

DETONATION PRESSURES IN SOME CONDENSED
EXPLOSIVES AT LOW AND HIGH INITIAL
DENSITIES.

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SUMMARY

Detonation pressure measurements using the multiple flash-gap technique have been found earlier to give good agreement with calculated data for cast and pressed solid explosives.

This report presents results showing a relatively large difference between experimental and calculated detonation pressures for liquid explosives. The difference appears to be coupled with a deviation from the condition of self-similar flow. The possibility of a deviation from the classical Chapman-Jouguet theory is discussed.

The report gives the text of a paper presented at the Second International Colloquium on Gas Dynamics of Explosions and Reactive Systems, Novosibirsk, USSR August 24 - September 2 1969.

DETONATION PRESSURES IN SOME CONDENSED EXPLOSIVES AT LOW AND HIGH
INITIAL DENSITIES

I would like to show some results of experiments designed to measure the detonation pressure of some simple high explosives. I am bringing these to your attention not because they are more accurate than similar measurements made at other laboratories, but because they give further evidence of deviations from the simple theory of an ideal Chapman-Jouguet detonation followed by a region of self-similar flow which we have been used to apply to any type of detonation as long as we have satisfied ourselves that the detonation velocity is close to the infinite diameter value.

Slide 1

The experimental arrangement is simply a stack of perspex plates in contact with the end surface of a cylindrical charge of length-to-diameter ratio 5. The plates are separated by extremely narrow air-gaps, and we record with a fast photomultiplier the consecutive light-pulses caused by the closure of the gaps by the shock wave. This gives us a plot of perspex shock velocity versus distance from the explosive end surface.

In the simplest analysis we extrapolate this to get the shock velocity at the interface, which in turn gives a detonation pressure by shock-impedance matching provided we know the detonation velocity and the perspex shock adiabat.

Slide 2

These are experimental results obtained in this manner, compared with Mader's calculated ideal detonation pressures. For the compact solid explosives, we have a very satisfactory agreement with the exception of TNT, where the very large content of free carbon makes the calculation difficult. For each explosive, the experiments were made at a charge diameter large enough for the detonation velocity to deviate less than 2% from the infinite diameter value. To investigate the rather large deviations for NG, we made a series of experiments at different charge diameters ranging from 10 mm, which is about seven times the critical diameter, to 40 mm. The results are shown in the next slide.

Slide 3

I have plotted the perspex shock velocity versus distance from the explosive end surface into the perspex. All these charge diameters are large enough for the radius of curvature of the front to be at its limiting value of about 3.5 charge diameters, and the detonation velocity to be within fractions of a percent from the infinite diameter value. This is thus well within the range of conditions where we would in the past have applied the theory of an ideal Chapman-Jouguet detonation followed by a region of self-similar flow. The self-similarity of the flow would extend into the perspex and we would have felt justified in making the measurement for one charge diameter and plotting the measured shock velocity as a function of a dimensionless distance normalized by the charge diameter. It is obvious from these results that such a procedure would lead to an error. The four curves are not brought to coincide no matter how we normalize the distance. We must conclude that these results appear to indicate an appreciable unexplained deviation from the simple theory.

SLIDE 4

Explosive	Density g/cm ³	Perspex Shock Velocity km/sec	Detonation Velocity km/sec	Detonation Experiment kbar	Pressure Calculated kbar
TNT	1.59	5.60	6.87	198	175
60/40 RDX/TNT	1.69	6.20	7.81	271	282
60/40 HMX/TNT	1.76	6.60	8.00	315	311
70/30 HMX/TNT	1.76	6.60	8.20	315	319
IPN	1.04	5.02	5.31	94	
NM	1.13	4.96	6.26	106	127
NG	1.60	5.92	7.58	218	239





