INHERENT IMPACT RESPONSE BEHAVIOR OF EXPLOSIVE CHARGE IN CONFINEMENT

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In safety tests simulating accident impact insults to explosive charge in metal case, the inherent characteristic response behavior of explosive can be observed with help of carefully designed diagnostics. As for Susan test [1], full scenario of typical accident response shows non-prompt reaction behavior in following steps: 1. large deformation and fracture of nose- cap with explosive damage which may last hundreds microseconds even beyond milliseconds before ignition event; 2. non-shock initiation inside the damaged explosive; 3. the propagation of combustion throng cracks in damaged explosive bulk and evolution of reaction violence inside damaged explosive without tightly case confinement. Intensive blast wave comparable to that of full detonation of explosive charge might be recorded at some distance away from the explosion locus, while the on-site reaction pressure goes up merely to hundreds MPa with a duration of hundreds microseconds to several milliseconds. The nose-cap fragments are scattered in nearby range showing no sign of high strain rate shear fracture and high velocity driven by detonation (see fig. 1). Such kind of high violence explosions do not necessarily correspond to real detonation event [2], it should be interpreted as multistage deflagration taking into account of the reaction of explosive particles dispersed inside the fire ball of the ongoing explosion. The blast wave intensity, e.g. equivalent energy release level does not present on-site reaction violence of explosive. Terms like transition into explosion, partial detonation or low order detonation should be redefined and used very carefully in this case.



Fig 1. Impact response of explosive with Al-alloy nose-cap confinement in Susan test

The multi-stage inherent behavior of accident response should be taken into account in physics models study and numerical codes validation on strict process aware logic base along with the real events sequence including pre-ignition deformation and confinement fracture, non-prompt ignition of combustion, reaction spreading through explosive cracks, violence evolution inside a partial fractured structure with mass confinement of damaged explosive and late stage massive combustion of explosive particles inside explosion fire ball [3, 4].

Reference

1. **Dobratz, B. M.**, LLNL explosives handbook: properties of chemical explosives and explosives and explosive simulants. Report, UCRL-52997-chg.2, 1985.

2. White, Paul C., Howard, Joseph S., LA-UR 04-3379 Sixty Years of Nuclear Explosive Safety: A Success Story, Safety Related Nuclear Weapons Technologies, VNIITF, May 19-20, 2004.

3. Li Tao, Study on reaction violence of explosive in case confinement under low amplitude impact loading [D]. Mianyang, Sichuan: China Academy of Engineering Physics, 2003.

4. **Hu Haibo**, Fu Hua, Li Tao, Shang Hailin, Wen Shanggang, Progress on experimental study on propagation of reaction after non-shock initiation and violence evolution of pressed explosive, EXPLOSION AND SHOCK WAVES, Vol. 40, No. 1, Jan., 2020.