INTRODUCTION

Deflagration-to-detonation transition, a phenomenon closely related to the reactivity of the mixture, has been extensively studied for many monofuel systems. At the same time, the detonation properties of binary fuel mixture remain poorly studied, especially systems with fuel components markedly differing in reactivity [1].

An important aspect is the safety of handling such fuels. In this case, it is reasonable to use binary fuel mixtures in which one of the components is an inhibitor of self-ignition or spontaneous decomposition with a rather high heat of reaction with the oxidant.

The effect of inhibition can be achieved in two ways:

(1) by introducing a gas with a high heat capacity, which can absorb a significant fraction of the heat released by the reaction without participating in it;

(2) by introducing a gas capable of terminating reaction chains via scavenging active radicals [2].

It was demonstrated that the role the chain reactions play in the process of combustion increases with the temperature [3]. It is known that [3–5], at atmospheric and elevated pressures, all regimes of combustions, including detonation, can be successfully inhibited, with the efficiency of the inhibitor being determined by its ability to terminate reaction chains.

One of the promising gaseous fuels, which is used in technologies based on the deflagration (welding, torch cutting) and detonation (sputtering, destruction) regimes, is acetylene; its mixtures with air (oxygen) have a high heat effect, small predetonation distance, favorable parameters of the detonation products, and wide detonatability limits. One drawback of pure acetylene is its tendency to decompose spontaneously with the formation of carbon and methane or hydrogen,

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\begin{align*}
2 \text{C}_2\text{H}_2 & \rightarrow \text{CH}_4 + 3\text{C}, \ T = 300^\circ\text{C}; \\
2 \text{C}_2\text{H}_2 & \rightarrow \text{H}_2 + 2\text{C}, \ T = 1200^\circ\text{C}.
\end{align*}
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These processes are accompanied by energy release and, possibly, detonation, a behavior that makes it a safety hazard.

This shortcoming can be remedied by adding a component capable of preventing acetylene decomposition.

The aim of the present work was to experimentally determine the lower concentration limit of dilution of acetylene with household propane–butane gas and hydrogen at which no self-decomposition of acetylene occurs.

EXPERIMENTAL SETUP

Experiments were performed using a setup assembled around a cylindrical shock tube 1617 mm in total length and 22 mm in inner diameter (Fig. 1). The shock tube consisted of a detonation chamber 585 mm in length and a 1032-mm-long test section, which were separated by a ball cock. The process was monitored using PCB 113A piezoelectric pressure gages and FD-256 photodiode. The gages were installed 200 mm apart; the distance between the first gage and the spark discharger was 816 mm. The detonation chamber and the test section were evacuated to 0.004 atm. The test mixture was prepared manometrically to an accuracy of 0.5% and allowed to stay in a 3-l vessel for 42 h at a pressure of 2 atm. The detonation chamber was filled with a stoichiometric acetylene–oxygen mixture to 1 atm, whereas the test section was filled with an acetylene–inhibitor section to the same when the ball cock was closed, after which the acetylene–oxygen mixture was detonated with the spark discharger to form a detonation wave. The predetonation distance was less than

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200 mm, substantially smaller than the detonation chamber length. The detonation wave passed the contact surface from left to right (position 0 in Fig. 1) and transformed into a shock wave propagating through the acetylene–inhibitor mixture. Figure 2 shows the overall picture of transformation of the detonation wave into the shock wave for the test section filled with air. The pressure gages and photodiodes were distributed over the entire length of the detonation chamber (Fig. 2).