Appendix B2: Wavelength-Scanning Technique

A wavelength-scanning technique is used in this study to capture steady-state absorption data. The classic method of determining the reference intensity is to use a beam splitter and separate detector to measure the reference intensity separately. However, in a combustion environment, many factors can affect the reference intensity such as beam steering, condensation on the optics, particulates, or flow-field interferences. These effects would not be accounted for using the classic method. In this study, a method was used that uses one detector and fits a polynomial to find the baseline (reference) intensity [1].

The wavelength of the DFB laser is governed by case temperature and injection current, as shown in Appendix B1. Case temperature is used to adjust the DFB laser to the linecenter of the desired transition. By dithering the injection current with a ramp input, it is possible to scan over the entire transition. Typically, DFB lasers are able to repeat 1.3 cm\(^{-1}\) scans at 3-kHz. The injection current modulates intensity as well as wavelength; a polynomial is fit to the parts of the scan with no absorption to find the reference intensity. Figure B2.1 shows an example of absorption data obtained using this technique.

![Figure B2.1. Transmission and Absorption Data with Polynomial Baseline.](image1)
The data was obtained on the turbulent, swirl-stabilized combustor.

Care must be taken when using this method to insure accurate baseline determination. The magnitude of absorption in the areas used for the baseline fit must be negligible, requiring an isolated transition. Experience has dictated that atleast 30% of the scan has negligible absorption, as seen in Figure B2.2. Also shown in Figure B2.2, the polynomial order must be kept low as extra degrees of freedom lead to increased
sensitivity to noise sources and result in under-prediction of the actual absorbance. A third-order polynomial was used in this study.

Figure B2.2. Effect of Scan Percentage and Polynomial Order. Error increases as less of the scan is used in the baseline determination and as the order of the polynomial is increased [2].

Bibliography