INITIATION OF NITROGLYCERINE BY SHOCK WAVES

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It is usually assumed that the reaction in steady detonation is initiated by the impact of the shock wave which proceeds with the velocity of the detonation and the front of which coincides with that of the reaction zone. R a t n e r 1) has calculated the pressure, velocity and temperature at the front of the shock wave in detonating nitroglycerine to about 500 000 atm, 4000 m/s and 3000°C respectively. He adopts for the nitroglycerine the following extrapolated equation of state:

\[ p = a \varrho T + b \varrho^4 - f \varrho^3, \]  

(1) 

in which \( p \) is the pressure, \( \varrho \) the density and \( T \) the absolute temperature. He indicates the constants as being in CGS-units:

\[ a = 1.9 \times 10^7, \quad b = 0.8 \times 10^{10} \quad \text{and} \quad f = 1.51 \times 10^{10}. \]

There are no data published for nitroglycerine at high pressure, but a critical examination shows that (1) is in poor agreement with Bridgman's data for the compressibility of liquids. A better idea of the conditions for the initiation of nitroglycerine by moderately strong shock waves would probably be obtained by comparing the nitroglycerine with other fluids and using the fact that different fluids behave, broadly speaking, alike as regards the compressibility.

For water extensive investigations have been made concerning the propagation of shock waves. The table shows, according to Kirkwood 2) and his co-workers, the connection for water of initially 20°C between the velocity of low \( u \), velocity of propagation \( U \), increase in temperature \( \Delta T \), pressure \( \varrho \) and increase in internal energy \( E \).
A rapidly rising part of the internal energy will, with increasing velocity, be in the form of elastic energy. As long as \( u \) is below 1200 m/s, one can, however, put as an approximation

\[
\Delta T = \frac{u^2}{2c}
\]

in which \( c \) is the specific heat. As the fluids behave rather alike, this formula can be assumed to be applicable also to the shock waves in other fluids. Another method is to put

\[
(c\Delta T)_I = (c\Delta T)_{II}
\]

for two fluids I and II at the same velocity of flow in the shock wave. The following table shows the temperature increase calculated for nitroglycerine with water as a comparison fluid. The specific heat of the nitroglycerine has been taken to be 1.68 kW\( \cdot \)s/kg\(^\circ\)C.

**TABLE II**

<table>
<thead>
<tr>
<th>( u ) m/s</th>
<th>( \Delta T ) °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>426</td>
<td>90</td>
</tr>
<tr>
<td>689</td>
<td>170</td>
</tr>
<tr>
<td>898</td>
<td>250</td>
</tr>
<tr>
<td>1075</td>
<td>320</td>
</tr>
<tr>
<td>1235</td>
<td>380</td>
</tr>
</tbody>
</table>

It can be mentioned that Ratnere's equation gives

\[
u \quad \Delta T^\circ C
\]

\[
800 \quad 200
\]

\[
900 \quad 400
\]