Experimental study of the transition of gaseous detonations with gradient composition.

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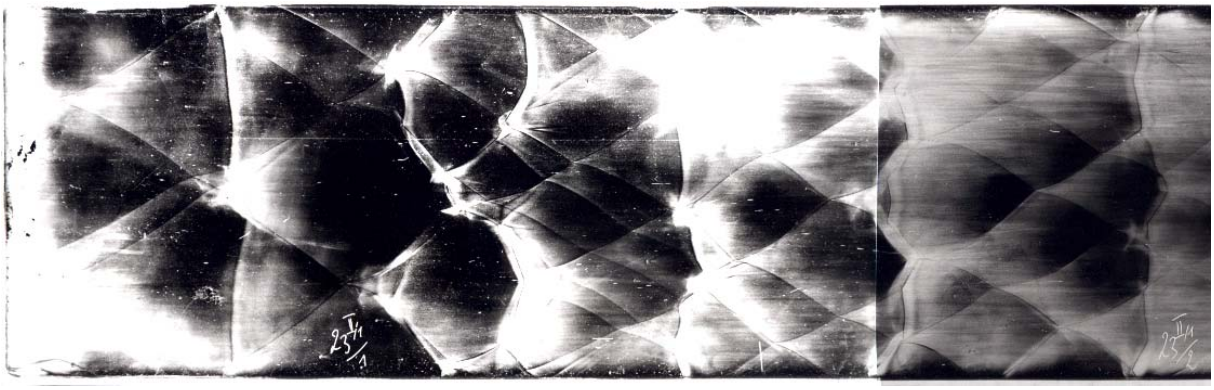
Many investigation about gaseous detonations have been devoted to mixtures with homogeneous chemical composition, although during natural events the gaseous explosions occur usually in mixtures with large composition gradients. If one does assume that a detonation process is set in for a well defined mixture composition, the question arises also how it will propagate at an interface due to large chemical composition gradients. To the best of our knowledge, previous studies addressing that problem are rather scarce in the literature. It should be mentioned the experiments reported by Strehlow et al. (1) on oxy-hydrogen mixtures diluted by argon or helium, as well as the behaviour of oxy-acetylene mixtures with several diluents investigated by Thomas et al. (2). Such phenomena are also of practical interest when the detonation limits are studied for ternary mixtures, see for instance Gel'fand (3). Furthermore, they play also a role in the development of Pulsed Detonation Engine, see Desbordes et al. (4) and this facet of the PDE problem has been touched upon already (5).

The propagation of detonation waves is controlled by specific physical (pressure, temperature, confinement …) and chemical conditions (composition and nature of fuels). Actually, the erratic behavior of explosions is the result of non uniformly distributed chemical compositions. Investigation to analyze the detonation process in mixtures characterized by equal pressure and initial composition discontinuities can be carried out in tube with rectangular cross section [32 mm x 92 mm]. The set up is similar to the one described previously by Libouton et al. (6), but the low pressure section is subdivided into two parts (SM1 and SM2) by a slide valve (V), operated manually in order to fill both parts with different chemical compositions. Side effects due to unevenness of the inside surface have been minimized in order to avoid perturbations as mentioned by Changming et al. (7). The investigated mixture compositions have various dilution (α), fuel ratio (β), equivalence ratio (ϕ) and inhibitor content (I). The initial pressures are 60, 75 and 95 torr (see table 1).

Mixture	Composition	α %	β %	ϕ	I %
A	$H_2/O_2/Ar$	70	100	1	0
B	$H_2/O_2/Ar$	50	100	1	0
BA	$H_2/O_2/Ar$	50	100	0.3	0
C	$H_2/CO/O_2/Ar$	50	50	1	0
D	$H_2/CO/O_2/Ar/CF_3Br$	48	50	1	2

Table 1

For each individual pair of mixtures, we recorded the mode, the cell length (L) by soot imprints, the average detonation velocity (D) in both parts (SM1 et SM2). The overall transition of the detonation wave occurs on a distance d (table 2), measured from the interface position (see picture).



←Interface located at 82.5 mm from left hand side of the picture.

Transition C ⇒ B: Establishment of the detonation in the second part of the tube (SM2) for a stoichiometric hydrogen - oxygen mixture (B) diluted by 50 % argon, initial pressure 60 torr. The mixture (C) contains carbon monoxide with a fuel ratio (β %) = 100.

Pairs (95 torr)	**Mode**	**L** (mm)	**D** (m/s)	**Mach**	**d** (cm)
B ⇒ B	11/12	29	1785	4.68	---
A ⇒ B	11/12	29	1788	4.72	79
BA ⇒ B	11	29	1789	4.73	59
C ⇒ B	11/12	28	1795	4.74	80
D ⇒ B	14/12	28	1788	4.72	93

Table 2

Additional runs, including runs from non reactive to reactive mixtures and reverse, have been performed and will be presented and discussed. Comparison will be made with numerical computations of detonation transition published previously (8).

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