MODELING OF HEAT AND MASS TRANSFER IN GEOTHERMAL SYSTEMS

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ABSTRACT

The energy of the Earth's interior is called geothermal heat. The temperature gradient between the core of the Earth (> 5000 °C) and the surface (15 °C) comes from the continuous flow of its natural heat. This gradient covers a wide range of geothermal energy sources, which are found at different vertical intervals at specific temperatures. These resources range from very shallow depths of several hundred meters (10^2 m, [50, 100] °C), then go through intermediate depths (10^3 m, [200, 370] °C), up to the great deep (10^4 m, [400, 800] °C), reaching the immense temperatures of the melted magmatic rocks. The fluids in deep systems can reach supercritical thermodynamic conditions with temperatures above 374 °C and pressures above 220 bar. These fluids have a higher density; containing more volumetric enthalpy and energy, can provide twenty times more power per cubic meter than normal geothermal fluids currently used. Geothermal heat is a natural, renewable and reliable source of energy with environmental and cost advantages over other energy sources. Using geothermal energy makes unnecessary spending, using or burning fossil or nuclear combustibles, nor is it necessary to transport, store, taking care or separate the waste, neither to confine them to avoid toxic damage that could impact or affect the environment. Specific technology can be used to drill wells into the reservoir, bring its hot fluids to the surface, take the underground heat and transform it into electricity. This natural heat may also be used directly in several applications besides electricity generation. The transmission of heat from the geothermal system or porous reservoir towards the field's surface is essentially conductive and convective. The reservoir fluid contains several components whose dynamics are affected by petrophysical heterogeneity in different ways. In this paper the general partial differential equations of the simultaneous transport of heat and multicomponent fluid in porous rocks are introduced and numerically solved using the finite volume method. The solutions of several problems are presented to illustrate this technique. A brief description of different geothermal systems is included.