CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Nitish Lakhanpal

Project Number
J1522

Project Title
Tempest in a Teacup: An Experiment to Examine Post-Superheating Nucleation in Microwave Heating

Abstract

Objectives/Goals
The objective of this study is to explore microwave heating and to examine the factors that impact post-superheating nucleation, in which a sudden violent boiling event occurs when a liquid is heated past its boiling point. Specifically, is post-superheating nucleation affected by: (1) the shape of the container? (2) the presence of pores on its internal surface? (3) the presence of scratches on an otherwise glossy internal surface? and (4) dissolving solutes such as salt, sugar and coffee in the water? These questions formed the basis of this experiment's hypotheses.

Methods/Materials
Materials: Microwave oven; Tap water; Distilled water; Glass containers in 3 shapes - walls flaring upwards, straight walls, and walls flaring downwards; Non-glossy internal surface container with small pores (Styrofoam); Salt, sugar, and coffee; Insulated gloves.
Protocol to measure time to post-superheating nucleation:
Put 200 mL. of liquid into container and place in microwave oven. Heat for 7 minutes. Observe when boiling first occurs and record time elapsed from initiation of heating. Let heating continue until sudden nucleation and accompanying 'explosion' occurs and again record the elapsed time. Use insulated gloves to carefully remove container.
Repeat this protocol for each set of independent variables described in each hypothesis - different container shapes, container materials, container surfaces, and solutions.

Results
The container with upward flared walls had the highest time to post-superheating nucleation followed by the one with straight walls and the one with walls flaring downwards. The container with pores on the internal surface had no post-superheating nucleation; once normal nucleation began, it continued. The container with scratches on the internal surface had similar results. Finally, the salt solution too had no post-superheating nucleation, while the time to post-superheating nucleation for the sugar and coffee solutions was longer than that for plain water. Error bars of one standard deviation were used for analysis.

Conclusions/Discussion
The observations supported all 4 hypotheses. Post-superheating nucleation is impacted by the characteristics of the container - the shape and the internal surface - as well as the characteristics of the liquid being heated. Results from this experiment offer suggestions for better regulating post-superheating nucleation and avoiding its catastrophic effects.

Summary Statement
This project examined post-superheating nucleation in microwave heating. Specifically, I studied the effect of varying a container's characteristics, as well as those of the liquid being heated, on the time to post-superheating nucleation.

Help Received
Parents helped with transportation and with buying materials.