

Thermoelectrics deliver hot or cold drinks for Audi drivers

Owners of Audi automobiles can keep their beverages hot or cold thanks to a thermoelectric cup holder mounted in the console. Designed by thermal consulting firm, AMS Technologies, Martinsried, Germany, the heating/cooling system faced multiple design constraints. Its thermoelectric modules and associated fan had to squeeze into limited space, consume minimum power, and the fan noise had to be kept to a minimum.

The initial design drew 4 A at 12 V, and engineering anticipated it would deliver an 11 W cooling capacity to produce a beverage temperature of 9 deg. C in a 22 deg C ambient. To verify its estimates, engineering built a detailed model using Coolit CFD software. The model included the module geometry, number of couples and material properties (Seebeck-coefficient, resistivity and conductivity as a function of temperature).

The thermal analysis revealed that the initial design was very inefficient. Less than 15% of the cooling capacity was cooling the beverage, while the remainder was lost to ambient and as backflow to a heat sink.

A series of what-if scenarios were run to measure the impact of changes in insulation geometry and properties, heat sink profile, air ducts and in the selection of a lower current thermoelectric module. In the final Coolit-optimized design the required cooling capacity of the thermoelectric module was reduced to 7 W, while the effective cooling capacity of the beverage increased to 3 W - almost three times more efficient than the original design. The new design could cool the beverage to 2 deg C; while the initial design only reached 9 deg C. At the same time, overall power consumption was reduced to 36 W from 48 W.

The final design achieved the best performance among several competing automotive suppliers. Since start of production, many tens of thousands of the thermoelectric cup holders have been installed.