

# HYDRAULIC NOZZLES

## FULL-CONE NOZZLES

A full-cone spray is one in which the drops are distributed uniformly throughout a conically-shaped volume with its origin at the orifice exit. Depending on the shape of the exit orifice, the cross-sectional shape of the spray envelope can be circular, square, rectangular, or oval.

Such a spray pattern is commonly used since it provides an even distribution of liquid on a surface. Another reason for using a full-cone spray is to distribute drops uniformly within a given volume, for example, distributing water drops inside a cooling tower.

The range of processes utilizing full-cone nozzles is large. As a result, many different types of designs have been developed to accommodate the requirements of specific applications.

### Standard full cone (Turbulence nozzle)

These nozzles use a specially shaped vane placed at the nozzle inlet to impart a rotational component to the fluid flowing through it. This causes the liquid exiting the nozzle orifice to open up into a full-cone shape. The cone angle is a function of both exit speed (therefore, inlet pressure) and the internal design of the nozzle. Cone angles can vary from 0° to 130°.



### Spiral full cone (impact nozzle)

This type of device does not technically produce a full-cone, but rather it generates a continuous liquid curtain that develops in the shape of a spiral inside a conical volume.

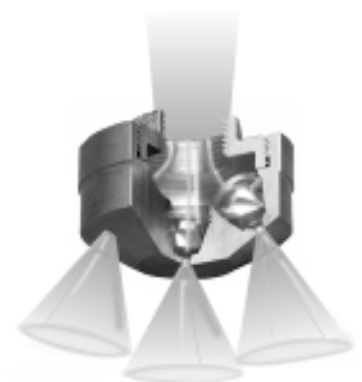
The distribution of liquid within the cone is not as uniform as that from conventional full-cone nozzles. However, this is offset by exceptionally good resistance to clogging, making it a good choice in those applications where clogging can not be tolerated.



### Multiple full cone (turbulence nozzle, air-assisted nozzle)

This configuration is employed in applications where very small drops are required to be distributed over a wide area and where relatively high flow rates are needed. Small drops are usually associated with air-assisted nozzles. However, that type of nozzle is limited both in its capability to produce a wide-angle spray and to operate at high flow rates.

In this design, several nozzles are clustered together, each pointed in a different direction. The resulting spray pattern comes from the addition of the patterns from each of the nozzles in the cluster.



## FLAT-JET NOZZLES

A flat-jet spray is one in which the liquid drops are formed into a long, narrow pattern. The thickness of the narrow dimension of the spray varies according to the design of the device and the flow rate.

The principal use of flat-jet spray nozzles is to produce a well-defined spray pattern on a surface as the surface (or the nozzle) moves transversely with respect to the wide dimension of the spray. A typical example would be nozzles used in a car washing tunnel. The majority of flat-spray nozzles used in industry operate according to one of the following principles:



### In-line flat jet (Pressure nozzle)

This is the general purpose flat-jet nozzle. Liquid enters the nozzle in-line with its length axis and is fed into a pressure chamber, from where it is ejected through the nozzle orifice. Flow rate and spray angle are determined by the cross-section and profile of the orifice.

### In-line straight jet (Pressure nozzle)

This can be considered a special type of flat-jet nozzle, with 0° spray angle. It produces a sharp, stable stream with powerful, uniform impact.

Typical examples of their use is in washing or gas cooling applications.



### Spoon flat jet (Impact nozzle)

For this type of nozzle, the liquid is fed under pressure into a round outlet orifice and then forced to impact onto a smooth surface causing it to assume a flat-jet shape.

This design has the advantage of producing a stronger impact than in-line flat-jet nozzles at the same feed pressures. The higher impact velocity results from the increased efficiency of the design.

## HOLLOW CONE

A hollow-cone spray pattern consists of drops concentrated on the outer surface of a conically shaped volume, with very little spray within the interior of the spray envelope. Typical examples of their use are in washing or gas cooling applications.



### Hollow cone (Turbulence nozzle)

These nozzles use a tangential injection of liquid into a whirling chamber to generate centrifugal forces that break up the liquid stream as soon as it leaves the orifice.

Precisely designed orifice profiles, which use the Coanda effect (a phenomenon in which liquid, moving at high velocity, tends to hug the walls of a chamber), allows very large spray angles to be developed.



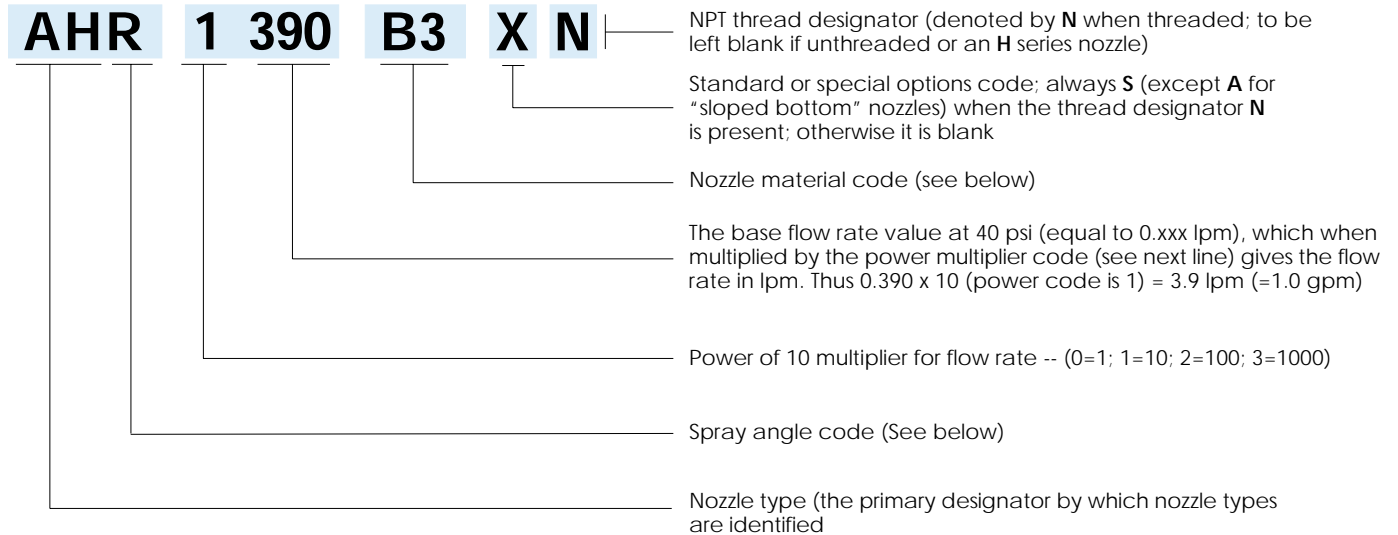
### Hollow cone (Impact nozzle)

This type of hollow-cone nozzle relies on having the liquid stream impact onto a specially designed surface in order to break the liquid into drops and distribute them into a hollow-cone spray pattern.

## NOZZLE CODING SYSTEM

Spray nozzles are available in a wide variety of configurations necessitating a precise coding system for specifying each product. The part numbering system used for PNR nozzles and other products is designed to accomplish that objective.

Following is an example that lays out all the elements of the code for hydraulic nozzles. The coding scheme for air-atomizing nozzles is somewhat different and is shown on page 51.



### NOTES:

- Flow rate values contained in the the tables for hydraulic nozzles refer to nozzles tested at 40 psi (shown in blue). Flow rates at other pressures are calculated based on the test results at 40 psi.
- The abbreviations used throughout the catalog tables and product descriptions are explained on page 90.

### SPRAY ANGLE CODES (DEGREES)

A	0	M	45	V	95
B	15	N	50	J	110
C	20	Q	60	W	120
D	25	R	65	Y	130
F	30	S	75		
H	35	T	80		
L	40	U	90		

The angle code serves as an indication only. Actual values can vary slightly depending on nozzle type and operating conditions.

### NOZZLE MATERIAL CODES

A1	FREE-CUTTING MILD STEEL	D6	FIBERGLASS-REINFORCED PP	L8	HASTELLOY C276
A2	CARBON (TOOL) STEEL	D7	HD POLYETHYLENE	P6	ABS
A8	ZINC-PLATED MILD STEEL	D8	KYNAR (PVDF)	P8	EPDM
A9	NICKEL-PLATED MILD STEEL	E1	TEFLON (PTFE)	T1	BRASS
B1	303 STAINLESS STEEL	E2	25% FIBERGLASS-FILLED PTFE	T3	COPPER
B2	304 STAINLESS STEEL	E6	LUCITE	T5	BRONZE
B3	316 STAINLESS STEEL	E7	VITON	T8	BRASS, NICKEL PLATED
D1	POLYVINYLCHLORIDE (PVC)	E8	BUNA SYNTHETIC RUBBER	T9	COPPER BODY, STAINLESS STEEL MESH
D2	POLYPROPYLENE (PP)	G1	CAST IRON	V1	ALUMINUM