Abstract

The gas centrifuge method is extensively used to separate stable isotopes. The detailed understanding of the flow within the spinning rotor of a gas centrifuge is highly important because it serves as the foundation for the designing of a gas centrifuge rotor that has both high separative power and efficiency. It is also essential to have an accurate understanding of the gas velocities inside of a rotating gas rotor in order to accurately predict the speed of rotation at which the separation of a specific isotope is achievable. The development of a laser Doppler velocimetry system allows gas flow velocity measurement without disturbing. The principle of this method is to measure the Doppler shift or the frequency changes that light undergoes when it is reflected by revolving flow field. Using this Doppler shift, the velocity of moving scatterers can be calculated by employing the Doppler equation. The present dissertation deals with the designing and fabrication of Laser-Doppler Velocimeter (LDV) system. The designed LDV system is a standard single-component crossbeam system, which can operate in either back-scattering or forward-scattering mode. The experimental measurement set-up includes the laser source, the optical components, a mist particle generator, a photodetector to capture scattered light, and an oscilloscope for signal monitoring. A continuous wave (cw) He-Ne laser with a wavelength of 632.8 nm and an output power of 5mW operating in TEM_{00} mode was used as a light source. A 50/50 beam splitter was used to split the laser beam into two equal-intensity beams. After splitting, the beams were passed through a convex lens generating a focused crossover point at the lens's focal point forming a fringe pattern. The light that has been scattered by moving particles as they pass through fringes is reflected and photodetector was used to collect the scattered light. Adjusting and monitoring of signal were done using an oscilloscope A simple program in MATLAB software is used to process the data files. The Doppler shifted frequency (f_d) is estimated by analyzing the signal's spectra using the Fast Fourier Transform (FFT) analysis. The development of laser Doppler velocimetry system makes it possible to measure the flow velocities of mist particles in both forward and back-scattered modes. The average flow velocities come out to be 0.54425 mm/s and 0.47432 mm/s in forward and back scattering modes of developed LDV system. This laser-Doppler velocimeter is highly beneficial for various gaseous flow velocity measurements in future.