A Computational Fluid Dynamics Simulation of a High Pressure Ejector COIL and Comparison to Experiments

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Comparing the results of three-dimensional computational fluid dynamics model calculations to available experimental results, we show that the model is applicable to high pressure, ejector type chemical oxygen-iodine laser (COIL), reasonably reproducing the measured gain, temperature and gas velocity.

To understand the complex kinetic and mixing processes that take place in the reactive medium of the chemical oxygen-iodine laser (COIL) it is necessary to have reliable models describing the COIL operation. Three-dimensional (3D) computational fluid dynamics (CFD) models are able to describe non-uniform distribution of the gain and temperature and, in particular, the horseshoe structure of the jets injected into the cross flow, shocks and turbulence. Another issue crucial for the understanding of the complex processes that take place in the COIL is unraveling the mechanism of I_2 dissociation. Recently [1] it was shown that a model which includes $I_2(A'\ ^3\Pi_{2u})$, $I_2(A\ ^3\Pi_{1u})$ and $O_2(a\ ^1\Delta_g, v)$ as significant intermediates in the dissociation of I_2 and referred to as Heidner-Lilenfeld-Azyazov-Heaven (HLAH) model, can better reproduce the measured gain and temperature at the optical axis of a supersonic, low pressure COIL as compared to the celebrated Heidner's model [2] that do not take into account these intermediates. However, since most COILs operate at higher pressure than that of the system for which the model was checked, it is of interest to test to validity of the model for the former systems. In the present paper the original model [1] is complemented by adding the effects of turbulence which play an important role in the higher pressure COIL systems. The results of the calculations of the extended model are compared to available experimental results [3]. Fig. 1 shows that the gain calculated by both HLAH and Heidner's models is in good agreement with the measured values for the wide range of the iodine and driver N_2 flow rates, the gains predicted by the HLAH model being closer to the experimental points at large driver N_2 flow rates. The temperature and gas velocity are also in agreement with the measured values.

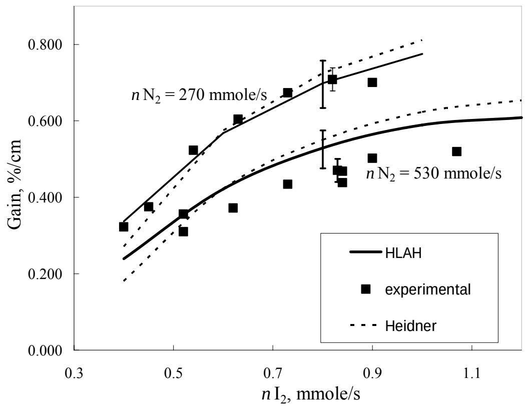

Fig. 1. Measured and calculated dependences of the gain on the iodine flow rate nI_2 for chlorine flow rate 39 mmole/s and different driver N_2 flow rates nN_2.

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