

DIFFERENCES BETWEEN BLAST IN AIR AND WATER

W. Arnold¹, E. Rottenkolber²

¹*TDW Gesellschaft für verteidigungstechnische Wirksysteme, Hagenauer Forst 27,
86529 Schrobenhausen, Germany*

²*Numerics GmbH, Mozartring 3, 85238 Petershausen, Germany*

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Detonations in air and underwater show significant differences in a variety of aspects and effects. In the present paper, we illustrate and describe these differences and attempt to explain them by the properties of the media. In particular we discuss the following topics:

- The characterization of an explosive shock in air is frequently done by giving the peak pressure and the positive impulse. In the underwater explosive shock a positive phase cannot be defined. Instead a decay time must be used to define a useful integration interval.
- Underwater shocks are traditionally characterized by their energy flux density, a magnitude that can be derived from the pressure history in water. The pressure history in air is not sufficient to calculate the energy flux.
- The shock velocity in air varies strongly with shock strength. Time of arrival measurements can be used to determine the peak overpressure even for weak shocks. In water, the shock velocity quickly drops to the sound velocity. It cannot be used to calculate the strength of weak shocks.
- The interface between detonation products and water is stable and maintains a smooth surface during bubble expansion and collapse. The interface between detonation products and air is unstable and products and air start to mix during the expansion phase.
- A consequence of mixing with air is that aerobic afterburn of under-oxidized detonation products becomes possible. Chemical reactions of detonation products with water are restricted to the smooth interface and can therefore hardly contribute to underwater performance.
- A metal casing around an explosive charge mitigates the shock wave in air. The shock wave in water benefits from a metallic casing.
- Similarly, a high detonation pressure and velocity lead to a strong shock in air, whilst energy release at lower pressures is beneficial for the underwater shock.

From the last topics it follows that compared to airblast applications the design of underwater explosives and warheads poses significantly different requirements on the weapon developer.