



## SIDE AIR JET MODULATION FOR THE CONTROL OF HEAT RELEASE, PATTERN FACTOR AND EMISSIONS

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### ABSTRACT

The effect of a forced dilution air jet, introduced through the combustor shell (see Figure 1), on the air-fuel mixing and nitric oxide emissions has been investigated. Temperature and emissions measurements have been made at a number of forcing frequencies in the range of 100-850 Hz, blowing ratios within the range of 4-10 and equivalence ratios between 0.6 and 1.0. Open-loop flame response to forcing has also been acquired by recording pressure and heat release spectra (see Figure 3). Results show that substantial reductions in nitric oxide emissions (15-20%) index can be obtained (see Figure 4) over a wide range of flow conditions with side air jet forcing [3].

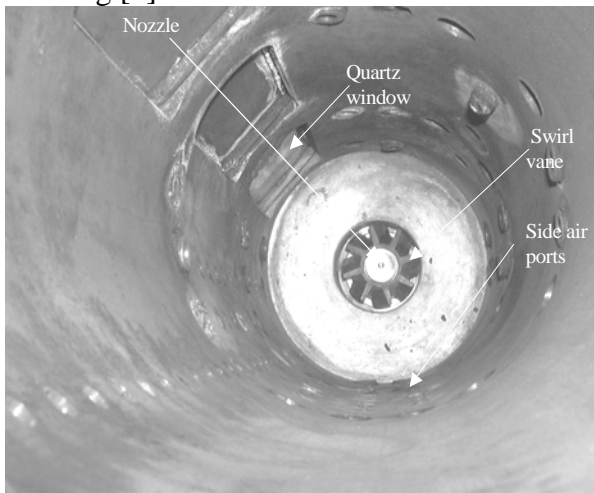


Figure 1 Inside View of the Combustor

In addition, forcing also alters the time averaged temperature field (see Figure 2). This is

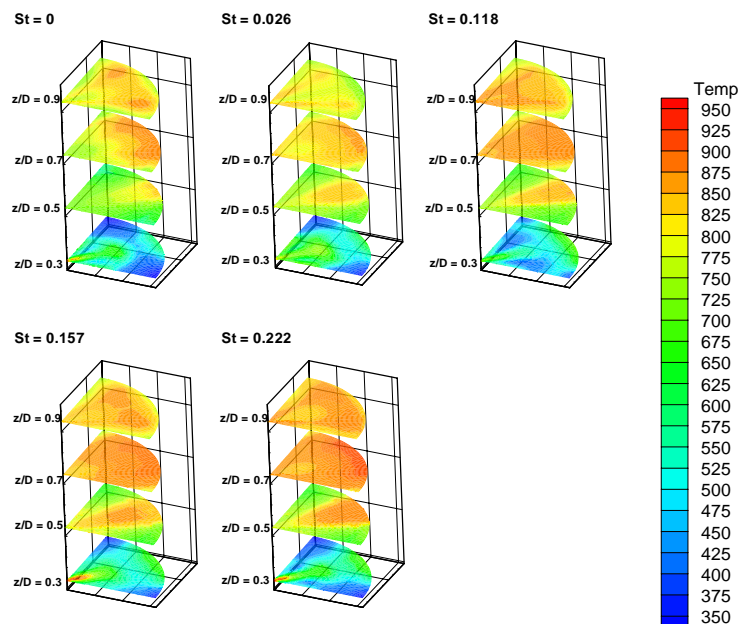
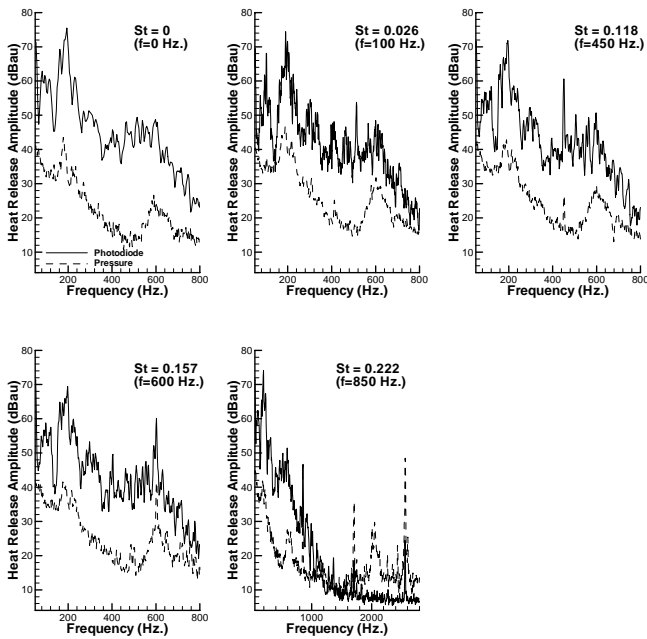


Figure 2 Effect of Frequency on 3-D Temperature Contours (Temperatures in °C)

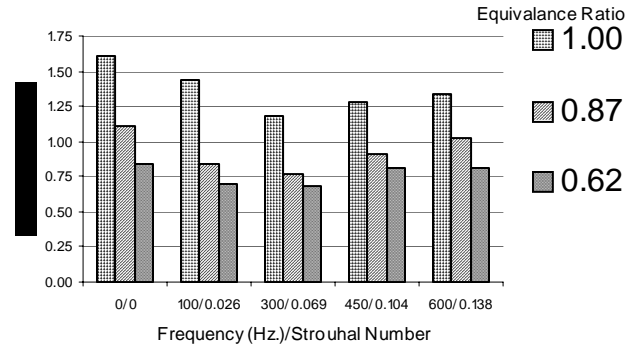
more pronounced near the dump plane of the combustor. As a result higher mean temperatures and more rigorous burning can be obtained due to enhanced fuel air mixing [1,2]. This in turn yields in an increase in the volumetric heat release and enables more compact combustors be designed. A wavelet multi-resolution technique is also utilized to analyze these temperature fields in order to decompose the time-averaged response of different hierarchical scales to forcing [5]. It is found that the jet penetration becomes more and more evident with successively decreasing resolution levels. Consistent with this

observation, forcing is found to have most impact on large-scale structures that are in the order of characteristic jet length scale. On the other hand relatively small-scale structures become more pronounced as the blowing ratio is increased. In order to achieve a favorable change in the time averaged temperature field strength of pressure fluctuations imposed by the forced jet should be comparable to the naturally occurring acoustic mode fluctuations as shown in Figure 3.



**Figure 3 Pressure and Heat Release Spectra**

Moreover, bulk mixing and/or mean temperature field is not the sole significant factor that determines the pollutant emissions level. Other closely coupled phenomena also need to be accounted for. Consequently, mixing and emission levels are not optimized at the same forcing frequency yet there exist select frequencies, which affect both emissions and mixing in a positive manner [4]. An optimization should be sought depending on design criteria and allowable emission limits. A multi-layer perceptron neural network is trained to mimic the combustor output over a range of load conditions [6], which can be coupled to an extremum-seeking algorithm to optimize the combustor behavior with regard to performance metrics.



**Figure 4 Effect of Forcing on the Emissions Index**

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