струи имела пористую структуру и испытывала действие интенсивных растягивающих напряжений.

Таким образом, проведенные теоретические исследования показали, что даже небольшие по величине изменения в форме головной части (всего-то ± 1.5 мм в ту или иную сторону от плоского торца) могут привести к значительному изменению скорости движения жидкой микроструи, а значит, и к существенному изменению ее импульса.

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EXPLOSIVE FORMATION OF HIGH-SPEED LIQUID JETS

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High-speed liquid jets (Figure 1) are widely used in various fields of science and technology, some areas of which can be traced in Figures 2-4, taken from [1 - 3]. In this case, liquid jets can be formed in various ways.

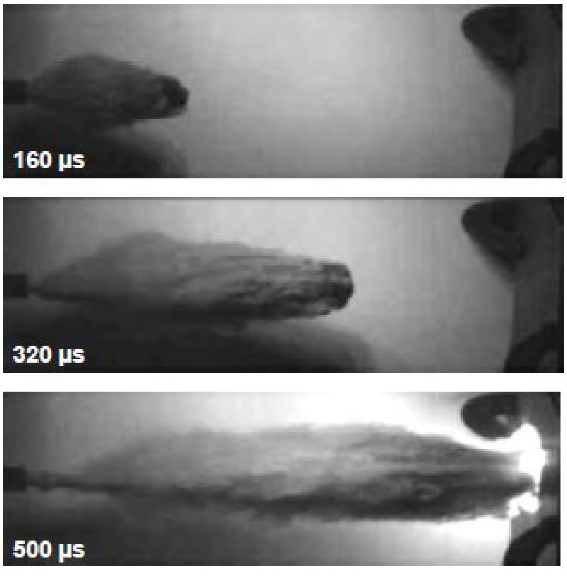


Figure 1. High-speed images liquid jet at various points in time

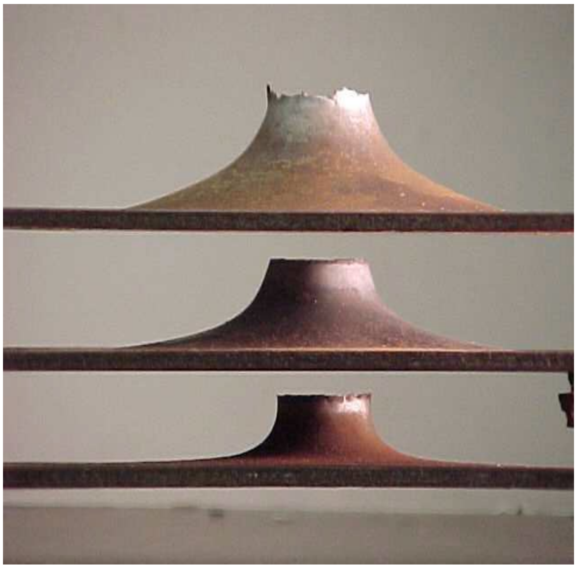


Figure 2. Firmware of three placed together 4.8 mm steel plates, water projectile weighing 240 g

Figure 3. The destruction of the reinforced concrete block with a thickness of 16 cmusing a water projectile weighing 230 g

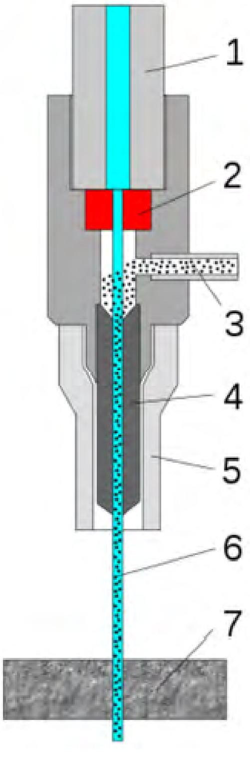


Figure 4. Typical installation scheme for waterjet cutting: 1 - high pressure water supply; 2 - nozzle; 3 - abrasive feed; 4 - mixer; 5 - casing; 6 - cutting jet; 7 - material to be cut

In order to miniaturize and create compact actuators for the formation and acceleration of a liquid jet to high speeds, explosives can be used. In this case, it is of interest to study the problems of interaction between the explosion products (EF) and the liquid, the parameters of the emerging liquid jets and the dynamics of their movement in the air.

In the present work, with the help of AUTODYN in the simplest setting, a numerical simulation of the explosive formation in air of high-speed liquid jets from a through cylindrical hole 6 mm in diameter in a steel plate 30 mm thick was carried out.

An explosive charge with TNT parameters was located at one end of the hole, the remaining part was occupied by a liquid (water). In the calculations, the lengths of the charge and the liquid were varied, while their masses did not exceed 1 g, and the free surface of the liquid could have a different shape — a flat, convex, cumulative notch. Consequently, with the selected parameters, an explosive formation of liquid micro jets takes place at a high speed, which ensures a short duration of the interaction of micro jets with energetic materials, if in practice this can occur.

The charge was initiated on the surface of the free end.

In the calculations, the effect of the parameters of the explosive charge and liquid on the mass-velocity characteristics of the formed microjet was estimated.

The equation of state for a fluid was given in the form of a “Shock” with Pmin = 0.

Table 1 shows some of the considered schemes for the explosive formation of high-speed liquid jets; μs), formed due to the action of tensile stresses in the liquid (cavitation). The maximum speed of the head of the jet V_{max} was determined by the motion parameters calculated in moving markers located in different sections along the axis of the liquid jet and in this variant reached a value of 1181 m/s (third column of table 1).

In further calculations according to this variant, the lengths of the explosive charge (the length increased) and the liquid column (the length decreased) were changed; The results of these calculations for V_{max} (β) are shown in Figure 5, from which it can be seen that when the length of the liquid column is 10 mm (β = 2.44), its maximum speed reaches a significant value of 2129 m/s.

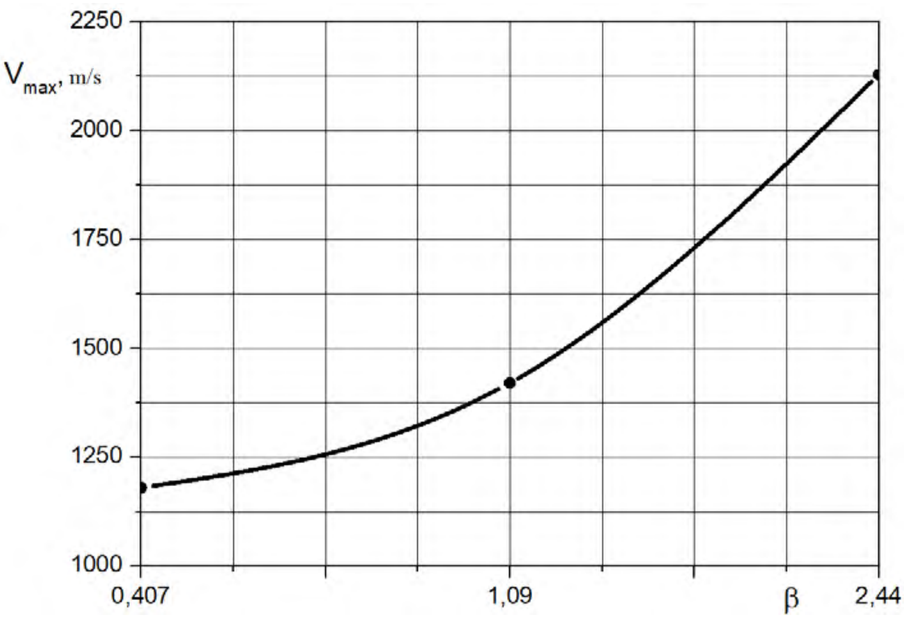
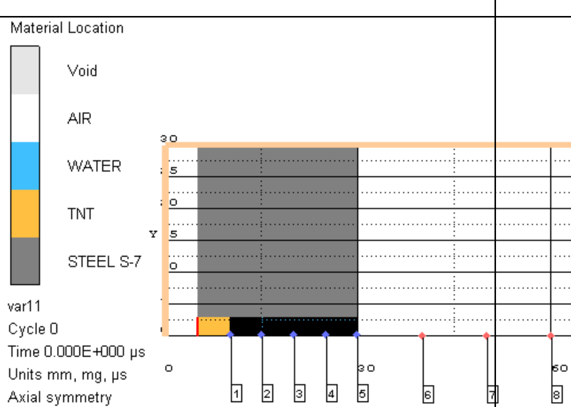
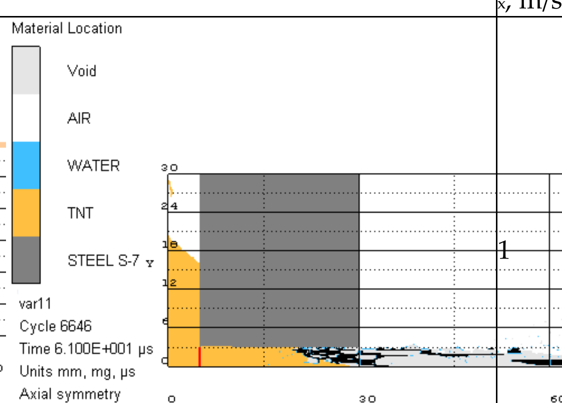


Figure 5. The change in the maximum velocity V_{max} of the head of the jet depending on the load factor β

Table 1. Some variants of the explosive formation schemes considered

<table>
<tr><th>Starting time</th><th>Current moment, μs</th><th>Vmax, m/s</th></tr>
<tr><td>
</td><td>
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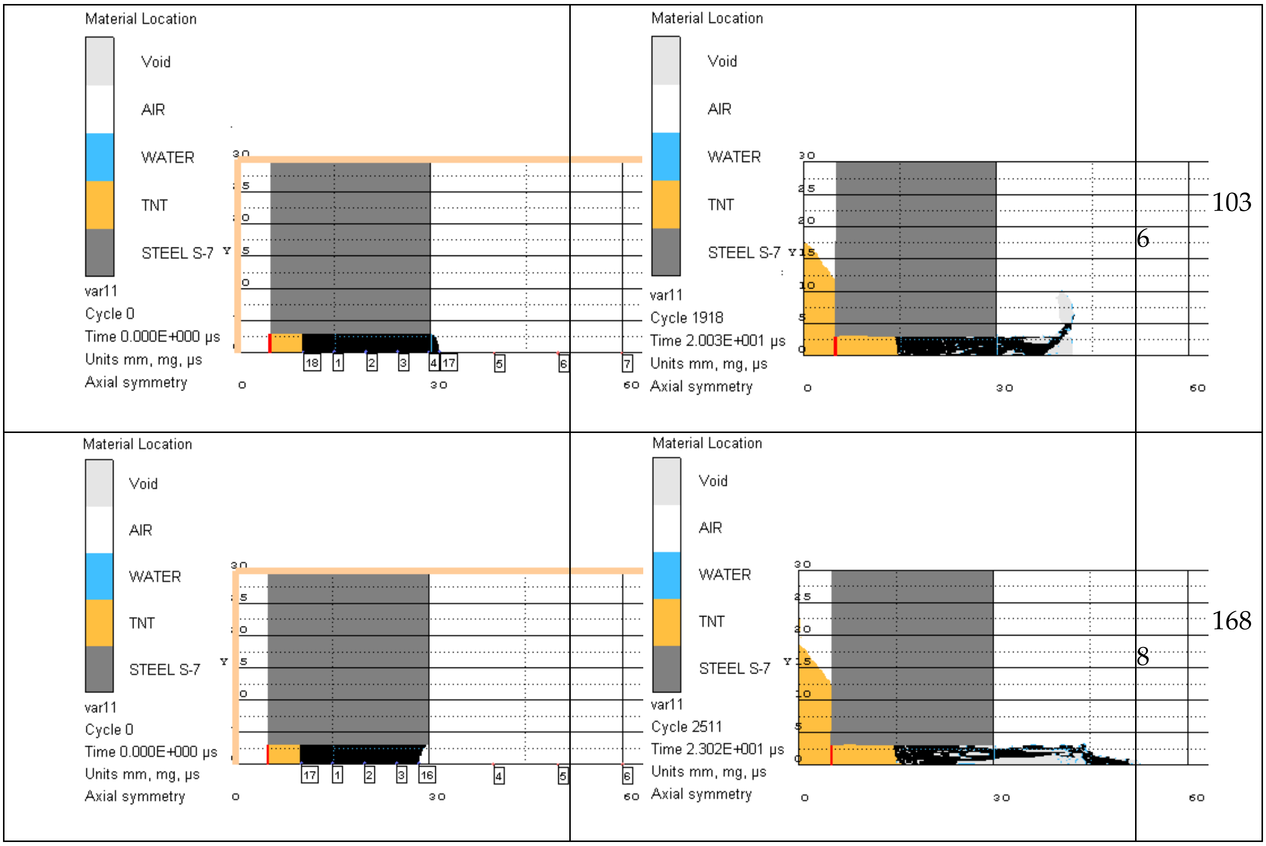

In option 2 (table 1), at the initial time, the jet had a free end in the form of a spherical segment 1.5 mm high, as a result of which the explosive formation of such a jet had its head part experienced spatial expansion over the entire surface of the segment, which led to an increase in its mid-section resistance when moving in air, and, accordingly, a decrease in the maximum speed to a value of ~ 1036 m/s (as compared with a value of 1181 m/s for a jet with a flat end).

Finally, in the latter version (table 1) at the initial moment of time the jet had a cumulative notch in the form of a spherical segment 1.5 mm high, which in the process of explosive formation led to the formation of the head part of the liquid in the form of a solid cone moving with a maximum speed in the head of ~ 1688 m/s, while the rest of the liquid jet had a porous structure and experienced the effect of intense tensile stresses.

Thus, theoretical studies have shown that even small changes in the shape of the head part (only ± 1.5 mm to one side or the other from the flat end) can lead to a significant change in the velocity of the liquid microjet, and therefore to a significant change its impulse.

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