**The Pulse Detonation Device and Pirolitic Technology for Utilization of Worn-Out Tires**

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***Key words:*** pulse detonation device, pirolitic technology, deflagration-to- detonation transition

Many methods of worn-out tire destruction including those uses cooling of tires are available now. All equipment consumes a lot of electric power and contains cutting parts to be exchanged. The idea of proposed method is fundamentally different and was described in [1]. It is based on drastically pressure increase inside the cooled down to fragile state tire. It can provide separation of rubber from the cord with the small pieces. The pressure increase in destruction chamber may be obtained due to explosion of detonable gas mixture. Investigation described in this paper concerns pulse detonation device (PDD) for worn-out tire destruction. PDD for these purposes should meet following conditions: (a) enough destroying loads, (b) compactness, (c) separate fuel components injection, (d) high mass flow rate of fuel components, (e) effective detonation ignition and (f) means of detonation wave diagnostics.

The lack of knowledge and understanding of the fundamental processes of pulse detonation makes it difficult to design a device for a specific application. Also some aspects of PDD needed to be optimized. Such aspects are the type of fuel (hydrocarbons or hydrogen) and oxidizer (pure oxygen or air), the effective range of equivalence ratio of mixture, diameter and length of detonation tube, initiation method (direct or with the help of artificial acceleration of flame up to detonation), the transformation of planar detonation wave to spherical and cylindrical one, etc.

Hydrogen provides the lower pressure than hydrocarbon, but in burned gases there is no toxic components. Air is more preferable from economic point of view. But in the case of hydrogen/air mixture energy of direct initiation is in the range 10 – 15 kJ at the initial pressure 1 atm depending on the nature of the initiator [2,3].

The detonation chamber (4) used in this study was equipped with tire destruction chamber (9) (Fig.1). To achieve high mass flow rate the additional pressure accumulators with fuel components (10), pneumatic valves (1), injection block (2) and pipes with inner diameter more than 12 mm were installed. Equivalence ratio (ER) was varied by reagents pressure variation. The ignition of detonation wave was realized by the means of traditional power technique – an electrical discharge of capacitor (3). Detonation ignition had been performing after valves' opening through a certain time enough to chamber was filled by detonable mixture. Additionally the ability of different construction outlets installation was foreseen.

For effective tire destruction the high initial pressure (3 – 6 atm) of hydrogen/oxygen and hydrogen/air mixtures (ER=0.5 – 2.3) was used. High pressure is preferable also from the ignition point of view, because the critical initiation energy is decreased at increase of initial pressure. The length of tube was sufficient for deflagration-to-detonation transition (DDT). To decrease DDT in hydrogen/oxidizer mixture the tube was equipped with specially developed obstacles (12, Fig.1.) according [4]. Tube diameter was sufficient for successful transformation of quasi-plane multiheaded DW to expanded quasi-cylindrical DW. Different divergent or convergent nozzles (11, Fig.1.) were used according [5-7].

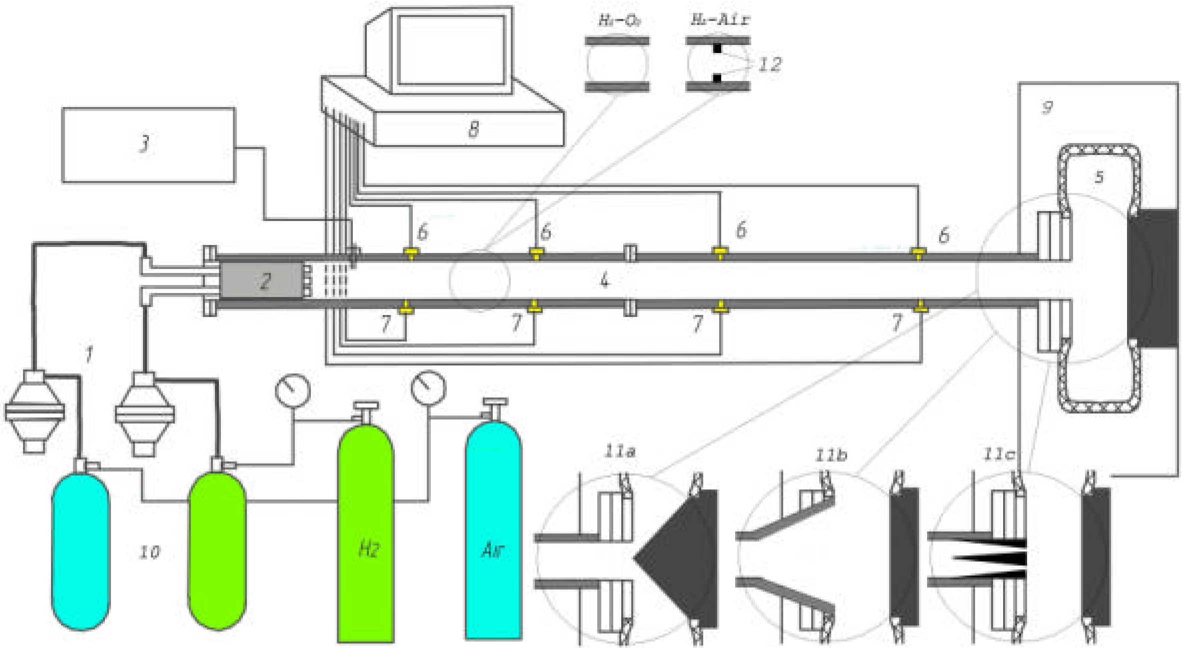


Fig.1 Schematic of the worn-out tires destruction experimental device: 1–pneumatic valves, 2–injection block, 3–ignition system, 4–detonation chamber, 5-tire, 6–pressure transducers, 7–photodetectors, 8–data acquisition system, 9-tire destruction chamber, 10-pressure accumulators, 11-outlet sections, 12-obstacles.

Influence of fuel components separate injection on DDT distance was investigated. The dependences of detonation parameters on mixture ER and injection time at the separate fuel components injection were obtained experimentally. Injection time range of minimal DDT distance was found.

Numerical simulation of detonation wave propagation in detonation chamber (4) and in tire (5) was carried out for stoichiometric hydrogen-air mixture under normal initial conditions. The system of equations describing the axial-symmetrical inviscid flow and equations of chemical kinetics [3] was used. The equations of gas dynamics were solved jointly with the equations of chemical kinetics by a finite-difference method [8] based on the Godunov's scheme. The pressure fields in detonation chamber and in tire are presented in (Fig.3).

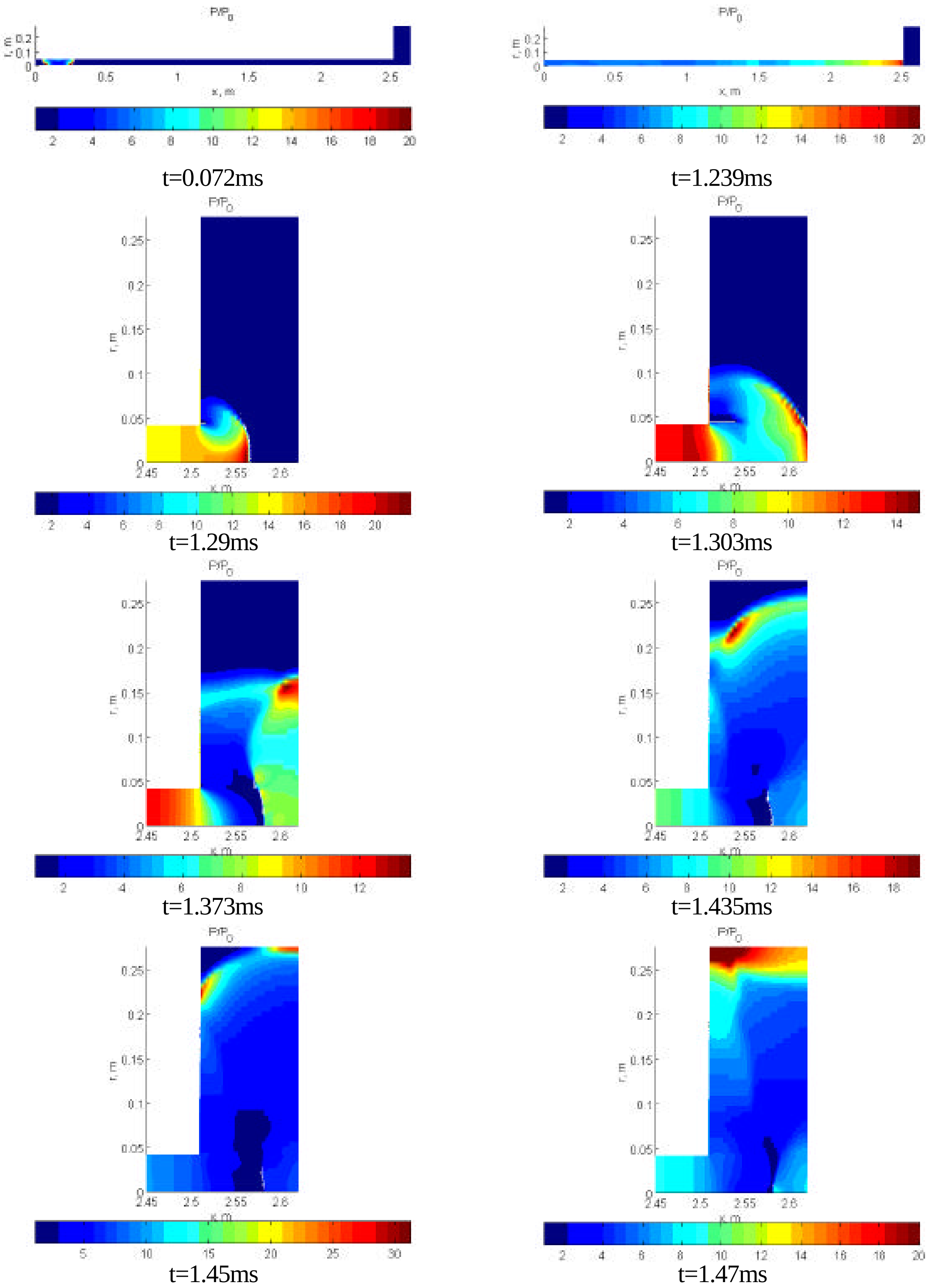


Fig.2. The pressure fields in detonation chamber and in tire.

Thus, experimental and numerical studies of critical conditions for detonation transmission from a tube to a tire show that basement wall can be responsible for detonation re-initiation in a wide range of governing parameters. It provides the pressure increase to separate about 80% of rubber from the cord. To separate the rubber from the cord completely the pirolitic technology was developed.


## Acknowledgement

This research was partly supported by INTAS grant No. 01-0792 and by the Russian Foundation for Basic Research grant No. 02-01-00110.


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