ΔT_S^*, coefficient of thermal efficiency; λ, velocity coefficient; $\mu = m_\chi/m_0$, relative mass flow rate of cold stream; ρ, density. Subscripts: 1, 2, 0, x, for the parameters of the beginning and end of the expansion process for cold flow arriving at the nozzle insert.

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NONEQUILIBRIUM NEGATIVE PRESSURES

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The possibility of obtaining brief negative pressures in real pipeline systems under definite nonequilibrium processes is experimentally considered.

A negative pressure is one of the metastable states at which the effect of tension and the subsequent discontinuity of the fluid appears. There are numerous results of experimental researches of static and dynamic nature in which a negative pressure appears to some degree [1]. Starting with the first tests of F. M. Donny, who obtained a negative pressure of just −0.12 bar and ending with the researches of L. J. Briggs who reached the value −425 bar, the main condition for the appearance of the effect in the tests performed was adequate "purity" of the fluid and the vessel, i.e., absence of any gas bubbles, impurities, foreign films, etc.

We investigated the condition for the origination of negative pressures in real pipeline systems for definite nonequilibrium transients. The diagram of the experimental set-up is represented in Fig. 1, where 1 is the high-pressure trap (3 m^3); 2 is the pipeline; 3 is the shutoff valve; 4 is a chromel-kopel thermocouple; 5 is a differential manometer; 6 is a valve; 7 is a tank; 8 are regulating gates; 9 are pumps; D are pressure strain gauges; DV is a Dewar vessel; P is the potentiometer P-363/1; CP is the control panel; Osc is the oscilloscope K12-22; A is an amplifier, and PR is a pressure regulation system. The working length of the horizontally mounted steel pipeline was 30 m. The cutoff valve assured practically instantaneous (10^{-2} sec) turn-on (or off) of the flow. The characteristic of the nonstationary process originating in the flow was recorded by the oscilloscope and potentiometer by means of appropriate pressure and temperature sensors. Semiconductor strain gauges developed in the Institute of Physics of the Academy of Sciences of the Azerbijan SSR were used as pressure sensors [2].

Water and viscoelastic oil from the Balakhyn—Sabunchi—Romaninskii deposits were used in the tests. When the cutoff valve was opened the fluid under investigation flowed into the

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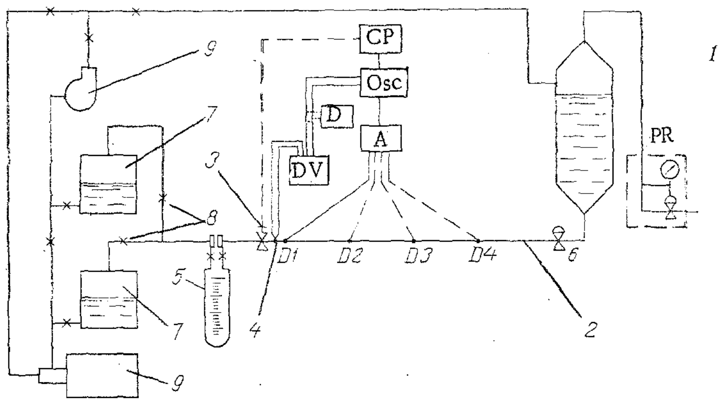

Fig. 1. Diagram of the experimental set-up.

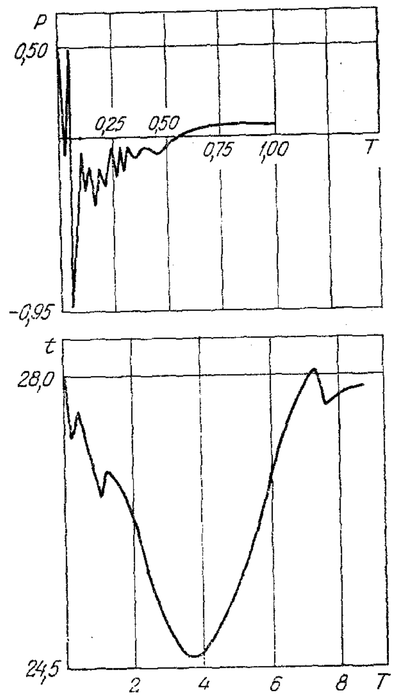

Fig. 2. Oscillograms of the pressure and temperature changes. P, MPa; t, °C; T, sec.

trap in which a definite pressure P_0 exceeding atmospheric pressure substantially was produced by using the air pressure regulator. Then the flow was cut off by means of the cutoff valve mounted at the end of the pipeline and the stream pressure and temperature changes were here recorded at the measuring point D1 at a 0.25-m distance from the cutoff.

The results of numerous tests performed show that upon the rapid shutoff of a flow in a pipeline previously pressurized to P_0 an abrupt pressure and temperature reduction occurs in the system. The pressure can here become negative for a brief time.

A characteristic oscillogram of the pressure and temperature changes upon the shutting off of the water flow (P_2 = 0.5 MPa, t = 28.0°C) is presented in Fig. 2.

As is seen, the process of the occurrence of a negative pressure whose limit value is −0.95 MPa occurs in fractions of a second. The temperature drop here, which agrees qualitatively with the pressure change, appears considerably later.

The temperature reduction phenomenon observable during a nonequilibrium negative pressure is in agreement with the deduction of the Frenkel theory about the fact that the fluid temperature should be reduced under an inverse adiabatic discontinuity [3].

Qualitatively analogous results are obtained in tests with water under the same conditions but with a lower initial temperature (13.8°C); however, the effect here appears more definitely, the temperature drops by 5.5°C maximum, and the pressure to −2 MPA. This fact is in agreement with the Briggs results which established that the limit bulk strength gradually diminished for water in the 5-50°C range as the temperature rose [1].

Recording the pressure and temperature at the point D2 at a 5-m distance from the cutoff yielded qualitatively analogous results.

Tests were also conducted with water with a surfactant added. The pressure reduction here is somewhat smaller and there is no negative pressure effect. This result agrees with the Frenkel theory about the role of surface tension in the appearance of a negative pressure. Tests also showed the significant attenuation of the effect as the percentage gas content increased in the flow.

Analogous results were obtained in tests with oil. A considerable temperature drop, up to 10°C, was here observed during the existence of the negative pressure.

The nonstationary effect pinpointed permits utilization of real fluid systems to obtain and investigate negative pressures, while great strictness relative to the fluid purity must be maintained in the static approach. This circumstance affords the possibility of producing and using brief negative pressures in many engineering processes.

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STATISTICAL THERMODYNAMICS OF SCHOTTKY DEFECTS IN MOLECULAR AND IONIC CRYSTALS

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A statistical thermodynamics of point defects is constructed that permits taking account of the influence of vacancies on both the thermodynamical and structural properties without involving any experimental information.

The study of the thermodynamics of point defects, and particularly of vacancies, is an important problem in connection with the influence they exert on the macroscopic properties of a substance [1].

A sequential description of the properties of defects should rely on the microscopic theory whose problem is to describe the local structure of the material in the neighborhood of the defect, on the one hand, and to give a description on this basis of the thermodynamical properties of a crystal with defects, on the other hand.

An approach of such a kind, based on the statistical method of conditional distributions [2], was developed earlier [3] and applied to an analysis of the equilibrium concentration of vacancies [4] in a molecular crystal. In this paper results are presented of systematic computations of the energy of vacancy formation for a molecular crystal, and in addition, the theory is extended to ionic crystals.

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