# NASA TECH BRIEF

*Lewis Research Center*



## Design Handbook for Gaseous Fuel Engine Injectors and Combustion Chambers

The results of an investigation of injection, mixing, and combustion processes using gaseous fuels and oxidizers have been summarized in a handbook presenting succinct design procedures for injectors and methods for estimating combustion efficiency, chamber heat flux and stability characteristics. Except for readily available thermochemical data, the handbook contains all required procedural and empirical data for making preliminary design calculations. The design procedures were derived from data accumulated from over four hundred cold flow and firing tests with six basic types of injector elements.

The investigation and tests were conducted to develop technology for the design of reliable injectors and combustion chambers for rocket engines, and particularly for the Space Shuttle auxiliary power system using a gaseous hydrogen/gaseous oxygen propellant combination over a wide range of operating conditions. The design procedures developed are applicable to almost any combination of gaseous fuels and oxidizers, and almost any operating parameters.

The handbook presents two approaches to injector and combustion chamber design: empirical and analytical. The empirical model uses the body of test data and correlates it directly with injector/combustion chamber design parameters which are controlling variables. The calculation procedure is simple, and the results are particularly accurate for gaseous hydrogen/gaseous oxygen combinations within the range of operating conditions investigated. The analytical model is more complex, but it has quantitatively characterized the mixing/combustion process so that it is general in nature and can handle all gaseous fuel/oxidizer combinations and operating conditions. It comprises a preliminary design procedure that is broadly applicable and is particularly valuable in trade-off studies. The handbook contains step-by-step procedures for both the empirical and analytical methods with most of the required information displayed in charts, graphs and tables. An example problem for each method is included.

Notes:

1. This handbook should be useful to designers of turbine engines and other types of engines and power plants using gaseous fuels and oxidizers.
2. Copies of the "Handbook for Design of Gaseous Propellant Injectors and Combustion Chambers" may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B73-10412 (Handbook)
3. A complete report of the investigation and tests conducted, and the development of the design models presented in the handbook, is available in the following report:
   NASA CR-121234 (N73-29799), **Investigation of Gaseous Propellant Combustion and Associated Injector/Chamber Design Guidelines**
   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   (address above)
   Reference: B73-10412 (Report)
4. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10412

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