ON THE SCALING OF BLAST WAVES FROM FUEL-AIR EXPLOSIVES

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For certain military applications, fuel-air explosives prove to be more advantageous than conventional solid explosives. In fuel-air explosive weapons, the fuel is explosively disseminated into the atmosphere to form
an explosive vapor cloud and then detonated subsequently by one or more initiating charges. The blast wave from such a distributed charge has different characteristics as compared to that from a concentrated solid explosive charge because the large charge volume of fuel-air explosions cannot be neglected. Thus apart from the conventional length scale derived from the energy of the charge (i.e. R0=(Eo/po)1/3) there exists also the charge radius R0 and this requires the use of two characteristic lengths for blast scaling in the near field (viz. R0) and in the far field (viz. RO). A further problem is presented in that the actual blast energy Eo in a fuel-air explosive charge is a priori an unknown quantity. A conventional solid explosive is sufficiently concentrated to be approximated as a point charge and all the chemical energy released can be assumed to go to the blast. The characteristic explosion length Ro is thus determined a priori once the charge weight is given. For fuel-air explosives, the actual blast energy is the work done by the interface between the charge and surroundings. This work is a priori unknown prior to solving for the blast flow structure itself. In other words, the chemical energy released by the charge is partitioned between combustion gases of the charge and the surrounding atmosphere. The present paper describes results of our study on the determination of -the effective blast energy of large fuel-air explosive clouds. A numerical code is developed to compute the work done by the expanding interface of the charge. In general, it is found that for most common hydrocarbon-air mixtures, about 20% of the chemical energy actually goes to the blast wave and this fraction increases for mixtures with higher energy densities (eq., about 25% for fuel-oxygen mixtures) Using this effective energy, blast scaling in the far field can be achieved and comparison with existing experimental results show good agreement.