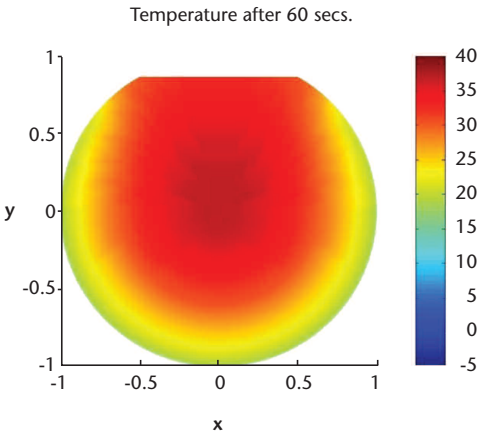
MATHEMATICAL MODELLING Series 1

Cheese and maths: a tasty formula

Mathematics and applied mathematics are used in everyday life. Stock markets, mobile phones, car manufacturing, Google, Hollywood special effects, digital TV and satellites all use cutting-edge mathematics tools in their basic functions. The Mathematical Modelling Series presents a number of applications of mathematics in domains as varied as the human body, volcanology, telecommunications or finance.

What makes cheese strings safe to eat? Prior to packaging, cheese strings are cooled down to 2°C or less to ensure that all harmful bacteria are killed. Given that the cheese strings are cooked at 40°C, we would like to know how long it takes for a cheese string to reach the desired temperature. Mathematics allows us to predict the temperature at any point in a cheese string at any time during the cooling process, and hence, the required cooling time.



How it works

Cheese strings are produced at a temperature of 40°C and are cooled in a solution of salt and water known as brine, which is fixed at -5°C. The density of the cheese is less than the density of the brine so the cheese floats on the surface of the brine. The position of the cheese in the brine is important, as it determines the fraction of the cheese surface that is in contact with the brine. We use Archimedes' principle and the law of floatation to find the position of the cheese in the brine. The deeper the cheese, the quicker the cooling. The conservation of energy law allows us to derive a large set of equations for the temperature at any point in the cheese at any time in the cooling process. Using a computer package, the resulting temperature equations are solved until all points in the cheese are 2°C or less. The figure left illustrates the temperature along a cross section of the cheese after 60 seconds. The red areas indicate the hot parts of the cheese.

Conclusion

Archimedes' principle and the law of floatation show that up to 80% of a typical cheese string is submerged in the brine. It takes approximately 10 to 13 minutes for all points in the cheese to reach the required cooling temperature of 2°C or less.

Parts of the curriculum used in this project:

- Differentiation
- Geometry and trigonometry
- Archimedes' principle
- Integration
- Centre of gravity
- Energy conservation

ACKNOWLEDGEMENTS AND MORE INFORMATION
This research is supported by the Mathematics Application Consortium for Science and Industry (MACSI) funded by the Science Foundation Ireland Mathematics Initiative Grant 06/MI/005.

If you want more information about MACSI and this project:

- Contact Martina O'Sullivan (project facilitator) – martina.osullivan@ul.ie
- Visit the MACSI website – www.macsi.ul.ie.

University of Limerick
Ollscoil Luimnigh
MACSI
Mathematics Applications Consortium for Science & Industry
sfi Science Foundation Ireland