# Performance Enhancement of PMMA/GOx Hybrid Rocket Engine Using Swirling Injection

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There are three propulsion systems in chemical rockets, and they are solid rocket, hybrid rocket, and liquid rocket. Compared to a solid rocket, we can verify the thrust of a hybrid rocket, and the design of engine is also safer than liquid rocket. However, due to its different state of fuel and oxidizer, its efficiency of combination is inferior to the others, and the lower efficiency of combination may result in lower thrust. To solve the problem, one of the methods to improve the downside of the hybrid rocket is using swirling injector, and it is designed according to the geometry swirling number. Swirling injector can produce swirl in the combustion chamber and the swirl can increase the efficiency of combination. This study focuses on developing a swirl-injection PMMA/GOx hybrid rocket engine. Proved by the experiment, after we plot the relation between our performance parameters and geometry swirling number, we find the thrust, thrust coefficient, fuel mass flow rate and fuel regression rate are proportional to geometry swirling number. Also, compared to axial engine, the thrust of swirling injection engine has increased over 100%. We hope that after enlarging the size of the hybrid rocket engine, it can serve as the propulsion system in small-scale sounding rockets, and in the future, we can send artificial satellites to the space at a lower cost by launching hybrid rockets.

**Awards Won:**
Third Award of $1,000
American Institute of Aeronautics &amp Astronautics: Honorable Mention