MASTER

Improvement and Verification of Fast Reactor Safety Analysis Techniques

Progress Report

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Abstract

Several of the time dependent properties of the dimethyl sulfoxide-acetyl chloride reaction system were determined.

The volume of a wax cylinder melted by conducting a dimethyl sulfoxide-acetyl chloride reaction in the vessel was compared with the melted volume calculated using several different heat transfer correlations. It was found that a laminar flow at the wall model provided the most accurate calculation of the observed melted volume.

Introduction

In the progress report covering contract work performed during the period of April 1, 1979 to June 30, 1979 (C00-2571-17) several heat transfer correlations were described. A portion of the physical properties of the dimethyl sulfoxide (DMSO)-acetyl chloride (AC) reaction system necessary for use in the described heat transfer correlations were described in the progress report covering work performed from July 1, 1979 to September 30, 1979 (C00-2571-18). The remainder of the necessary properties were determined during the contract period covered by this report.

The volume of wax which was melted by conducting a DMSO-AC reaction in a wax vessel was compared with that calculated by using the proposed heat transfer correlations. The results of this comparison are presented as a portion of this report.

The methods and results of this contract period are described in brief form in the body of this report with a reference to the appendix for a more detailed discussion.

Equipment to carry out a similar set of tests in a closed system is being assembled.

Volumetric Heat Generation

The volumetric heat generation was determined by dividing the product of the mass loss per time and the heat of vaporization by the liquid pool volume. A more detailed description may be found in the appendix on pages 66 to 68.

Superficial Vapor Velocity

The superficial vapor velocity was calculated as the vapor volume generation rate divided by the cross-sectional area of the vessel. Pages 62 to 65 of the appendix contain a more detailed description of the calculation.

Bulk Liquid Temperature

The bulk liquid temperature was measured by means of a thermistor suspended concentrically approximately 1.5 cm above the floor of a wax cylinder in which a DMSO-AC reaction was conducted. A more detailed description of this method may be found on pages 57 to 59 of the appendix.

Pool Height

The height of the liquid pool as a function of time was determined by means of super movie films which were taken of the reaction being conducted in a glass cylinder. This procedure is detailed more completely on pages 59 to 62 of the appendix.

Area for Heat Transfer

The area for heat transfer was determined from 35 mm photographs. The photographs had been taken at 5 sec to 10 sec intervals of the

DMSO-AC reaction being conducted in a half cylinder of wax which had been fused to a glass plate. This procedure is described in more detail on pages 75 and 97 to 101.

Conclusions

The heat transfer correlations used in this study consisted of an altered free convection model, a laminar flow at the wall model and a turbulent penetration model. The findings of this study indicate that the laminar flow at the wall model provides the most accurate calculation of the actual heat transferred to the wall. The turbulent penetration model provided results which were approximately 50% higher than observed. The altered free convection model provided results that were approximately 50% lower than the observed. A more detailed discussion of the results and findings of this study are found on pages 102 to 106 of the appendix.

Continuing Research

All experiments in this study were conducted in an open system at atmospheric pressure. Many core disruptive accident (CDA) scenarios describe a crust of fuel and steel forming in the reactor void spaces during the CDA. Should this occur, a closed system would be formed. To observe the effects which may occur as a consequence of the system closure, many of the experiments in this study will be repeated in a closed environment where pressure will change as a function of time. The crust formation in the DMSO-AC system conducted in a cavity in SUN-3420 wax will be quantified to better understand the crust formation which may occur in a CDA in an actual reactor.

Should a CDA occur in which total core melt occurred within 1000 seconds and the containment maintained its integrity for 24 hours, as required by the NRC for the Clinch River Breeder Reactor, (Nuc. News, July 1976), the physical properties of the system would be more constant after the initial 1000 seconds than those of the DMSO-AC system used in this study. To provide for more constant physical properties in the DMSO-AC reaction system, future research will consist of repeating many of the experiments of this study in such a fashion that fresh reactant may be added and reaction mixture removed in a controlled fashion. This will sustain the heat generation over a prolonged period of time and will maintain the physical properties of the system at constant values. To control the reaction would allow properties such as pool height and temperature difference to be maintained at a constant value. This would eliminate much of the scatter observed in the data of this study and would provide for a sustained temperature difference of sufficient magnitude to allow the accurate measurement of the downward heat transfer.

Thesis Cycled Separately.