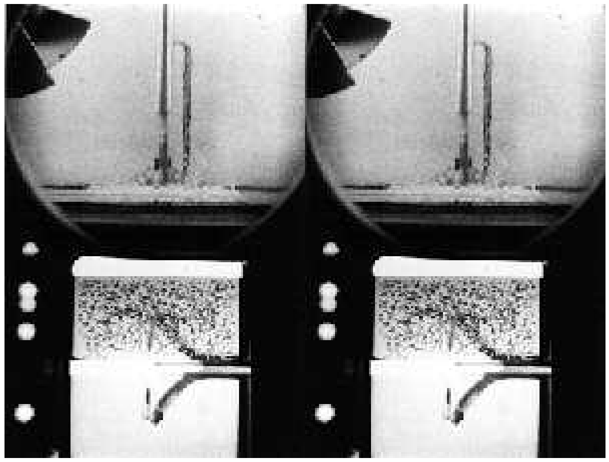
Pool Boiling Experiment Has Five Successful Flights



Pool Boiling Experiment.

The Pool Boiling Experiment (PBE) is designed to improve understanding of the fundamental mechanisms that constitute nucleate pool boiling. Nucleate pool boiling is a process wherein a stagnant pool of liquid is in contact with a surface that can supply heat to the liquid. If the liquid absorbs enough heat, a vapor bubble can be formed. This process occurs when a pot of water boils. On Earth, gravity tends to remove the vapor bubble from the heating surface because it is dominated by buoyant convection. In the orbiting space shuttle, however, buoyant convection has much less of an effect because the forces of gravity are very small. The Pool Boiling Experiment was initiated to provide insight into this nucleate boiling process, which has many earthbound applications in steam-generation power plants, petroleum plants, and other chemical plants. In addition, by using the test fluid R-113, the Pool Boiling Experiment can provide some basic understanding of the boiling behavior of cryogenic fluids without the large cost of an experiment using an actual cryogen.

The experiment was conceived by Professor Herman Merte of the University of Michigan, was developed by the NASA Lewis Research Center, and is supported by NASA Headquarters' Microgravity Science and Applications Division. The pool boiling prototype system, which was initially flown on the STS-47 shuttle mission in September 1992, acquired a considerable amount of scientific data. The expected boiling pattern was observed in all high-heat-flux cases, but a different pattern was observed in the low-heat-flux cases. These differences appear to be caused by the rewetting of the heater surface. Photographic data indicate that the saturated cases experienced a more activated boiling process (more vapor than expected was generated).

Some minor modifications were made in the timing sequences in the test matrix on the next two experiments that were flown on space shuttle flights STS-57 and STS-60. This

was done to increase the probability of observing the initial dynamic vapor bubble growth while the camera was running at the higher speed and to observe the influence of a stirrer on the active boiling process. Currently, results appear to indicate the potential for quasi-steady nucleate pool boiling in long-term microgravity, with certain combinations of levels of heat flux and bulk liquid subcooling. These were the first experiments of nucleate boiling obtained for long periods of microgravity, and the matrix test conditions were selected in part to cover a reasonably broad range of test parameters.

The primary objective of the last two experiments, flown on STS-72 and STS-77, was to determine the factors governing the onset of dryout and/or rewetting on a flat heater surface. On the STS-72 mission, the subcooling levels were increased, whereas on the STS-77 mission, the heat flux levels were reduced. For high-heat-flux levels at all but the highest subcooling, dryout was observed. For lower levels of heat flux where dryout did not take place, it appeared that the excess surface energy associated with the coalescence of bubbles was sufficient to impel the resulting combined bubble away from the vicinity of the heater surface. This sufficiently stirred the liquid so as to bring the subcooled liquid to the heater surface.

Find out more about the Pool Boiling Experiment, Lewis' fluids experiments, and other Lewis microgravity experiments at our PBE homepage.

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