# Fuel Jet in Cross Flow: Experimental Study of Spray Trajectories at Elevated Pressures and Temperatures

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**Abstract**

This paper describes an experimental investigation of the spray created by Jet-A fuel injection into the cross flow of air at elevated pressures and temperatures that are encountered in modern gas turbines. Fuel was injected from a 0.671 mm diam. orifice with flow coefficient $C_D$=0.683. The orifice was incorporated into the wall of a rectangular air channel (25.4×31.75 mm). In some experiments the orifice was installed flush with the wall of the channel and in others in a cavity recessed in the wall. The pressure of air in the channel was P~200KPa and temperature was *T*=590K and *T*=700K. The aerodynamically shaped design of the air channel created a uniform trapeze-shape velocity profile with turbulence level in the core of about ~2%, while thickness of the boundary layer was ~3mm. The momentum flux ratio of the fuel jet to the crossing air was kept in a range between *J*=5 to *J*=40. Shadowgraph spray images were captured using a high speed camera at a rate of 24,000fps. The length of the record was typically 8000 frames. Exposure time was minimized by using short flashes (30ns) of a copper-vapor laser synchronized with the camera shatter. This methodology allowed obtaining statistically relevant maximum, mean and fluctuating characteristics of spray penetration into the cross-flow. Two image sizes were captured: a general view image that covered 22.5mm×50.5mm and a zoomed view of 10.7mm×10.6mm. This corresponds to the downstream distances from the orifice *z/d*~70 and *z/d*~15, respectively. Simple correlations for spray trajectories were obtained using only two empirical coefficients for each flow condition or injector mounting. Spray penetration was found to be proportional to the square root of momentum flux ratio and independent of the Weber (*We*) number in the range investigated (*We*=400….800). The spray shape was well determined with the logarithmic function. More sophisticated correlations with up to four empirical constants were attempted. These included use of momentum flux ratio in powers that differs from ½, dependence of penetration on *We*, and use of power functions instead of logarithmic functions to determine spray trajectory. All these attempts did not improve the correlations significantly.

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