Theoretical Basics

1. Correlations in spray technology

1) Pressure p of liquid or gas, impinging on the nozzle
2) Specific gravity of liquid (g/m³)
3) Viscosity (dyn sec./cm)
4) Surface tension (dyn/cm²)
5) Temperature of liquid (t)
6) Spray patterns of the nozzle, nozzle type and its dimensions, such as outlet bore diameter, section of swirl slots and frictional resistance inside of the nozzle

	Increas. operating pressure	Increased specific gravity	Increased viscosity	Increased surface tension	Increased liquid temperature	Increased outlet diameter
Spray quality	improves	negligible	deteriorate	negligible	improves	negligible
Flow rate	increase	decrease	a	no effect	b	increase
Spray angle	rather greater	negligible	decrease	decrease	increase	negligible
Droplet size	smaller	negligible	increase	increase	decrease	increase
Droplet velocity	increase	decrease	decrease	negligible	increase	increase
Force of impact	increase	negligible	decrease	negligible	increase	increase
Wear	increase	negligible	decrease	no effect	b	b

Illu. 1 a – increases for hollow and full cone nozzles, decreases for flat fan
b – depends on liquid to be sprayed and nozzle type

2. Pressure - Flow rate

A nozzle's flow rate increases when pressure is increased while all other factors remain constant. Increased pressure leads to a higher outlet velocity and also to smaller droplets. This catalog lists all flow rates in l/min for a given pressure. A liquid flow rate of at least 0.3 to 0.5 bar has to be given to enable atomization.

The theoretical flow rate is proportional to the pressure ratio's square root.

$$\dot{V}_2 = \sqrt{\frac{p_2}{p_1}} \cdot \dot{V}_1 \text{ [l/min]}$$

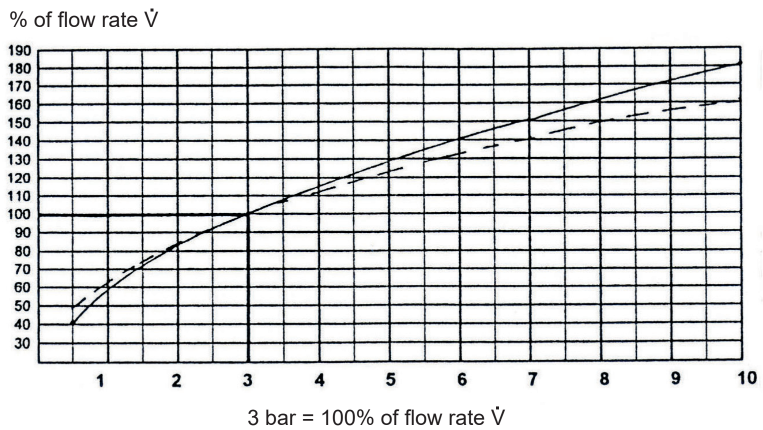
This formula proves to be highly accurate for almost all unary nozzles.

$$\dot{V}_2 = \left(\frac{p_2}{p_1}\right)^{0,4} \cdot \dot{V}_1 \text{ [l/min]}$$

Only axial-flow full cone nozzles change the flow rate characteristics.

Illu. 2

To simplify matters, ratios can be taken from the adjoining diagram according to percentage.



<u>Example:</u> If a nozzle's flow rate is known to be at 3 bar, the flow rate for other pressure ratios can be seen in the adjoining diagram.
3 bar = 100 % flow rate
1 bar = 60 % of 3 bar ratio

- $\dot{V}$ % unary nozzles
-- $\dot{V}$ % axial-flow full cone nozzles

3. Specific gravity

All information in the catalog with regard to flow rates always refer to the medium of water. For other liquids the flow rate will vary inversely to the square root of the specific gravity.

$$\dot{V}_{FL} = \dot{V}_W \frac{\sqrt{\gamma W}}{\sqrt{\gamma FL}}$$

To simplify matters, this can be done with the help of a conversion factor, resulting in the following formula:

$$\dot{V}_{FL} = \dot{V}_W \times X$$

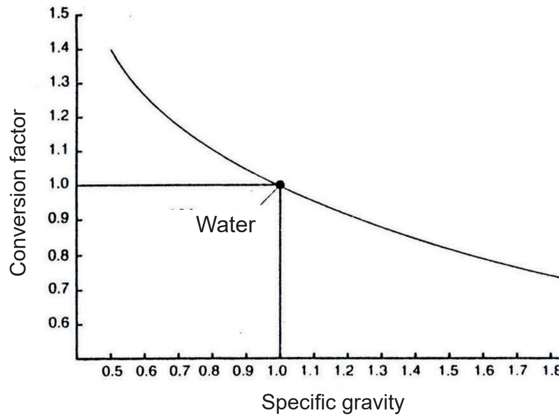
$\dot{V}_{FL}$ = **Flow rate of liquid meant to be atomized**

$\dot{V}_W$ = **Flow rate of water (catalog ratio)**

γ_W = **Specific gravity of water**

γ_{FL} = **Specific gravity of liquid meant to be atomized**

X = **Conversion factor**



Illu. 3