

## Can a wine cooler work without ice?

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

### QUESTIONS? ANSWERS!

**QUESTION:** At restaurants sometimes a bottle of white wine is placed inside a very simple wine cooler consisting of a thin-walled tall glass container. The wine cooler's outside surface is coated with a shiny metal film. Does this type of wine cooler really work or should it contain crushed ice?

Johan H

**ANSWER:** This is not actually a wine cooler but rather a device for reducing the heat flow from the room to the bottle and its contents. Reducing the supply of heat makes it possible to keep the wine at a low temperature for a longer period of time than if the bottle was just standing by itself on the table. Room temperature is often over 20 °C and a medium dry white wine should be kept at 8–10 °C.

The heat from the room is transferred to the outside of the glass container by convection and radiation. The shiny metal film on the outside reduces the radiation's contribution to the heat flow, because the emission coefficient is low. The air movements in the room are mostly small, which means that natural convection exists. Inside the glass, the heat is transferred by thermal conduction and the temperature difference between the outside and inside surfaces of the thin glass is very small. In the air gap between the glass container and the wine bottle, the heat is transferred partly by radiation and partly by thermal conduction or convection. The size of the air gap and the temperature difference between the glass container and the bottle are two of the factors that determine how the heat transfer occurs.

Direct contact between the glass container and the bottle increases the heat flow by conduction. Such contact always exists at the bottom of the

bottle and often on the side, because it is hard to place the bottle so that it has no contact with the side of the container. It is above all the air gap that limits the heat flow compared with when the bottle is standing by itself on the table. In the latter case, the heat flow from the room via radiation is also greater.

The heat flow is greatest at first but decreases as the temperature difference decreases. How fast the wine heats up depends, in addition to the heat flow, on such factors as the mass and thermal properties of the components – glass container, bottle and wine. After a while, the wine in both cases will take on room temperature but normally the wine has already been drunk before that happens. If crushed ice is put inside the glass container, then it can be called a wine cooler. In such a case, the heat flow would then go partly from the room to the ice and partly from the wine to the ice. As long as there is melting ice present, the temperature is 0 °C of the ice and water mix. There is therefore a risk that the wine can become too cold.

### Similarities and differences with temperature measurement

The same types of heat transfer mechanisms as in the case of the wine bottle inside the glass container exist with a sheathed thermocouple inside a protection tube, but there the similarities end. In the former case, the aim is to have as little heat flow as possible, whereas in the latter case the aim is to have as great a heat flow as possible in order to reduce the response time. The outside surface of the protection tube should therefore have as large an emission coefficient as possible and preferably there should be no air gap between the protection tube and the sheathed thermocouple.

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