UMH - 3

CONTRACT NOrd 7924

QUARTERLY REPORT

(Period 1 October 1950 to 31 December 1950)

UMH-3-B BOUNDARY-LAYER STUDIES

UMH-3-D TURBULENCE

PROBLEM STATEMENT

The problem embraces the measurement of scale and intensity of turbulent fluctuations in air velocity and a study of the effect of turbulence on the rate of evaporation of a liquid fuel spray whose drop size distribution is to be determined. This includes the development of a method for comparing the rates of evaporation in a series of experiments. The variables to be investigated are intensity and scale of turbulence and the air velocity.

PERSONNEL WORKING ON PROBLEM

The personnel working on the problem are A. R. Hanson and A. M. Kuethe (supervisor).

WORK ACCOMPLISHED

(Period 1 October 1950 to 31 December 1950)

Summary

Earlier discrepancies in the theory of the effect of relative velocity upon rate of evaporation have been largely cleared up. Except for a few minor points, the application of this theory to the data has been completed.

Discussion

A new determination of the average velocity of the spray leaving the nozzle was made by measuring directly the thickness of the spray-cone close to the tip of the nozzle. Under the assumption that the spray is still mainly an unbroken sheet of liquid, the average velocity can be calculated from the known mass flow and the equation of continuity. The

new value of the initial spray velocity is much lower than that used earlier. A check on the present value will be made by the Engineering Mechanics Department, using equipment which measures the spray-cone thickness by electromechanical means.

It is found that the theory of Frössling[1] for the evaporation of small, single drops may be applied to the present problem. The agreement with experiment is satisfactory, considering the assumptions necessary in carrying over the theory to a spray of drops.

The question of the temperature of a representative drop during its motion through the test section has been analyzed. An approximate calculation of drop temperature as a function of time after leaving the nozzle shows that within a few tenths of an inch of the nozzle the temperature has practically leveled off at the wet-bulb temperature (i.e., wet-bulb, with respect to hexane). This means that over the range of the tests, in which $9 \leq x \leq 26$ inches, it is safe to say that temperature and vapor pressure are constant at the surface of the drop.

FUTURE WORK

(Period 1 January 1951 to 31 March 1951)

Work will be continued towards clearing up remaining points in the application of Frössling's theory. This done, the final report for the contract will be prepared.

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[1] Frössling, N., "Uber die Verdunstung fallender Tropfen," Gerlands Beitrage zur Geophysik, 52, 170-216 (1938).

UMH-3-F ON THE TRANSPORT PHENOMENA IN RARIFIED GASES

PROBLEM STATEMENT

Theoretical investigation of transport phenomena in rarified gases.

PERSONNEL WORKING ON PROBLEM

The personnel working on the problem are C. S. Wang Chang and George E. Uhlenbeck.

WORK ACCOMPLISHED

(Period 1 October 1950 to 31 December 1950)

A report (CM-654), entitled "The Transport Phenomena of Very Dilute Gases II" containing the zeroth approximation calculation of the drag on a small moving sphere and a small moving plate has been completed. The difficulties in evaluating the integrals have as yet prevented us from making any progress in the higher order approximation calculation of the drag on a small moving object.

In the meantime, we have looked again at the theory of the effect of the internal degrees of freedom on the transport phenomena as mentioned also in our first report (CM-443), "On the Transport Phenomena in Rarified Gases." Our special interest is the effect of the internal degrees of freedom on the dispersion of high-frequency sound in polyatomic gases.

UMH-3-H HYDRAULIC VACUUM DEVICE

PROBLEM STATEMENT

Study of the characteristics of hydraulic vacuum devices which may be used in connection with large hydraulic compresscrs. This investigation is to cover vacuum-air mass flow characteristics down to one-tenth atmosphere absolute pressure for an assumed optimized design. The study is to be theoretical and experimental on scale models and is to be carried to such a stage that a comprehensive evaluation can be made of the device's usefulness in connection with a supersonic ram jet testing laboratory.

PERSONNEL WORKING ON PROBLEM

The personnel engaged on this project are L. Talbot, W. W. Hagerty, and R. A. Dodge.

WORK ACCOMPLISHED

(Period 1 October 1950 to 31 December 1950)

The experimental work on the Hydraulic Vacuum Device shows that it has serious limitations. When drawing low pressure air the ratio of water to air by weight gets to be very large. A report on the work was nearly completed but the study of the data suggested a modification which may improve the performance. Consequently, a few new experiments are now being made to test this latest idea. It now appears quite certain that the most practicable system would consist of a combination of a conventional Taylor compressor and a supersonic ejector. Calculations on the efficiency of this combination are being made now. Aside from the actual efficiency of the process, the combination appears to be desirable because compressed air can be stored and drawn down during a test run. There seems to be no way to parallel this process with the Hydraulic Vacuum Device.

FUTURE WORK

(Period 1 January 1951 to 31 March 1951)

It is planned to investigate a new method of air entrainment using the principle of momentum exchange as opposed to suction methods. This is being done in the hope of improving the ratio of air to water.