How cold is it in the refrigerator?

QUESTION: To measure the temperature inside my refrigerator I use a refrigerator thermometer, which hangs under one of the shelves. How good is this measuring method?

Maj F

ANSWER: The temperature inside a refrigerator depends on many factors, including how the refrigerator is constructed and used. The thermometer's heat exchange with the air inside the refrigerator occurs via convection. Heat exchange via radiation occurs between the thermometer and the refrigerator's walls, door, shelves, evaporator unit and food contents. In the thermometer itself, heat transfer occurs via conduction. Because the conditions vary, the measured temperature will also vary, partly depending on where inside the refrigerator the thermometer is located.

The heat leaking into the refrigerator through its door and walls is transferred out from the refrigerator compartment via the evaporator unit, which usually is placed on the refrigerator compartment's back wall. Via the refrigeration cycle this heat is transferred to the condenser, where it is then transferred to the air in the room outside the refrigerator. The condenser is usually located on the back of the refrigerator. The refrigeration compressor is not in constant operation, which means that the evaporator unit's temperature varies, and thereby so, too, does the temperature inside the refrigerator. The measured temperature thus varies both with the thermometer's location inside the refrigerator and over time.

Every time you open the refrigerator door, warm air from the room enters the refrigerator compartment. This air must be cooled down and the heat is transferred out from the refrigerator compartment via the evaporator unit. Food items placed inside the refrigerator compartment must also be cooled if they are warmer than the refrigerator compartment's temperature. If we assume that 300 litres of air must be cooled from room temperature (20 °C) to 5 °C, this means that just over 5 kJ must be transferred to the evaporator unit. If 1 litre of milk at room temperature is put inside the refrigerator, just over 60 kJ must be transferred to the evaporator unit.

The thermometer has a certain mass, which means that fluctuations in the air temperature are moderated and you get a phase shift. [Ref 1]. If you want to easily determine an approximate average temperature you can measure the temperature in a mug of water,

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

QUESTIONS ANSWERS

which you put in various places inside the refrigerator compartment. The length of the response time varies from case to case. You can also use measuring equipment which reads the temperature continuously at one or more locations and calculates the average temperature. As with all measuring processes, you should calibrate the thermometers being used.

A complicated measurement problem

Measuring the temperature in a refrigerator is an example of a complicated measurement problem, where the temperature depends on both time and the thermometer's location. Evaluating the measurement result requires, among other things, an understanding of how the heat exchange occurs between the thermometer and its surroundings. In this case, the measurement result is affected by the properties of the refrigerator, the refrigerator's contents at the time, the thermometer being used, etc.