SEED PARTICLE GENERATION FROM MODEL 9306 SIX-JET ATOMIZER

APPLICATION NOTE 9306-001 (A4)

The Model 9306 atomizer is an aerosol generator specifically designed to generate particles in droplet and solid forms. The generators can be used to disperse various types of matter, including water droplets, salt or sugar particles, polystyrene latex sphere (PSL) particles and oil droplets, for LDV and PIV applications. The atomizer incorporates several special features, such as a built-in pressure regulator and pressure gauge, which makes it a convenient and flexible instrument. It also has a self-contained dilution system and users can select one to six particle-generating atomizer jets. The result is a broad range of control over both the particle number concentration and the total particle output.

Design of the Atomizer

The atomizer is made up of four subassemblies: the pressure regulator, atomizers, the dilution system and the aerosol outlet. Figure 1 identifies these subassemblies on the atomizer.

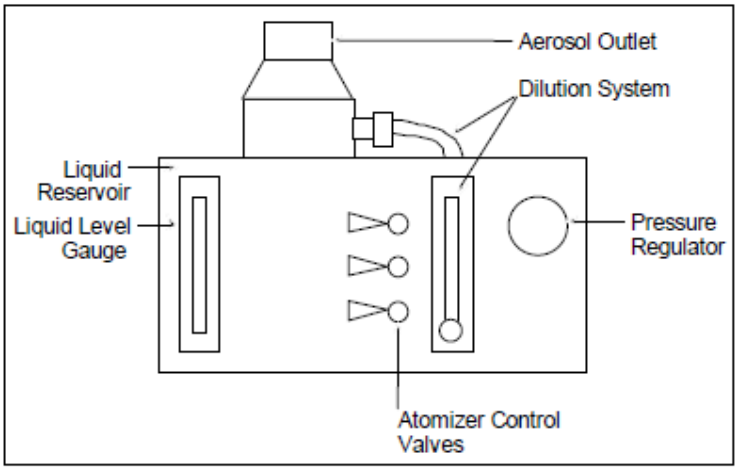

Figure 1: The Four Subassemblies of the Atomizer

Pressure Regulator

A regulator and pressure gauge are mounted on the atomizer. The regulator controls the input pressure which is displayed on the gauge. The precise relationship between input pressure and aerosol output is shown in Table 1.

Table 1. Aerosol Flow Rate Per Jet

Input Pressure		Aerosol Output*
Psi	kPa	L/min
5	34.5	2.4
10	68.9	3.7
15	103.0	4.7
20	138.0	5.7
25	172.0	6.6
35	241.0	8.3
45	310.0	10.2
55	379.0	12.0

*Outlet opens to the atmosphere.

Atomizers

All six atomizers may be used at one time. Figure 2 shows one of the six individual particle-generating atomizers within the liquid reservoir. As shown in Figure 2, pressurized air forms a high-velocity jet through a 0.015-inch-diameter orifice. The pressure drop from this jet draws liquid up through a narrow tube. The liquid is then broken up into droplets by a high-velocity air jet. The resultant larger droplets impinge on the spherical impactor, while the smaller droplets make no contact and form an aerosol that exits through a specific outlet.

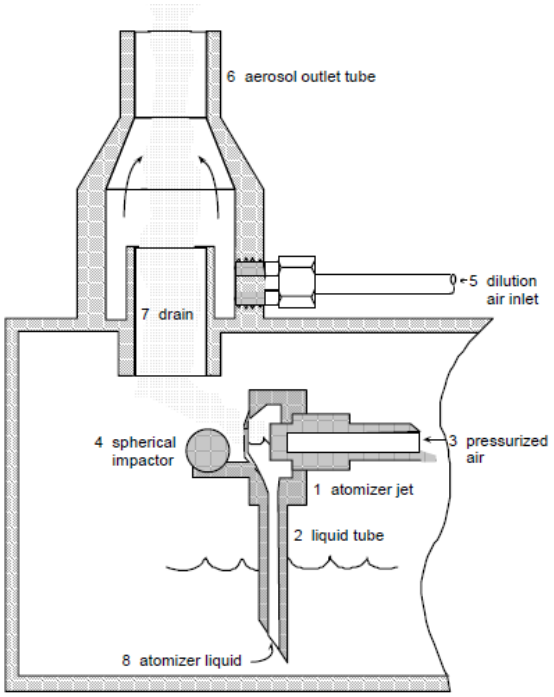

Figure 2: Schematic of the Atomizer

Dilution System

An aerosol dilution system is incorporated in the atomizer to allow the variation of the particle concentration and to help dry the solid particles that are generated from a solution. A rotometer is mounted next to the regulator, which gives the flow rate of the dilution air.

Aerosol Outlet

The aerosol outlet assembly in cross-section is shown in Figure 2. The assembly meets the high aerosol output demand when all six atomizer jets are used and/or when high dilution-air settings are used. The relatively large aerosol outlet was selected to maintain low aerosol velocities, which are critical for PIV and LDV applications, because high momentum from the particles may impact the intended flow measurements.

The total aerosol (particle) output depends on the input pressure and the number of jets operating. At fixed input pressures, the particle output is directly proportional to the number of jets that are open. Figure 3 shows the general behavior of the aerosol output rate with respect to the input pressure to the atomizer.

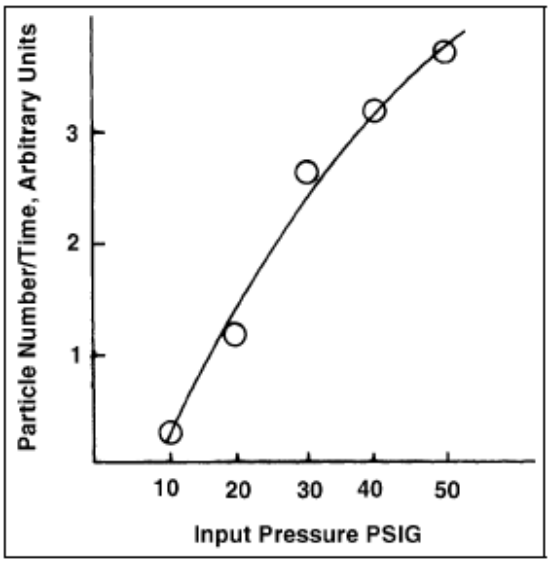

Figure 3: General Trend of the Rate of Particle Output vs. Input Pressure

Principle of Operation

The operation of the atomizer is quite simple. Please see the following instructions on how to operate the atomizer.

Adding Atomizer Liquid

Remove the red plastic filler cap on the cover of the reservoir and pour in the liquid which will be atomized. Observe the liquid level shown in the glass gauge on the front panel. Fill the reservoir no more than half, to ensure that the atomizing jets are not submerged.

Connecting the Compressed Air

Be sure to close both the regulator valve and the dilution air valve before connecting the compressed air. To close the regulator, turn its knob counterclockwise until at least three-fourths of an inch of the shaft is exposed. To close the dilution air valve, turn it fully clockwise.

Now, connect a source of clean compressed air to the atomizer at the inlet fitting on the pressure regulator.

Connecting the Aerosol Outlet

Connect the atomizer to the flow system that is to be seeded, using one-inch ID flexible tubing (Tygon®, for example). Slip the tubing over the aerosol outlet. Under atmospheric conditions, no hose clamp is necessary.

Setting the Regulator Pressure

The atomizer works well under input pressures between 20 and 50 psi. Under atmospheric conditions, an input pressure of 25 psi is typical.

Operating the Jets

Open the jet or jets needed. Three *on/off* valves control the jets' operation. The label beneath each valve indicates the number of jets that each valve controls. Thus, the valve labeled "1 JET" controls a single jet; the valve labeled "2 JETS" controls two additional jets, while the valve labeled "3 JETS" controls three additional jets. One to six jets may be operated by opening the appropriate valve(s). If the valves labeled "1 JET" and "3 JETS" are open, a total of four jets would be in operation.

Operating Characteristics for Different Types of Aerosols

The atomizer is very versatile in terms of generating different types of aerosols or particles. The characteristics of the aerosol output are described below, depending on the particle type:

Liquid Particles

The atomizer is used most often for generating liquid seed particles because liquid particles are spherical, inexpensive, and can be generated by the atomizer at high concentrations. Typical materials may include dioctyl phthalate (DOP), polyethylene glycol 400, oleic acid, olive oil, and propylene glycol.

Solid Particles

NaCl, or sugar particles, may be generated in the atomizer by atomizing a solution of these solids. Once completely dried, the final size of the particles depends on the concentration of the solution used; thus, a lower solids concentration yields smaller particles. Since the solubility of sugar is higher than NaCl, sugar is preferred when particles larger than one micrometer are desired.

Monodisperse Latex Sphere (PSL) Particles

Monodisperse aerosols can be generated by dispersing uniform PSL particles using the atomizer. The resultant monodisperse PSL aerosols are very useful for system evaluation and calibration. To generate PSL particles, make a very dilute solution with two to three drops per one liter of distilled water. It is important that the solution be sufficiently diluted so that the probability of a liquid droplet containing more than a single PSL particle is low. This becomes more important when the aerosol is intended for system calibration. For seeding, a more concentrated solution may be used (10 drops per liter).

An aerosol of original particle size is obtained only after the liquid droplets are completely dry. Mixing the aerosol with a sufficient volume of warm, dry air is perhaps the best way of drying the particles.

TSI and TSI logo are registered trademarks of TSI Incorporated.

UNDERSTANDING, ACCELERATED

TSI Incorporated – Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 874 2811	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 1 41 19 21 99	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

9306-001-A4 (8/6/2015) ©2015 TSI Incorporated Printed in U.S.A.