

Description

In support of NASA's lean-burning low NOx turbine engine combustion initiative, Active Signal Technologies has developed a low flow number valve for high frequency modulation of jet fuel through distributed ports.

REQUIREMENT	VALUE
Bandwidth	1 kHz
Flow rate (flow no. 3-5)	0.8-1.5 cis
Flow modulation	± 25%
Input pressure ($\Delta p=700$ psi)	1500 psi
Operating temperature	150°F

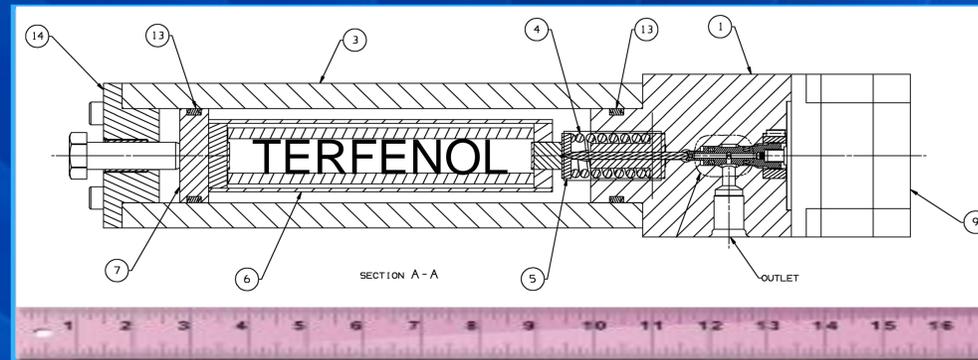
Benefits

NASA has demonstrated that high frequency (500-1000Hz) fuel flow modulation at relatively high flow numbers (>8) into a lean-burning combustion chamber can effectively suppress instabilities arising from interaction of the combustion front with acoustic reflections from the walls of the chamber. Translating these findings to lower flow numbers (3-5) will enable fuel introduction at multiple locations to enhance control authority over these instabilities.

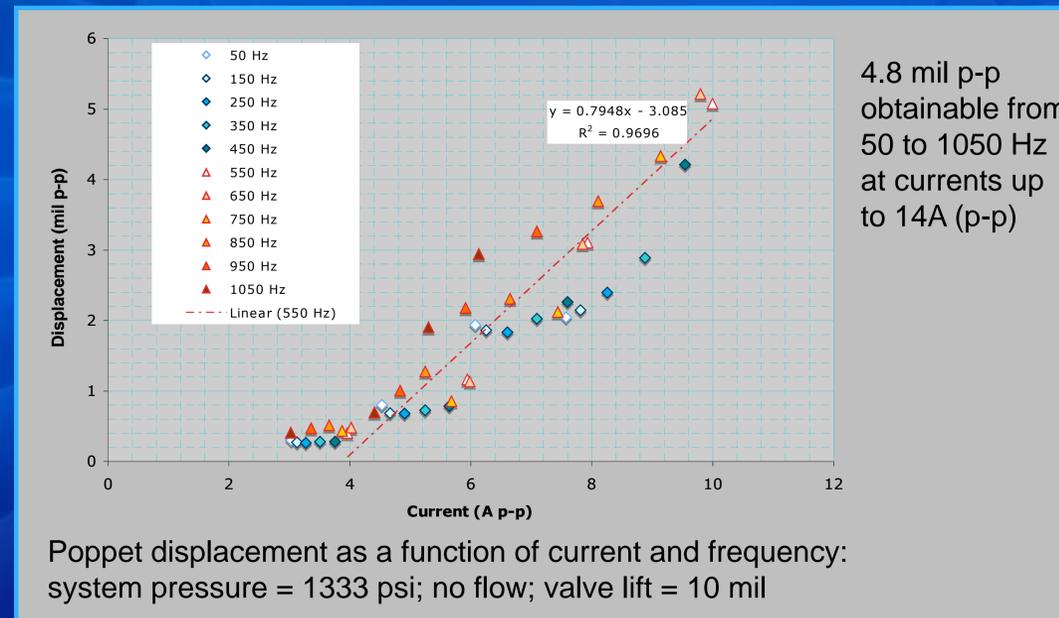
Existing engine designs suppress instabilities in leaner burning engines within a narrow operating band using baffles and modifications to the combustion chamber geometry. The present high frequency fuel modulation approach may become attractive 1) to address transient events, and 2) if environmental regulations become more stringent requiring "true" lean burning technology.

Approach

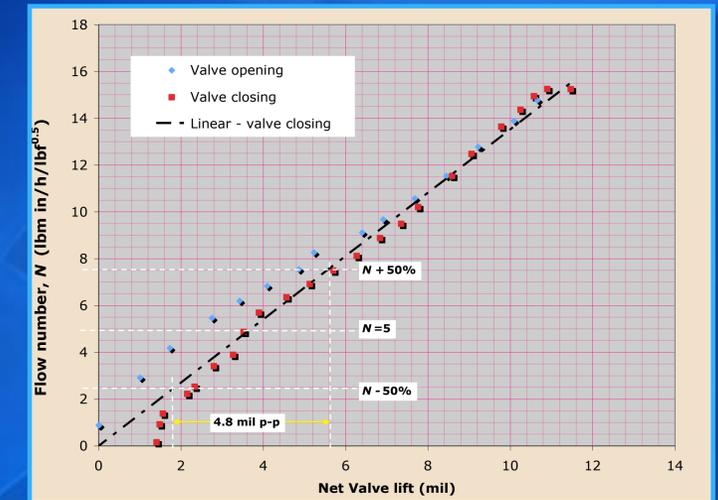
A Terfenol driven poppet valve was designed to meet the necessary temperature, frequency and displacements. The wet-end of the valve was designed based on well-established empirical pressure/flow/geometry relationships widely used in the hydraulics industry. The effect of frequency on flow was predicted with theoretical fluid dynamics calculations examining the time-dependence of the curtain volume between the poppet and its seat.



Recent Results

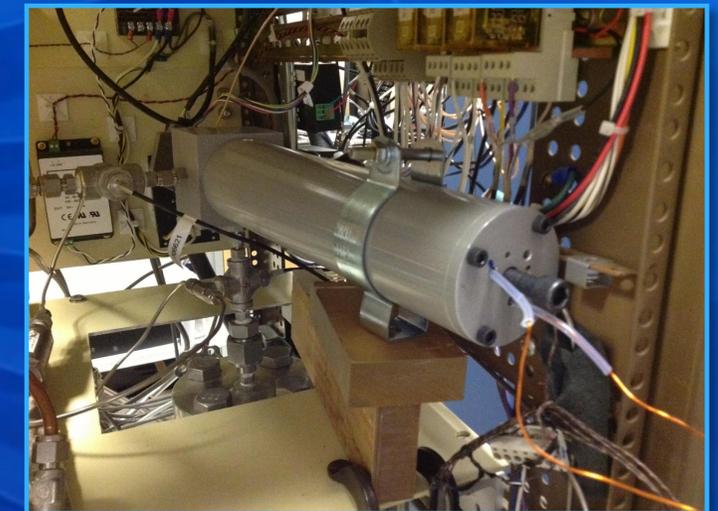


Flow modulation under Terfenol control ($\sim 0.08\%$ strain (p-p) at 1kHz ~ 4.8 mil) capable of $\pm 50\%$ modulation around flow number 5. Testing included prolonged soak at 1kHz and 150°C.



Linear mean flow control versus pintle displacement demonstrated from flow number 2 to 16

Future Work



The valve has been installed at NASA in the GRC flow calibration test bed. Work is underway using the NASA dSPACE system to demonstrate mean flow control and superimposed modulation before transferring the valve to the GRC combustion simulator

