Thermophysical properties of a chromium-nickel-molybdenum steel in the solid and liquid phase

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The chemical composition of the investigated steel is optimised for applications where a homogeneous structure of the metal is required. Due to the high amount of chromium, nickel and molybdenum and the low carbon content this alloy is very resistant to intergranular corrosion in the temperature range up to 400°C. Further the resistance to acids, having a reducing effect on the material, is good. The steel is not susceptible to pitting, crevice and stress corrosion, cracking in media containing chloride ions and possesses excellent resistance to the attack of urea.
Products made of this alloy are components for urea plants, pump heads, valve stems, condensers, reactors and parts in the dyeing, textile, paper, leather, chemical and synthetic fibre industries.

For processing the metallic melts numerical simulation of fluid flow, heat transfer, solidification or thermal induced stresses have gained a tremendous significance in metal industry. With the availability of adequate computing power, full three-dimensional calculations of the determining physical equations have become possible. A major drawback of these simulation techniques is the lack of accurate thermophysical properties. Important input parameters for the heat transfer equation are heat capacity, heat of fusion, density and thermal conductivity. Since direct measurements of thermal conductivity of alloys in the liquid state are almost impossible, its estimation from the electrical conductivity using the Wiedemann - Franz law is very useful.

Wire shaped samples of the steel are resistively volume heated as part of a fast capacitor discharge circuit. Time resolved measurements with sub-µs resolution of current through the specimen are performed with a Pearson probe, voltage drop across the specimen is measured with knife-edge contacts and ohmic voltage dividers, radiance temperature of the sample with a pyrometer and volume expansion of the wire with a fast acting CCD-camera. These measurements allow to determine heat of fusion as well as heat capacity and electrical resistivity of the steel as a function of temperature in the solid and in the liquid phase. Thermal conductivity is estimated via the Wiedemann - Franz law.

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