The atomization of a liquid by means of a compressible fluid like air, steam or a gas, is defined pneumatic, two-phase, or twin-fluid atomization. Many industrial processes require the availability of finely atomized droplets and the techniques to produce atomized jets have been largely improved in the recent years. In addition, more sophisticated process techniques have increased the demand for a precise definition about the characteristics of the spray and are now available to the design engineer. Since many years PNR can supply upon request complete documentation containing test reports about the more interesting and additional information, which are described below, for all PNR products.

**Laser Interphorometer Test (By Pdpa)**

PNR droplet size test reports are performed by means of a Laser Interphorometer (Phase Doppler Particle Analyzer), where two laser beams cross in a given point of the spray and define a test probe area. Droplet flying through the probe area cause a light scatter which is picked up by the instrument receiver and processed through a computer, in order to obtain relevant information about the spray characteristics.

**Report Information**

Report information is made of data printed on three pages, where the first page contains the most interesting data which make possible to base process calculations upon precise data about spraying degrees, process efficiency and jet behavior in operational ambiance. These pages contain the Sauter Mean Diameter value whose knowledge is of special importance in heat exchange calculations about evaporative gas cooling processes, since it gives the possibility of evaluating the exchange surface obtained by atomizing for a given liquid volume.

The upper picture at page 18, referring to atomizing water by means compressed air, shows two following histograms:

- Distribution curve of droplet diameter (micron)
- Distribution curve of droplet velocities (mps)

and the below described values

- Arithmetic Mean Diameter \(D_{10}\)
- Surface Mean Diameter \(D_{20}\)
- Volume Mean Diameter \(D_{30}\)
- Sauter Mean Diameter \(D_{32}\)

<table>
<thead>
<tr>
<th>Formula</th>
<th>Description</th>
<th>Note</th>
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</thead>
<tbody>
<tr>
<td>(D_{10}) = (\frac{\sum n_i d_i}{\sum n_i})</td>
<td>ARITHMETIC MEAN DIAMETER</td>
<td>This is a diameter value which, multiplied by the local number of droplets in the sample, equals the addition of all droplets diameters</td>
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<tr>
<td>(D_{20}) = (\sqrt{\frac{\sum n_i d_i^2}{\sum n_i}})</td>
<td>SURFACE MEAN DIAMETER</td>
<td>This is the diameter of such a droplet whose surface, multiplied by the total droplets number, equals the sum of all droplets surfaces</td>
</tr>
<tr>
<td>(D_{30}) = (\sqrt[3]{\frac{\sum n_i d_i^3}{\sum n_i}})</td>
<td>VOLUME MEAN DIAMETER</td>
<td>This is the diameter of such a droplet whose volume, multiplied by the total droplets number, equals the sum of all droplets volumes</td>
</tr>
<tr>
<td>(D_{32}) = (\frac{\sum n_i d_i^3}{\sum n_i d_i^2})</td>
<td>SAUTER MEAN DIAMETER</td>
<td>This is the diameter of such a droplet whose volume/area ratio, equals the ratio between the sum of all droplet volumes divided by the sum of all droplet surfaces</td>
</tr>
</tbody>
</table>
LIQUID SPRAY AND SPRAY NOZZLES 

Droplet spectrum

Attempts
Droplet number crossing probe area during test time. This includes both validated and not validated droplet.

Correct Count Criteria
A mathematic correction is applied to validate droplets which cross Probe Area in a peripheral belt, or to droplets without a perfect spherical shape, so that all validated droplets parameters are homogeneous. (This correction is necessary so that there is direct proportionally between laser beam phase and droplet number diameter).

Number Density
It is the number of droplets passing through probe area within test time.

Probe area
This is the area where the two laser beams are crossing, so determining the probe area. All droplets intersecting probe area are checked. droplets which respect given parameters for shape are taken as valid droplets and make up the sample, whose size and velocity parameters are reported.

Validations
Droplets accepted, based on given shape parameters, to make up for test sample.

Velocity Mean
Droplets distribution speed histogram (m/s).

Volume Flow Rate
It is the volume, measured in cubic centimeter per second, of the validated droplets making up for the sample.

Volume Flux
It is the flow rate per specific area, measured in cubic centimeter per second and square centimeter, of the validated droplets making up the sample.
PNR can supply upon request complete documentation containing test reports about the aforementioned parameters and additional information, for all PNR atomizers. The diagrams beside show the distribution of droplet diameters and droplet velocities of a spray under test as available to our customers.

In the photo beside a test being performed at our laboratories. We use a computer driven laser interferometer to detect and record the spray parameters, while fluid capacities and feed pressure values are monitored through high precision instruments.

IMPORTANT NOTE

The droplet size values measured with a PDPA instrumentation are representative of a well specified volume inside the spray, and taking measurements in a different volume they can be considerably different. A correct spray droplet size characterization requires then not only tests being performed in several volumes within the spray, but also that those measure volumes are selected with regard to the process the droplets are expected to perform. As an example the droplet characterization of a spray should define how many volumes have been tested and which are the coordinates of each single test volume in relation to the nozzle orifice.

Most of the times pretending to describe the droplet spectrum of a spray nozzle at a given pressure with only one diagram is therefore not correct.