Technological advancements in thermal systems demand an innovative heat dissipation technology. Magnetorheological (MR) fluid has a huge potential to solve the problem. However, characterising thermal conductivity of the materials in magnetic fields required tailored instruments. This paper presents a concept design of the MR fluids thermal conductivity measurement instrument. The developed instrument was designed to be able to measure thermal conductivity in both parallel and perpendicular orientations with magnetic field. Magnetic fields distribution of the proposed concept design was analysed using finite element method for magnetics. Design modification then conducted to improve the magnetic fields strength. Findings of this study showed that gap thickness played a significant factor in determining the optimal design. Simulated magnetic fields strength at both parallel and perpendicular orientations were found identical, yet varied in distributions.