FULL CONE PATTERN

In a full cone spray the droplets are distributed into a volume which is limited by a cone, having its origin point at the nozzle orifice. Such spray pattern is commonly used in a large variety of industrial processes, since it is the one which allows to distribute in an even way the water flow onto a surface: the full cone spray pattern is therefore useful, as a typical example, to evenly spray cooling liquid on a still surface. Another typical use is to distribute liquid droplets within a certain volume, like for example evenly distributing water droplets in the inside volume of a cooling tower.

Because of the wide number of processes performed by means of full cone nozzles the original shape has evolved into a range of specialised types, where the full cone spray pattern, or a pattern similar to a full cone one, is obtained by different techniques.

**Standard full cone (turbulence nozzle)**

These nozzles use a specially shaped vane placed at the nozzle inlet, to give a rotational speed to the fluid flowing through the nozzle.

Because of the rotational speed of the fluid, water exiting the nozzle orifice is subjected to centrifugal force and opens up in the shape of a full cone.

The extent of the angle of the cone is a function of both exit speed (created from the inlet pressure) and the internal design of the nozzle. It can vary in practice from 15° to 120°.

These nozzles can be also produced as square full cone nozzles, where the square shape of the pyramidal spray is obtained by a special design of the outlet orifice.

Two important details have to be noted from the system designer when using these type of nozzles:

- the spray angle is measured on the side of the square section
- the square section of the spray rotates within the distance from the nozzle orifice to the target area.

**Spiral full cone (deflection nozzle)**

This is not properly a full cone, but rather a continuous liquid curtain evolving with the shape of a spiral inside a conical volume. The disadvantage of a scarcer even distribution is compensated by an exceptionally good resistance to plugging, which makes this nozzle the best choice in those applications where safety or system reliability are the prime concern, e.g. fire fighting systems.

**Multiple full cone (turbulence nozzle, air atomizer)**

This spray pattern is used in two cases, that is:

1. When a wide spray angle is to be reached with nozzles which inherently can only produce a narrow one, or in such cases where small size droplets and rather high capacities are required.

Therefore several nozzles are grouped in a cluster with different spray directions: the resulting spray pattern occurs from the additional group of single nozzle sprays and the droplet size of the spray remains the same as one of single nozzle. It must be noted that a smaller nozzle will normally make smaller drops as compared to a larger size nozzle of the same type operating under the same conditions.

2. When it is necessary to obtain a wide angle jet using nozzles which inherently deliver a limited angle spray, in the case of a wide angle air atomizer, for example, the droplet distribution is obviously not homogeneous and the result is rather a number of small angle sprays with different directions, but still the liquid is atomized towards all the parts of the volume to be treated.
LIQUID SPRAY AND SPRAY NOZZLES *Spray nozzle types*

**FLAT JET SPRAY PATTERN**

In a flat jet spray the liquid droplets are sprayed in the shape of a flat liquid layer, with different thickness according to the principle used to generate the spray. A flat jet spray nozzle serves the purpose of spraying onto a surface or an object moving in a transverse direction with respect to the one of the jet surface, a typical example being the nozzles in a car washing tunnel. The vast majority of flat spray nozzles used in the industry work according to one of the following principles.

**In line flat jet (pressure nozzle)**
This is the general purpose flat jet nozzle, where the liquid enters the nozzle in line with the axis length and is fed to a pressure chamber, from where it is ejected through the nozzle orifice. Flow value and spray angle are determined respectively from the orifice cross section and the orifice edge profile.

**In line straight jet (pressure nozzle)**
These nozzles can be considered a special kind of flat jet nozzle, with naught degree spray angle. They are designed to produce a sharp stable stream, with powerful impact on a given point, and serve normally to perform cleaning processes or to cut soft materials.

**Spoon flat jet (deflection nozzle)**
In this type of nozzle the liquid is fed under pressure to a round outlet orifice, and then deflected onto a smooth profiled surface so as to assume a flat jet shape. This sophisticated design is of advantage since it offers a stronger jet impact using the same feed pressure.

Higher efficiency comes from the very little energy required to just change the direction of the liquid flow, this being the only energy required to generate the flat jet.

**HOLLOW CONE SPRAY PATTERN**

A hollow cone spray pattern consists of droplets concentrated onto the outer surface of a conical shape volume, with no droplets contained in the inside of the conical jet shape. These nozzles are normally used for smoke washing or gas cooling applications in several industrial processes.

**Hollow cone (turbulence nozzle)**
These nozzles use a tangential injection of liquid into a whirling chamber to generate centrifugal forces which break up the liquid vein as soon as it leaves the orifice. Precisely designed orifice profiles, making use of the Coanda effect, provides the ability to obtain very large spray angles.

**Hollow cone (deflection nozzle)**
A hollow cone can also be obtained taking a liquid flow to change direction onto a properly designed surface, in order to break the liquid into droplets and distributing them as a hollow cone spray pattern.

This kind of nozzle is mainly used for applications in dust control and fire fighting systems.