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**Title**

# Cold flow analysis of spray angle and droplet size distribution of a pintle injector for green hypergolic propellants


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## Abstract

In future space propulsions it is planned to substitute the conventional hypergolic propellants (e.g. monomethyl hydrazine and nitrous oxide) due to their high health risks by green hypergolic propellants. Promising candidates are ionic liquids as fuel using hydrogen peroxide as oxidizer. However, conventional hypergolic propellants remain often used within developments of throttleable space propulsions today but could be substituted by green hypergolic propellants.

Over the past few decades, pintle injectors have proven themselves for throttling applications. Nevertheless, designing a pintle injector for green hypergolic propellants can be challenging due to their higher viscosities and higher ROF compared to conventional hypergolic propellants. Introducing DLR's new cold flow test bench studies of cold flow sprays with a pintle injector were conducted. The design of the liquid-liquid pintle injector is kept simple, by reducing the functionality to two liquid sheets (radial expanding and annular) impinging orthogonal at the pintle tip. The tests were conducted with low mass fluxes up to 50 g/s and low pressure losses up to 7 bar.

For a deeper understanding in atomization and pintle injector development for high and low viscos fluid combinations cold flow tests were conducted. To investigate the spray behavior non-reactive simulants were used. In addition to water simulating fuel and oxidizer also a water-glycerin mixture is used to simulate the rheological properties of the ionic liquid. Comparisons between the spray behavior of both simulants are made with shadowgraph imaging and droplet size measurements.

From the shadowgraph images it can be seen, that with a high and low viscose fluid combination irregularities in the spray sheet and spray distribution are more pronounced than with simple water-water injection. By comparing the droplet size, the droplets of water/glycerin-water injection are bigger than the droplets measured while water-water injection. But with a certain amount of pressurization the droplet size of water/glycerin-water injection can be strongly decreased.