FACTORS AFFECTING THE DISPERSION OF SHOTGUN PELLETS IN SHORT-RANGE COMBAT

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Abstract. This study was designed to determine the extent to which aerodynamic interactions affect the pellet pattern from shotguns as this has considerable influence on their impact. After the characteristic separation of pellets was obtained from their probability densities, the detailed flow field was obtained using Computational Fluid Dynamics (CFD) analysis. The reported initial results illustrate the influence that the wake of preceding pellets has on the trajectory of trailing pellets.

BACKGROUND

Experimental studies into pellet dispersion with range indicate the presence of non-linear effects. These arise mainly from combination of three factors: aerodynamic interaction between pellets, irregularities in pellet shape, and their rotation during flight. Difficulties in experimental techniques prevent detailed measurements, so only generalised data is available. In contrast, CFD methods provide extensive flow field information. Recent advancements in CFD now allow pellet cloud aerodynamics to be considered in more detail.

The CFD calculations determine the relationship between lift, drag and separation. This is further analysed in order to provide a relationship between the characteristic separation of pellets within the cloud and increasing range. In this way the effects on statistical extrapolation of pellet dispersion back to the muzzle can be assessed with respect to the extent and magnitude of longitudinal and lateral aerodynamic interaction between pellets. It should be noted that modern ammunition is further complicated by the presence of the 'cup wad' driving piston, the impact of which is not considered in this paper.

The key findings are summarised in Figure 8. This was achieved by first considering the practical conditions affecting the problem then, using data on shotgun performance, determining the characteristic separation of pellets in flight so that the subsequent CFD computations are dimensioned to model the typical mutual proximities between the pellets. The graphic result illustrates a leading pellet at the origin showing, for a variety of initial starting points, the path of a trailing pellet influenced by the preceding wake.

The CFD methodology we describe can be used to asses the aerodynamic tendencies for pellets from shotguns used in short-range combat or in sport shotguns. It is also applicable to other type of ammunition involving more than one flying object—such as petals in sabot discard, or submunitions.

PRACTICAL CONDITIONS AND DOMINANT FACTORS

The muzzle velocity of shotguns is typically 400 m/s, corresponding to Mach 1.2, diminishing to about Mach 0.5 within a representative useful range of 40 m. This paper is primarily concerned with the aerodynamic interactions between pellets within the first 10 m of flight, during which the pellets are either marginally supersonic or transonic. Most shotguns possess a restriction in their diameter at the muzzle: this is referred to as a 'choke' and is used to modify the subsequent dispersion of the pellets in flight. Pellets are driven from a shotgun by a wad which acts as a piston. The wad has a low sectional density and so is soon lost from the ensemble of pellets by aerodynamic retardation. These features are illustrated in Figure 1.

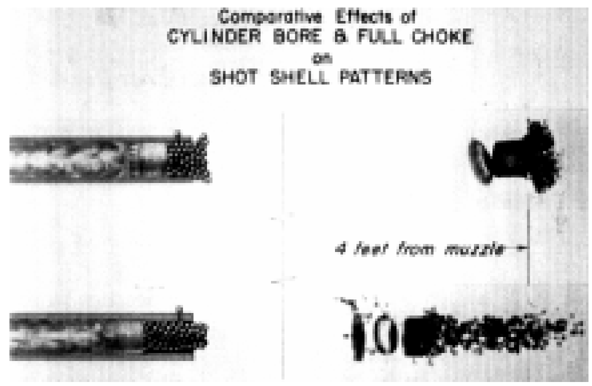

Figure 1. Cut-away sketch of the shot column exiting cylinder (upper) and choked (lower) muzzles, with superimposed flash photographs of the resultant pellet dispersions at 1.2-m (4-feet) range [1].

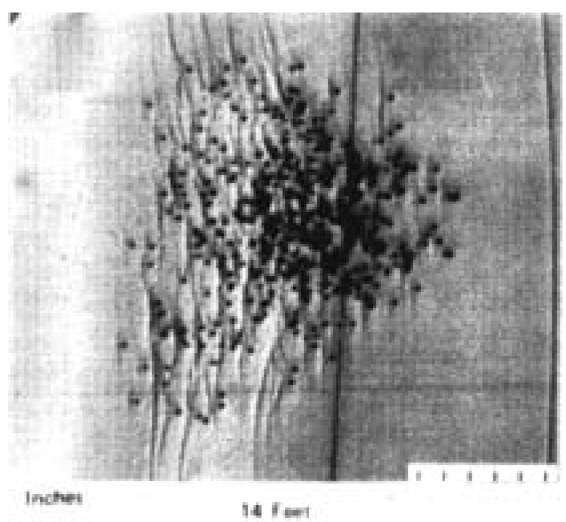

Figure 2. Flash photograph of the dispersed pellets at 4.3-m (14-feet) range fired from a cylinder muzzle. Note transverse trigger wire. Also note the composite bow shock at the extreme right-hand side. [1].

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