Numericalsimulationswereperformedinordertostudycombinedforcedandnaturalconvectionflowbetweentwo coaxial vertical cylinders under an axial magnetic field. The effects of the axial magnetic field and six annular gaps on flow structures and heat transfer were assessed. The governing Navier-Stokes, energy, and potential equations are solved by using the finite volume method. The three-dimensional symmetry breaking of the basic state appears as the annular gaps become larger. Asymmetric m = 1 and 2 azimuthal modes are observed. Finally, our results show that the magnetic field controls both the heat transfer and the transition to asymmetry flow. 