figs. 7.8 and 7.9. Buoyancy parameter λ1 also increases the temperature distribution in the flow. Fig. 7.10 shows that Eckert number Ec increases the particle distribution and the thermal boundary thickness. There is higher temperature distribution for $\phi\neq0$ case of both fluid and dust particle. Figs.

7.11 and 7.12 show the effect of volume fraction of dust particles ϕd on velocity and temperature fields. Higher ϕd means more dust and fluid concentration, which lowers the velocity boundary layer. This may be due to both dust and nanoparticles. However, thermal boundary layer increases with ϕd, because of higher particle interaction. $\phi\neq0$ case has higher thermal boundary than $\phi=0$ case of fluid and dusty fluid. Figure 7.12. Effects of ϕd on temperature profiles. Tables 7.3 and 7.4 show the influence of the parameters on skin friction and Nusselt number. The article discusses how to analyze MHD fluids using equilibrium and stability concepts. These help to categorize different configurations based on their relevance, usefulness, and significance for science and technology.

The main focus is on magnetic plasma confinement for controlled fusion (MFE), but there are other applications in various fields. MHD equilibria are situations where the plasma pressure gradient and the Lorentz force balance each other and any other forces on the magnetofluid. These are called MSEs if the pressure gradient and the Lorentz force are the main factors. MSEs are important for MFE. They have magnetic fields that come from external coils and plasma currents. The pressure and current profiles depend on the position in the torus. Most MSEs have closed magnetic field lines. The article also presents some numerical results on skin friction coefficient and Nusselt number for two cases: $\phi=0$ and $\phi=0.05$. These are related to the nonlinear convection effects. The results show that friction coefficient and heat transfer rate decrease as some parameters increase.

The execution time is faster for $\phi=0.05$ for some parameters and slower for others. The article provides two tables with the values of these variables for different combinations of parameters. Some possible additional sentences to conclude the paraphrased article are: - The article demonstrates the complexity and diversity of MHD phenomena and the challenges of modeling them accurately. - The article provides useful insights and data for researchers and engineers working on MHD applications and simulations. - The article highlights the importance of MHD theory and methods for understanding and controlling plasma dynamics and fusion processes. Magnetic surfaces (MS) are surfaces that contain a fixed amount of magnetic flux. They have an effective radius r, and we usually ignore how p and J depend on θ and ϕ. Plasma particles cannot easily cross a MS and are trapped inside. This is why a MS is also called a magnetic bottle.MSs are symmetric and can have toroidal, spheroidal, or helical shapes. Toroidal MSs are important for MFE and include the tokamak and the RFP. These are called toroidal pinches because a toroidal current creates a magnetic field that squeezes the plasma. A tokamak has a strong external toroidal field, while a RFP makes its own toroidal field by twisting some of the current into the poloidal direction. This is similar to the dynamo process. RFPs are always changing and not stable. Spheroidal MSs include the spheromak and the spherical torus, and helical MSs include the heliac, a kind of stellarator. Stellarators do not need currents like toroidal pinches, but they lose the symmetry of the torus. In this section, we only talk about toroidal pinches, especially tokamaks.

The MS of a tokamak is simple because the pressure and current profiles, $p=p(R)$ and $J\phi=J\phi(R)$, only depend on one coordinate, R, which is like the distance from the center.When we have a closed MS, we need to check if it is stable in MHD. This means that small changes that break the symmetry do not grow bigger. This growth happens when the MS releases potential energy and changes the pressure and current profiles p(r) and Jϕ(r), which lowers the potential energy and makes the MS worse. Stability is a linear idea and only matters for a short time, until the changes become big. Then the plasma either finds a new MS with less potential energy and different symmetry, or loses energy through dissipation (like viscosity). This often happens when the MHD makes smaller scales.. MHD instabilities can be categorized as pressure-driven or current-driven, depending on whether they involve changes in plasma pressure or current.

They can also be classified as ideal or resistive, depending on whether they violate Alfvén's frozen flux condition or not.

Ideal instabilities do not break this condition, while resistive instabilities do, usually due to collisional effects. MHD instabilities are important for MFE, because they restrict the possible MSEs and affect the performance of fusion devices. Many books have been written on the MHD stability of fusion devices, but here we only present some basic concepts and applications. One way to study stability is to use the conservation of total energy E in ideal MHD. This is the sum of kinetic energy EK, magnetic energy EM, and internal energy EI. Before any disturbance, the plasma is at rest, so $EK=0$ and $E=EM+EI$. A small disturbance creates some EK, which may grow by reducing EM+EI, indicating instability; or stay small, indicating stability. We can use an analogy with a ball rolling on a surface S under gravity.

EK is the ball's kinetic energy and its height z is like EM+EI. A magnetostatic equilibrium is like the ball being still at a point P where the surface is flat (i.e., the tangent plane at P is horizontal, as shown in Fig. 12). In Fig. 12A, the ball is at the lowest point of z, and the system is stable to any disturbance, no matter how big or which direction. In Fig. 12B, the ball is at a high point of z, and the system is unstable to any disturbance. In Fig. 12C, the ball is at a saddle point of z, and the system is unstable to some disturbances, but stable to others. In Fig. 12D, the ball is at a local minimum of z, and the system is stable to small disturbances, but unstable to large ones. Figure 12. Equilibrium points (•) of a ball rolling on a surface. (A) global stability; (B) instability at a maximum of z; (C) instability at a saddle point of z; (D) stability for small perturbations but not large.Likewise, if EM+EI increases for every small disturbance of a MSE, it is stable, as in Figs 12A and 12D. The MSE is unstable if there is any disturbance that decreases EM+EI, as in Figs 12B and 12C. Figure 12C is the better . A MSE is stable against most perturbations, as they either increase EM or both EM and EI. However, some perturbations may lower EM+EI, and these should be avoided or minimized. These perturbations tend to reduce the current or pressure gradients.B.H. Yan, ... L.G. Li, in Annals of Nuclear Energy, 2020Magnetohydrodynamic (MHD) power generation converts plasma energy into electric power by passing it through a magnetic field (Rosa, 1987). This method has high efficiency at high temperature. It requires a super-cooled magnet and a high-energy plasma. A 2000 K gradient is needed in a small space. The core design at very high temperature is also a challenge. This method is being developed for space applications, but most information is not public.Yueguang Deng, ... Jing Liu, in Solar Energy Materials and Solar Cells, 2021The liquid metal MHD power generation uses the Faraday's law of electromagnetic induction, unlike the liquid metal solar thermal power generation. The MHD power generation exploits the electromagnetic properties of the liquid metals, not their heat transfer properties. When liquid metal crosses the magnetic field, it induces an electric force in the direction orthogonal to both magnetic field and flow direction [109].The working fluid of MHD power generation can be gaseous plasma or liquid metal. The liquid metal MHD power generation can work at lower temperature, pressure, and flow speed, as the liquid metal has much higher electrical conductivity than the gaseous plasma. A typical design of liquid metal solar MHD power generation is shown in Fig. 10 [110].Fig. 10. The design of a typical liquid metal solar MHD power generation system.The liquid metal MHD power generation system can operate over a wide temperature range of 600–3000 °C [111], and it can use a conventional steam-cycle power system as the second stage to increase power output and generation efficiency. However, the liquid metal MHD power generation system is rare in industry, due to the complex structure and two-phase flow instability. Some applications for space power supply have been suggested and studied. The results showed that specific power of 600W/kg could be achieved, which was more competitive to solar cells power system for deep space exploration [112].For the liquid metal . The thermal MHD system faces material and flow issues at high temperatures, and needs economic assessment for industrial use. Recently, liquid metal MHD power generation has been explored for harvesting energy from ocean waves and human motions [113,114], based on the liquid metals' electromagnetic properties. These applications have potential in the energy field, but require more work on material engineering, system optimization and cost evaluation. Naoyuki Kayukawa, in Progress in Energy and Combustion Science, 2004 Various analytical methods have been developed to simulate open-cycle MHD power generation processes. These include time-dependent, quasi-1D analyses [30] for transient and stability effects in case of power faults; time-dependent 2D analysis [31] for pulsed operation; steady state 3D analyses [32] of the whole channel plasma phenomena; and time-dependent 3D analyses for local electro-gas-dynamical behaviors in a limited area [33]. For performance prediction and design, the current numerical methods are adequate for the gas-fired MHD generator with moderate interaction parameter times electrical efficiency, defined by $\eta_e I_p = \eta_e \int_0^L |J \times B|/p dx \leq 1$, where L is the channel length and η_e is the local electrical efficiency defined by $\eta_e \equiv |J \cdot E/u \cdot (J \times B)|$. In high interaction cases where $\eta_e I_p > 1$, the plasma behaviors are often time-dependent and highly three-dimensional. The advanced MHD 3D codes [34] are usually based on the parabolic assumption that $\partial^2/\partial x^2$ is much less than $\partial^2/\partial y^2$ and $\partial^2/\partial z^2$, which cannot handle boundary layer separation and flows crossing the critical Mach number ($M=1$). E.R.G. Eckert, ... U. Kortshagen, in International Journal of Heat and Mass Transfer, 2000 MHD still poses interesting challenges for numerical models, though most publications deal with applications other than MHD power generation. Sahin et al. [40U] analyzed the thermal efficiency of a MHD generator based on optimal power density and component inefficiencies.

Several papers studied the effect of a magnetic field perpendicular to a free convection flow field of an electrically conducting fluid with different configurations: along a semi-infinite vertical plate with radiation heat transfer included [41U], inside a cubic enclosure [39U], from a horizontal cylinder with forced convection included [31U], for the same configuration but with the cylinder inside a porous medium [30U], from a The article discusses the effects of magnetic fields on fluid flow and heat transfer in various porous media. It reviews the existing literature on the topic and presents some numerical and analytical solutions for different scenarios. The scenarios include a channel with a transverse magnetic field [36U], a wedge in a porous medium [36U], a shallow porous cavity [34U], and an inclined porous cavity [35U]. The article compares the results for different boundary conditions and parameters, such as the Hartmann number and the Rayleigh number. The article aims to provide a comprehensive overview of the current state of knowledge on mhd power generation pdf.