

**DEVELOPMENT AND PERFORMANCE STUDIES  
OF  
ARC TUNNEL**

**BY**

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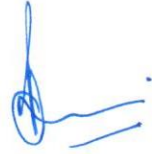
## Certificate

This is to certify that the work entitled “**Development and Performance Studies of Arc Tunnel**” being submitted by **Mr. Vidya Sagar** is original and has been carried out by the author under our guidance. The matter contained in this dissertation has not been submitted in full or in part for other diploma or degree course of this or any other university.



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## Abstract

The thesis reports the Development and Performance Studies of 50 kW arc tunnel relevant for a kW level Hydrogen Fluoride / Deuterium Fluoride (HF/DF) laser. HF/DF is a high power chemical laser based on vibrational transition. The plasma arc discharge in an arc heater/ generator is essentially employed for inducing thermal dissociation of SF<sub>6</sub> for production of fluorine atoms. The dissociation of SF<sub>6</sub> is a much safer alternative than other options of combustion of F<sub>2</sub>/ NF<sub>3</sub> in an environment of H<sub>2</sub>/D<sub>2</sub>. The present work discusses the overall mechanism of an arc discharge phenomena by numerical modeling employing commercial code COMSOL and subsequent development of arc heaters for HF/DF laser applications. The variations in material properties, temperature, and velocity due to the generated arc have been studied. Comparing these results with studies available in the literature has validated the computational results. A 50 kW arc heater system suitable for a kW level HF/ DF laser was designed and developed. A dedicated custom-built Data Acquisition System (DAS) has been developed and interfaced with arc-driven HF/DF laser tunnel. The DAS has been designed to work in a noisy and hostile environment for testing and performance evaluation of arc tunnel. The arc behavior has also been studied on 50 kW arc heater using Argon and Nitrogen. The development of 50 kW arc tunnel with supersonic nozzle, cavity, diffuser and vacuum dump was implemented and experimental results conducive for lasing are reported here. Since each designed plasma arc tunnel is unique in itself and specific to the application, this would enable altering arc discharge parameters for optimization of the intended laser.

## Publication from thesis

- 1 Vidya Sagar, Chhaya Ravikant, AP Mittal et al, "Development of data acquisition and analysis system for HF/DF chemical Lasers", KIET International Journal of Communications & Electronics, Vol. 1, Issue 1, pp5-10, Jan – Feb, (2013.)
- 2 Vidya Sagar, Chhaya Ravikant, AP Mittal et al, "Numerical modeling of arc plasma generator for chemical Laser applications", Journal of Engineering Physics and Thermophysics (Springer), Vol. 85, pp605-613, May, (2012).
- 3 Vidya Sagar, Chhaya Ravikant, AP Mittal et al, "Data acquisition system for arc driven HF/DF chemical Lasers", Journal of Instrumentation Science & Technology (Taylor & Francis), 40, pp262-274, June, (2012).
- 4 Vidya Sagar, Chhaya Ravikant, AP Mittal et al, "Performance and Control of 50 kW arc heater for chemical Lasers", Journal of Advanced Physics (American Scientific Publishers), Vol. 1, pp1-8, (2012.)
- 5 Vidya Sagar, Chhaya Ravikant, AP Mittal et al, "Development of data acquisition and analysis system for HF/DF chemical Lasers", paper presented in IEEE sponsored International Conference on Communication & Electronics (ICCE-2012) during 19-20 October, (2012).