

THE SHOCK WAVE OF UNDERWATER NUCLEAR EXPLOSION

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Abstract: On the basis of experimental data and theoretical asymptotics, thermal and caloric equations of state (including the two-phase water–steam domain) at temperatures up to 10 000 K and densities from 0 to 2.3 g/cm³ have been obtained. The computer simulation of shock wave propagation at underwater nuclear explosion is performed. In determining the initial data, the results of solving the problem of strong self-similar explosion in water were used. Interpolation formulae are obtained for the dependence of the pressure on the front of the shock wave on a distance it traveled and for the dependence of the distance on time. The TNT equivalent and the amount of steam formed during the underwater nuclear explosion have been estimated.

Keywords: equation of state; heat capacity; water; steam; nuclear explosion; shock wave; strong self-similar explosion; asymptotics; vaporization

References

1. Kuznetsov, N. M. 1961. Uravnenie sostoyaniya i teploemkost' vody v shirokom diapazone termodinamicheskikh parametrov [The equation of state and the specific heat of water in a wide range of thermodynamic parameters]. *PMTF* 1:112–120.
2. Kuznetsov, N. M. 1959. Udarnaya volna podvodnogo atomnogo vzryva [The shock wave of underwater nuclear explosion]. Ph.D. Thesis. ICP AS USSR Library. Inv. No. 3/4083. 129 p.
3. Sedov, L. I. 1977. *Metody podobiya i razmernosti v mekhanike* [Similarity and dimensional methods in mechanics]. Moscow: GTTI. 440 p.
4. Koul, R. 1950. *Podvodnye vzryvy* [Underwater explosions]. Moscow: IL. 494 p.
5. Anisimov, S. I., and N. M. Kuznetsov. 1961. Avtomodel'nyy sil'nyy vzryv v vode [The self-similar strong explosion in water]. *PMTF* 6:167–168.
6. Kochina, N. N., and N. S. Mel'nikova. 1958. O sil'nom tochechnom vzryve v szhimaemoy srede [On strong point explosion in a compressible medium]. *PMM* XXII(1):3–15.
7. Kuznetsov, N. M. 1981. Dvukhfaznaya sistema voda–par. Uravnenie sostoyaniya, skorost' zvuka, izentropy [The two-phase water–steam system. Equation of state, speed of sound, isentropes]. *Dokl. AN SSSR* 257(4):858–860.
8. Vukalovich, M. P., S. L. Rivkin, and A. A. Aleksandrov. 1969. *Tablitsy termodinamicheskikh svoystv vody i vodyanogo para* [Tables of thermodynamic properties of water and steam]. Standards Publs. 220 p.
9. Trinitrotoluol [Trinitrotoluene]. 1995. *Khimicheskaya entsiklopediya* [Chemical encyclopedia]. Izd-vo Bol'shaya Rossiyskaya Entsiklopediya. 4:637.

10. Landau, L. D. 1945. Ob udarnykh volnakh na dalekikh rasstoyaniyakh ot mesta ikh vozni-
knoveniya [On shock waves at large distances from the place of their origin]. *PMM* IX(4):286–
292.
11. Landau, L. D., and E. M. Lifshits. 1954. *Mekhanika sploshnykh sred* [Continuum mechanics].
2nd ed. Moscow. 624 p.

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