VKI Lecture Series – Post-Processing of Numerical and Experimental Data
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PARTICLE SEEDING

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SUMMARY

Laser velocimetry is based on the scattering of light by particles assumed to follow the fluid velocity. Therefore it is necessary to seed these flows with "known" particles, generally small enough to well represent the flow fluctuations. A great variety of aerosols and generators has been used and is reviewed.

1. INTRODUCTION

This paper deals with the flow seeding, which remains the most empirical problem in any laser velocimetry experiment, in spite the fact that the result quality strongly depends on the amount of seeding and of the size of the particles used. We shall describe different types of particle generators; the ways to qualify the aerosols in situ are reviewed.

2. PARTICLE GENERATORS

Different types of aerosols are used in laser velocimetry, issued from various particle generators. The theory tells that particles must be in the submicronic range in order to be able to follow the flow gradients; they must be the smaller as the velocities become higher. If a particle is too large, it will not follow the flow, resulting in an inaccurate representation of the fluid velocity. If a particle is too small, it will not scatter enough light to provide the signal to noise ratio necessary to minimize measurement uncertainty in the signal processing electronics. When the researcher finally gets around to deciding on the material to be used for the seed particles and the method for their generation, he is faced with a myriad of possibilities.

To generate the particles, different solutions are possible: atomizers of various types, vaporizers, injectors, fluidized beds [1]. The oil/air atomizer (Fig. 1) is a sophisticated perfume sprayer. Air is forced through a small jet which blows over a reservoir of oil. The combination of capillary effect and reduced pressure within the jet causes the oil to rise within the oil gap where the jet shears it into small particles. The size of each particle will depend on how much liquid is sheared to form that particle, the surface tension of the liquid, and the amount of evaporation prior to reaching the measurement volume. Clearly this type of generator lacks sufficient control of particle size.

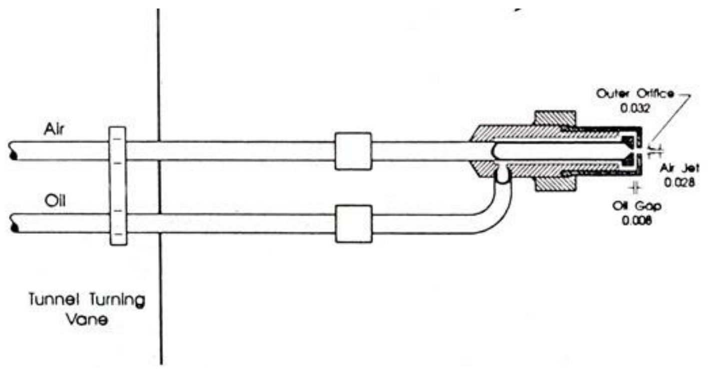

Figure 1: Scheme of a particle generator based on an oil/air atomiser.

A variation of the oil/air atomizer is the Laskin nozzle (Figure 2). The major difference is the immersion of the atomizer within the liquid. The generated particles are contained within bubbles produced by the air jet. These particles are released when the bubbles reach the surface. This method reduces the number of large particles since they will not remain suspended within the bubbles. Using dioctyl-phtalate (DOP) with a Laskin nozzle [2] produces particles smaller than 2 µm. To further reduce the particle size, an impactor is placed on the generator output (Figure 3), and DOP can be mixed into alcohol.

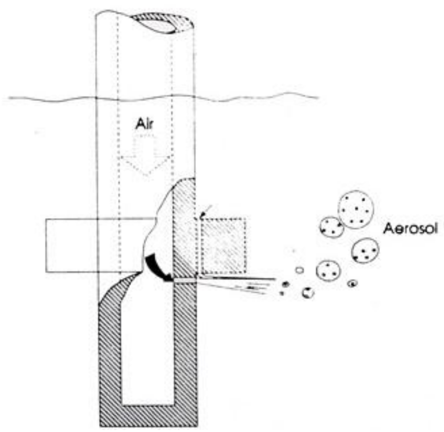

Figure 2: Scheme of Laskin nozzle device

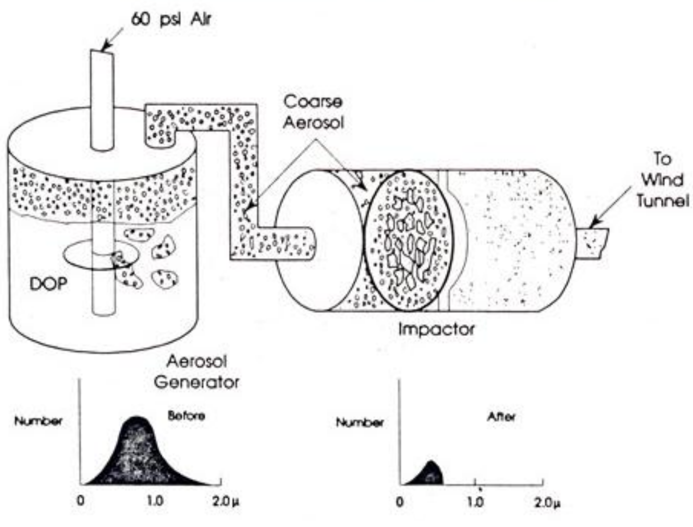

Figure 3: Scheme of a Laskin vaporisation system with an impactor [1]