MASTER

Library
Astronuclear

WANL-TMI-419

December 13, 1962

COMPARISON OF EXPERIMENTAL DATA WITH COMPUTER CALCULATED VALUES
FOR SINGLE PHASE FLOW AND TRANSIENT HEAT TRANSFER TO GASEOUS HYDROGEN

by
John W. H. Chi

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Distribution

Dr. W. H. Esselman
Dr. W. H. Arnold, Jr.
Mr. H. F. Faught (2)
Dr. E. A. DeZubay
Mr. F. D. Retallick
Mr. J. G. Gallagher

Dr. A. H. El-Waziri
Mr. K. L. Rieke
Mr. J. W. Sadler
Mr. G. R. Thomas
Mr. A. M. Vetere

DISTRIBUTION OF THIS DOCUMENT UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

SUMMARY

Comparisons between experimental data obtained from single-phase gaseous hydrogen cool-down with those computed from a computer program have shown excellent agreements.

It has been concluded that on the basis of these results, a high degree of confidence can be placed on

1. The experimental results from the test loop, and
2. The computer program for single-phase gaseous hydrogen flow and heat transfer.

INTRODUCTION

In a previous memorandum*, the writer presented data from studies on heat transfer to single-phase gaseous hydrogen in a two-foot copper tube. The various pressure drop and heat transfer correlations applicable to the system were discussed. This memorandum presents comparisons of the experimental data with those calculated from a computer program.

* "Fluid Flow and Transient Heat Transfer of Gaseous Hydrogen at Low Temperatures",
WANL-TMI-344.

COMPARISON OF EXPERIMENTAL AND COMPUTED DATA

A computer program has been written by the Reactor Analysis group for the study of single-phase gaseous flow and heat transfer in a single pass. Based on the same initial conditions as those found in experimental Run 1-GH-1*, the temperature and pressure drop histories for the test section were computed. These results are compared with the measured values in Figures 1, 2 and 3.

* i. d.

DISCUSSIONS

It is evident from Figure 1 that the agreement between computed and measured temperatures at the inlet to the test section is excellent. This is expected since the pressure and flowrate inputs to the computer as well as the initial temperatures were based on the experimental data. At the inlet to the test section, the maximum deviation in wall temperatures is 3% and that of the fluid is 1%; the average deviations are negligible.

The more significant comparisons are those at the exit of the test section. As seen from Figure 2, the computed temperatures at the exit to the test section are in general lower than the measured values. The average deviation in wall temperatures is 2% with a maximum of 5%. The average deviation in fluid temperatures is 2% with a maximum of 6%. The deviations are well within the experimental error.

A comparison of measured and computed pressure drops is shown in Figure 3. As seen from the figure, the measured pressure drops are consistently higher than those computed. This is readily explained by the fact that thermocouples had been inserted into the stream for the measurement of fluid temperatures, resulting in additional friction; consequently higher pressure drops were observed. The apparent "equivalent roughness factor" for the test section is 1.5 (compared to a smooth tube). The hand-calculated steady-state pressure drop based on a "rough" pipe is seen in Figure 3 to be between the computer calculated values for a smooth tube and those observed experimentally.

CONCLUSIONS

The slight discrepancies between the measured and calculated temperatures at the exit to the test section have been satisfactorily explained by the known experimental conditions; therefore the agreement between experimental and computer calculated temperature and pressure measurements can be considered excellent. This check suggests that a high degree of confidence can be placed on

1. The experimental results from the test loop, and
2. The computer program for single pass, single phase gaseous flow and heat transfer.

Figure 1 COMPARISONS OF CALCULATED AND MEASURED INLET WALL AND FLUID TEMPERATURES

Figure 2 COMPARISONS OF CALCULATED AND MEASURED EXIT WALL AND FLUID TEMPERATURES

Figure 3 COMPARISON OF CALCULATED AND MEASURED PRESSURE DROPS ACROSS THE TEST SECTION