Don't burn your Christmas porridge!

Questions should be of general interest and be about temperature measurement techniques and/or heat transfer.

QUESTIONS ANSWERS

QUESTION: We have an electric hob with traditional solid metal burners. I've heard that one shouldn't cook porridge in a stainless steel saucepan because then it's easy to burn the porridge. Is that true?

Johan H

ANSWER: The risk of burning your porridge increases if the bottom of the saucepan has an uneven temperature. Unfortunately, an even temperature of the saucepan bottom will not prevent the porridge from being burned but the risk is less. The thermal properties of stainless steel can easily create an uneven temperature in the saucepan bottom compared with what happens with a different type of saucepan, such as an aluminium one. After a saucepan has been used for a while, its bottom becomes more or less uneven, and this also affects the heat flow. Depending on what type of electric burner you are using, the burner can also be uneven.

If the saucepan bottom and/or the burner are uneven, there are areas that have direct contact between the burner and the saucepan. Underneath other parts of the saucepan there is therefore a tiny distance between the burner and the saucepan bottom. In the areas with direct contact, the heat transfer occurs via thermal conduction. In the other areas, the heat transfer occurs via radiation and thermal conduction in the thin layer of air. The heat flow from the burner to the saucepan bottom in the areas of direct contact is considerably greater than in the areas without direct contact. This in turn causes the saucepan bottom to develop an uneven temperature. The exact temperature differences involved depend on such factors as the material of the saucepan.

The temperature differences in the saucepan bottom cause a heat transfer parallel to the saucepan bottom, which evens out the temperature. This equalisation is considerably greater in an aluminium saucepan than in a stainless steel one due to their differing thermal conductivities. A stainless steel saucepan that is equipped with a thick base of aluminium or copper has about the same thermal properties as an aluminium saucepan. The approximate thermal conductivities are, in W/(m·K): stainless steel 15, aluminium 160, and copper 390.

Contact resistance causes errors

In industrial contexts, surface temperature is often measured with a strap-on temperature sensor. Unfortunately, contact resistance sometimes develops between the sensor and the measurement object, which means that it is possible to measure the incorrect temperature. Such contact resistance can easily arise due to corrosion or inadequate contact between the sensor and the measurement object. We would like to hear about more examples of sensor installations in which contact resistance has caused measurement error.

If you have comments or questions, contact Professor Dan Loyd at the Institute of Technology at Linköping University: dan.loyd@liu.se