# Experimental spray characterisation of air-assisted impinging jets

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## Abstract

Air-assisted atomization, in which kinetic energy of air is used to aid the liquid atomization, has been used in the past to atomize various liquids. In most studies, either an annular/central liquid sheet is blasted with air jets, or the gas is allowed to mix with the liquid inside the atomizer to form the spray. On the other hand, impinging jet atomizers are used in applications such as bipropellant rocket engines and chemical processes which require rapid mixing between two fluids. In the present study, an arrangement consisting of impinging jets along with air-assist has been studied to take advantage of both methods.

The atomizer employed in the current study consists of two liquid nozzles with 0.76 mm diameter orifices, and a gas nozzle with a 1.1 mm diameter orifice. The liquid jets impinge and form a liquid sheet in the plane perpendicular to that containing the axes of the injectors, and the gas supplied through the gas orifice is used to assist the break-up of this sheet. The gas injector is placed above the impinging point, making equal angles with the two liquid jets. In the present study, spray structure measurements are taken at three different liquid jet impinging angles viz. 60°, 90° and 120°, and at different gas flow rates at each angle. The liquid jet velocity has been varied between 1.8 m/s and 7.3 m/s at each impingement angle and gas flow rate. Spray images are taken using backlit imaging technique. A pulsed Nd:YAG laser along with a diffuser is used to back-illuminate the spray and an Imager Pro X 4M CCD camera with 2048 X 2048 pixel CCD resolution was used to capture images of the spray. The images show that introducing a small amount of gas assists in breaking up the sheet formed by the liquid jets. Increasing the gas flow rate resulted in complete breakup of the sheet as shown in Fig. 1a. The spread of the spray is similar in both the plane of sheet and plane of jets at low liquid jet velocity. However, at higher liquid jet velocity, the spray spreads more in the plane of the sheet compared to the plane of the jets. The breakup length of the sheet is computed from the images as the distance from the impinging point to the point where sheet detaches completely. The results indicate a reduction in breakup length with increase in gas flow rate. Particle/droplet imaging analysis (PDIA) technique is used to measure the spray Sauter mean diameter (SMD). Droplet size measurements were performed in an area 5 mm X 5 mm, at an axial distance 75 mm downstream of the impingement point. These measurements were performed at four different radial locations, with impinging angle of 90° and gas flow rate of 10 LPM. Experimental observations showed that introducing gas flow results in a significant reduction in droplet diameter, as expected. The effect of gas is predominant at low liquid jet velocities and is reduced for increased liquid jet velocities. Variation in the SMD is observed with radial location as shown in Fig. 1b, and this variation in SMD with radial distance is observed to be more at higher liquid jet velocities. Air-assisted impinging jets resulted in a spray with larger droplets at the center and smaller droplets away from the axis of the spray.

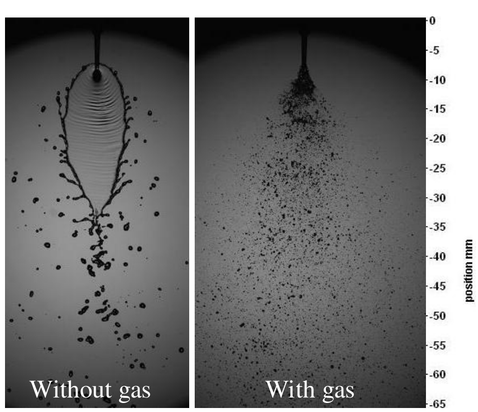


Figure 1 a) Effect of gas on spray

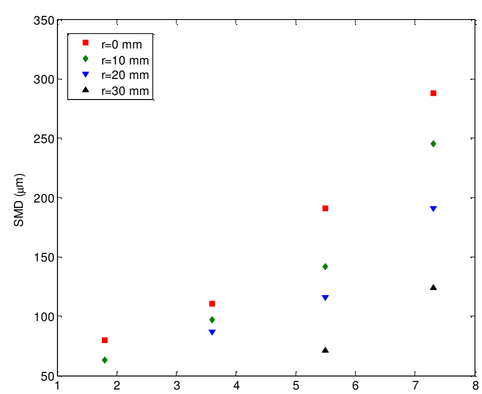


Figure 1 b) Variation of SMD with radial location

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