The gravity impact on the V-shape flame instability

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The burning of gaseous fuels is essential both in terms of fundamental knowledge and in terms of applicability. The influence of gravity on combustion processes, and especially on instability, is an important modern task. The instability of combustion from a practical point of view is related to stabilization problems. The main tasks of flame stabilization are the expansion of the range of velocity and concentration limits of ignition and stable combustion, and suppression of various types of instabilities leading to extinction. As is known, flame stabilization methods can be divided into active and passive. Active ones include methods that lead to a change in the composition of the fuel-oxidizer mixture and reagents, or in which a constant or periodic additional source of energy is introduced into the system. The most common active methods are stabilization by an ac/dc electric field, using of a pilot flame. Passive methods include methods that to some extent alter the geometry of the flow, basically it is aimed to create a recirculation zone for intensification of mixing and additional heating of the fuel in the vicinity of the reaction zone. For this, various stabilizing bodies are used, for example a cross, a disk, a cylinder, a ring, a wire or inclining blades, which swirl the flow as a whole. Also a combination of such methods is used, for example, burner rim, leads both to the appearance of a toroidal vortex, and to the fact that thin edges are warmed up and also serve as an additional source of heat for heating the burning mixture. The use of wire as a stabilizing body in the jet flame (similar to the use of stabilizing crosses in internal combustion engines) leads to the formation of a recirculation zone in the center of the flow. In this case, the conical flame turns into the inverted conical one (V-shape). Such a flame differs from a conical one. They generate different velocity gradients due to the buoyancy forces and because of the flame itself: the streamlines in the conical flame deviate from the axis as they pass through the flame front and the mixing layers move away from each other as they move away from the burner edge. Whereas in the V-shape it is vice versa, the streamlines deviate towards the center and the layers approach each other. Thus, the mixing layer, arising from the buoyancy forces in the conical flame, can affect the flame front flickering in the lower part of the flow, and in the inverted only in the upper part. The present work is devoted to the study of the gravity effect on the V-shape flame instability. Blow-off and flash-back limits were experimentally established, as well as flickering frequencies as a function of the direction of the gravitational vector with respect to the direction of the flame front propagation.

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