Measurements of the Density, Speed of Sound, Viscosity and Derived Thermodynamic Properties of Geothermal Fluids from South Russia Geothermal Field

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The geothermal fluid samples for the present study comes from geothermal wells Izberbash No.68, No.129 and Ternair No. 27T, No. 38T (Dagestan, south Russia Geothermal Field). The Geothermal Field is located in the southern part of Russia, approximately 60 miles to the south-west of capital city Makhachkala of Dagestan, near Caspian seashore (about 2 mile away from the seashore). The wellhead temperature is within (62 to 69) °C, while the wellhead pressure is within from (0.8 to 2.0) atm. The density, speed of sound, and viscosity of four natural geothermal fluid samples have been measured with Anton Paar Instruments: vibrating-tube densimeters (DMA 4500); sound-speed analyzer (DSA 5000 M); and Schtanbergviscodensimeter (SVM3000), respectively. Measurements were performed at temperatures from (278 to 343) K and at atmospheric pressure. The combined expanded uncertainty of the density, viscosity, and speed of sound measurements at the 95 % confidence level with a coverage factor of k = 2 is estimated to be- density: 0.0005 % (for DMA 4500 densimeter), 0.02 % or 0.5 $kg \cdot m^{-3}$ (for the SVM 3000 viscodensimeter) and 0.01 % (for the DSA 5000 M sound-speed analyzer); viscosity-0.35 % (for SVM 3000); and speed of sound-0.1 %(DSA 5000 M), respectively. Measured values of density and speed of sound were used to calculate other very important derived thermodynamic properties of the geothermal fluid samples. Measured values of density, viscosity, and speed of sound were used to develop correlation models which reproduced the experimental data within 0.03 % (density), 2.55 % (viscosity), and 0.06 % (speed of sound), respectively. The measured properties at atmospheric pressure have been used as a reference values for prediction high pressure properties. The temperature behavior of the density, speed of sound, and viscosity for geothermal fluids are just like pure water and other binary aqueous salt solutions. The measured density, speed of sound, and viscosity data were used to develop correlation model (Riedel model) to predict the values of these properties for various concentrations of ions and temperatures from (278 to 343) K. The contribution basic ions in the geothermal fluids (Na^+, Ca^+, Mg^+, K^+) to the total experimentally observed values of the density, viscosity, and speed of sound was estimated.