Injector References

This reference list is an all-inclusive vacation to rocket injector design, theory, and implementation. While the sources compiled for your entertainment present a wealth of knowledge, it is worth noting that more resources out there exist. Make sure to use other verified documentation to get smart and inspire innovation! Of course, the resources we provide are a great way to start off.

Color Codes:

- 🚀 Magenta - starting material, recommended for new members and anyone wanting to learn the basics
- 🚀 Blue - more technical and specific material

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Check out how we use this knowledge at PSP Liquids! Click any of the icons below to see our dedicated and brilliant team in action and to learn more about our other subteams!

YouTube PSP

General Injector

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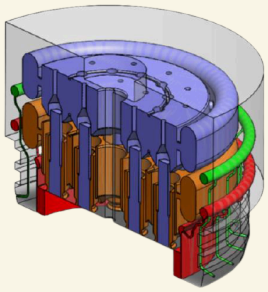
1. **NASA SP-8089: Liquid Rocket Engine Injectors**
   - **9-18,** Injection element selection and types
   - **18-25,** Orifice diameter and diameter ratio
   - **25-28,** Impingement angle
   - **28-29,** Impingement distance
   - **29-33,** Element distribution
   - **33-36,** Combustion instability
   - **36-45,** Orifice geometry
   - **45-56**, Manifolds and upstream geometry
   - **58-63,** Injector assembly, pt. 1
   - **63-72,** Injector face
   - **76-86,** Injector flow system geometry
   - **90-98,** Injector assembly, pt. 2



2. **Design and Dynamics of Jet and Swirl Injectors** - ***Bazarov and Yang:***
   - An amazing text, *consume whole*

3. **Rocket Propulsion Elements 7th Ed.** - ***Sutton and Biblarz:***
   - **268-270,** Thrust chambers
   - **271-281,** Injectors
   - **296-300,** Aerospikes
   - **96,** Variable thrust, pt. 1
   - **323-324,** Variable thrust, pt. 2
   - **334-335,** Sample thrust chamber injector design
   - **348-360,** Combustion instability

4. **Rocket Propulsion** - ***Heister, Anderson, Pourpoint, and Cassady:***
   - **282-285,** Basic elements of a LRE
   - **309-326,** LRE injectors
   - **327-329,** LRE combustor and injector design and analysis
   - **479-525,** Combustion instability

5. **NASA SP-125: Modern Engineering for Design of Liquid Propellant Rocket Engines - *Huzel and Huang:***
   - **121-131,** Injector design
   - **143-150,** Combustion instability
   - **151-175,** Pressurized-gas feed systems

6. **Liquid Atomization - *Bayvel and Orzechowski:***
   - **160-171,** Jet atomizers
   - **172-188,** Swirl atomizers
   - **189-193,** Jet-swirl atomizers
   - **237-251,** Design of jet atomizers
   - **252-272,** Design of a swirl atomizer
   - **273-279,** Design of a jet-swirl atomizer

7. **Handbook of Atomization and Sprays - *Ashgriz:***
   - **214-477,** Atomization and spray models
   - **478-773,** Atomizers and spray generators

8. **A Historical Systems Study of Liquid Rocket Engine Throttling Capabilities - *Betts and Frederick:***
   - An amazing throttling paper, *consume whole*

9. **Liquid-Propellant Rocket Engine Throttling: A Comprehensive Review - *Casiano, Hulka, and Yang:***
   - An amazing throttling paper, *consume whole*

10. **Fluid Flow and Heat Transfer in a Liquid Rocket Fuel Injector - *Tully, Omar, Chung, and Carroll:***
    - A thorough and captivating paper on injector heat transfer, *consume whole*

Pintle Injectors

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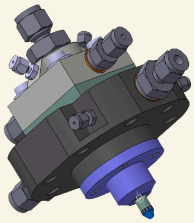
1. **TRW Pintle Engine Heritage and Performance Characteristics** - ***Dressler and Bauer:***
   - An amazing text, *consume whole*

2. **Handbook of Atomization and Sprays** - ***Ashgriz and Heister:***
   - **647-655,** Chapter 28, Pintle injectors
   - **649-651,** Pintle heritage
   - **651-653,** Design methodology

3. **Design Procedure of a Movable Pintle Injector for Liquid Rocket Engines** - ***Son, Radhakrishnan, Koo, Kwon, and Kim:***
   - An amazing paper, *consume whole*

4. **Spray Characteristics of a Pintle Injector Based on Annular Orifice Area** - ***Lee, Kim, Koo, and Yoon:***
   - An amazing text, *consume whole*



5.

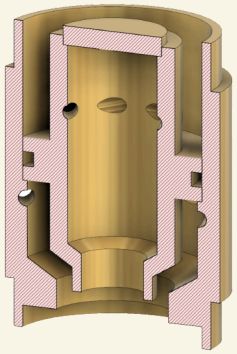
Coaxial Swirl Injectors

1. **Effects of LOX Post Recess on the Combustion Characteristics for Bi-Swirl Coaxial Injector** - ***Kim, Han, Seo, Moon, Kim, and Seol:***
   - An amazing text, *consume whole*

2. **Minimizing Hydraulic Losses in Additively-Manufactured Swirl Coaxial Rocket Injectors via Analysis-Driven Design Method** - ***Morrow:***
   - An amazing text, *consume whole*

3. **An Extensive Study on the Discharge Coefficients of Open-Type Swirl Injectors** - ***Ahn and Choi:***
   - **835-837,** Introduction material
   - **837,** Open-type swirl injectors
   - **839-841,** Comparing empirical and past equations
   - Else, an amazing text, *consume whole*

4. **Combustion Stability Characteristics of Coax-Swirl- Injectors for Oxygen/Kerosene** - ***Martin and Mäding:***
   - **5-6,** Measurements and data treatment
   - **6-7,** Chamber and feed system acoustics



Industry Leaders

Copenhagen Suborbitals

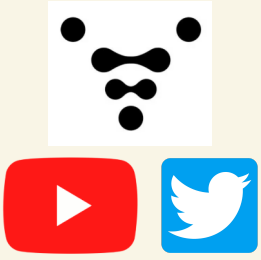
The world's only crewed ametuer spaceflight program. This Denmark-based program is entirely crowdfunded and known for their wonderful coaxial swirl injectors.

Launcher Space

Launcher develops wildly efficient rockets and transport vehicles to aid satellites into orbit. This company excellently documents engine tests on their YouTube.

Relativity Space

Relativity is known for their 3D printed rocket components, advertising fewer components and fast manufacturing. They're also building an autonomous rocket factory.



We only briefly discussed three organizations leading injector design and engine testing, but don't worry, there are many more out there! Check out PSP's company list!

Additional Media

Awesome Videos:

- CNC Machining Coaxial Swirl Injectors for the Spica Rocket Engine
- How Rocket Engine Fuel Injectors Work: Coaxial Swirlers
- Liquid Rocket Engines 2: Injector Trades
- Rocket Fuel Injectors - Things Kerbal Space Program Doesn't Teach
- Launcher E-2 test fire - 22k-lbf thrust LOX/RP1 liquid 🚀 engine. 3D print...
- September 2020
- PSP-L BZB Hotfire 2

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- Charlie Garcia
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- Everyday Astronaut
  - YouTube:
- This guy that makes keg rockets
  - Twitter: