On Experimental Defining of Turbulent Mixing Zone Width in Case of Heavy Material Deceleration against Light One at ~10^8 g

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Introduction. An intensive turbulent mixing (TM) of compressed media developing under the effect of high gasdynamic acceleration 10^6¸ 10^{15} g_0 is characteristic of a number of devices. At present the calculation-theoretical description of such flows is possible only due to a use of semiempirical models. The experimental data obtained at accelerations 10^0¸ $10^2 g_0$ is used for calibration and verification of models. For this reason the experiments studying the TM zone, developing at deceleration of a copper of lead plate with initial velocity of ~10 km/s against the layer of light material (polyethylene or water), are of interest. The plate is driven by the current of the explosive magnetic generator (EMG) [1] or by explosive (HE) projection realized in a three-cascade scheme [2].

1. Calculations of the TM zone width. The model [3] with the transport equations for the components of turbulent stress tensor, realized in one-dimensional technique VORTEX [4] was used for evaluation. At bigger thickness of the light layer the shock wave does not have enough time to approach the TM zone and its evolution happens only due to Raleigh-Taylor instability. The TM zone width depends weakly on the EOS and the initial velocity and by the moment of rotation it makes 4¸ 5 mm.

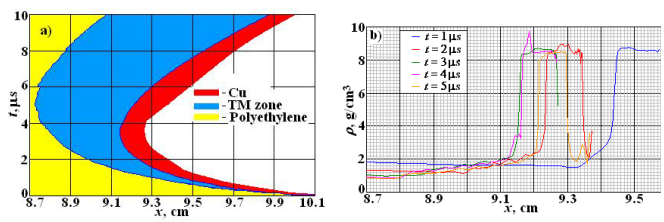

Figure 1. Calculated *rt* diagram of the TM zone boundary - a) and density distributions –b) at Cu plate deceleration against polyethylene.

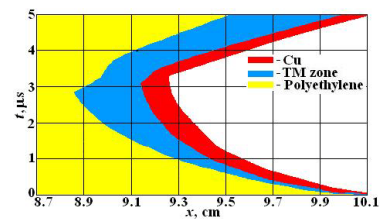

Figure 2. *rt* diagram of TM zone boundaries at plate deceleration against the layer of polyethylene 3 cm thick.

Figure1 shows the calculated *rt*-diagram of the TM zone boundaries and distributions of density of compound for the polyethylene-copper system at the copper plate velocity v_0=10 km/s. In case the thickness of a light layer is reduced and a massive plate of heavy material is placed at the left boundary, it is possible to explore the interaction of the TM zone with the reflected shock wave (Figure 2).

2. Calculations of velocity imparted by a 30-element DEMG Æ250mm to the liner. The calculations were conducted for two liners: with a mass of 6.4 g and height of 1 cm, and with a mass of 12.8 g and height of 2 cm. the initial radius of both liners is 1.5 cm, the thickness is 0.75 mm. The calculations were conducted until the time moment when the radius of the liner achieved 0.75 cm, i.e. the acceleration length of 10 initial liner thicknesses. The results are presented in Figure 3.

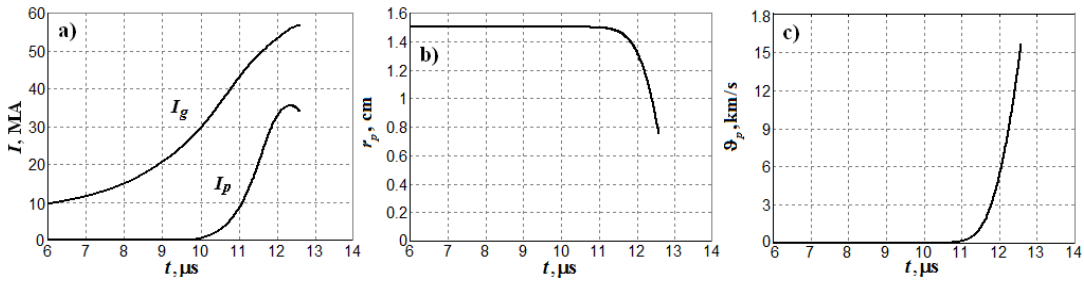

Figure 3. Time dependences of currents in the circuit of a generator and a pinch –a), radius -b) and liner velocity *J* for the liner with a mass of 6.4 g.

The liner velocity is 16 km/s at the maximum current of 35 MA. For the liner with the mass of 12.8 g the maximum velocity is 14 km/s. the liner velocity can be increased with the use of a more powerful DEMG Æ400 mm.

3. Possibilities of the TM zone radiography. To X-ray the object, it is possible to use the radiation of three betatrons of RGK-B complex located at the angles of 45° relative to each other; each of them generates from one to three pulses of gamma-radiation with threshold energy of 56 MeV. The pattern of thickness measurement in the axisymmetric dynamic objects in the X-raying direction with the help of the method of a photometric prism is given in Figure 4.

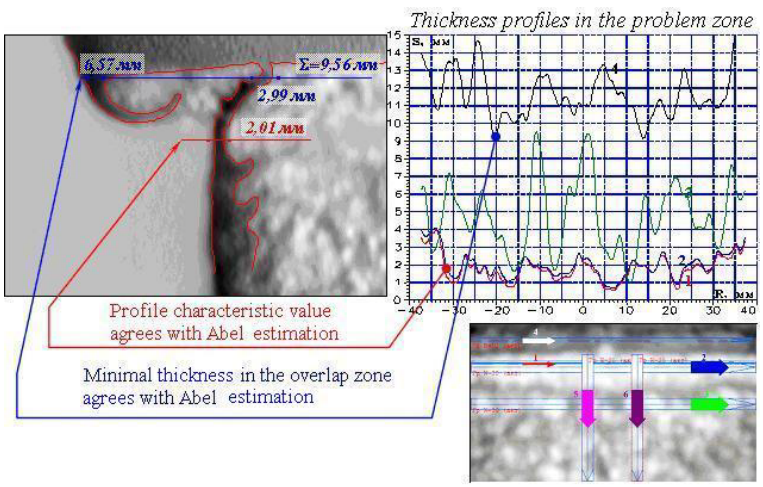

Figure 4 – Determination of thicknesses of an axisymmetric object.

Limitations on application of the RGK-B complex are related to small distances from the point of firing to the bunker wall (1300 mm). The weight of HE in the explosive experiments should not exceed 60 kg without the use of a protective container. The mass of HE of a 30-element DEMG Æ250 mm is not more than 50 kg.

References

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