About the structure of a mixing zone at an unstable interface

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The development of instability of an interface of two media of different densities, moving with acceleration, leads to the formation of a mixing zone, which is called, according to the generally accepted terminology, "turbulent mixing zone". The report discusses the question of whether such term is adequate on the basis of the results of experiments performed by the author and with his direct participation.

When the Rayleigh-Taylor (RT) instability develops at a gas - liquid interface, gas in the mixing zone penetrates into liquid, taking the form of an ensemble of gas bubbles that become larger with time. As a result, almost along the entire interface between the liquid and the mixing zone, the concentration of the liquid falls from 100% to ~0. It is assumed [1] that such *abrupt fall* of concentration (and density) at the interface between the denser medium and the mixing zone is to occur practically in any case of RT mixing, for the unimpeded development of instability to take place. Formation and stability of an interface *with the abrupt fall* in concentration is maintained as a result of the stabilizing effect of an <u>*accelerated*</u> *shear flow at the interface of media having different density* [2], similar to effect of *relaminarization* of a turbulent boundary layer [3].

When an interface of two gases (air -- helium) is accelerated by shock waves [4], a similar situation with the formation of abrupt fall at the air -- mixing zone interface is realized; here, the concentration of air at such interface falls from 100% to ~15%.

There are some differences in the formation and development of an interface with abrupt fall in a) gas-liquid case and b) gas-gas case [4]; in case of a), gas penetrates *through the mixing zone* into liquid, taking the form of bubbles that become larger with time, and in case b), a denser gas penetrates into the mixing zone, taking the form of jets.

In both cases, the interface with abrupt fall is *perturbed* and, consequently, the average profile density in the mixing zone has the form of a *smooth* S-shaped curve.

The development of RT-mixing is accompanied by the development of counter streams of substance in the mixing zone -- the denser is going in one direction, the less dense in the opposite. As the mixing zone becomes wider, these streams are increasing with time as t^2. At the boundary between these streams, a speed disruption is to occur; such disruption also grows with time. At the same time, the results of experiments on the interaction between local perturbations [5,6] and an RT mixing zone illustrate that streams of both denser and less dense medium, growing with time as $\sim t^6$, can flow through the mixing zone.

With the development of the Richtmyer-Meshkov (RM) instability, the width of the mixing zone increases proportionally $t^{0,3}$ [7]. Accordingly, the structure of the RM-mixing zone must be substantially different from the case of RT-mixing.

When a thin layer of water in a closed channel is accelerated by the pressure of products of detonation of acetylene and oxygen mixture, a mixing zone of dispersed water, air, and detonation products is formed, with its width growing by more than an order of magnitude compared with the initial thickness of the layer [8]. When a thin layer of dust is accelerated in such conditions, fibre-like structures can form in the mixing zone [9].

Thus, as the results of the experiments show, in a mixing zone at a moving-with-acceleration unstable interface of different density media, the features of chaos and of an orderly flow are combined. These conclusions are consistent with the theoretical analysis [10,11].

Therefore, the term "turbulent mixing zone" is not quite adequate and, if does not distort, veils the essence of the phenomenon.

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