Supply air nozzle VŠ-1

Application:
VŠ-1 supply air nozzles are designed to supply air into rooms in applications requiring large throw distances and low noise levels. By arranging nozzles in blocks, the throw distance is considerably increased. In terms of materials and shape, blocks of air nozzles can be designed according to to fit well into room decoration.

Description:
VŠ-1 supply air nozzles are of a fixed construction. They are made of anodised sheet aluminium. On request, they can be powder painted in any of the RAL scale colours.

Sizes and Dimensions:
VŠ-1 supply air nozzles are available in six sizes: from 20 to 250.

Installation methods:
Size 20 and 50 VŠ-1 supply air nozzles are installed by gluing, while size 100, 140, 160 and 250 air supply nozzles are installed by means of rivets or 3.5 mm self-tapping screws. VŠ-1 supply air nozzles are supplied without mounting holes.

<table>
<thead>
<tr>
<th>Size</th>
<th>φd</th>
<th>φD₁</th>
<th>φD₂</th>
<th>b</th>
<th>φC</th>
<th>Aₘ (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>20</td>
<td>40</td>
<td>52</td>
<td>60</td>
<td>46</td>
<td>0.00025</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>100</td>
<td>116</td>
<td>100</td>
<td>108</td>
<td>0.00181</td>
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<tr>
<td>100</td>
<td>100</td>
<td>200</td>
<td>220</td>
<td>160</td>
<td>210</td>
<td>0.00785</td>
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<tr>
<td>140</td>
<td>140</td>
<td>250</td>
<td>290</td>
<td>250</td>
<td>270</td>
<td>0.01496</td>
</tr>
<tr>
<td>160</td>
<td>160</td>
<td>250</td>
<td>290</td>
<td>250</td>
<td>270</td>
<td>0.01960</td>
</tr>
<tr>
<td>250</td>
<td>250</td>
<td>400</td>
<td>440</td>
<td>350</td>
<td>420</td>
<td>0.04830</td>
</tr>
</tbody>
</table>

Ordering example:
Supply air nozzle type: VŠ-1
Size: 100
Pcs: 25
### Technical data of single supply air nozzles VŠ-1:

Supply air nozzle is considered a single unit when the distance between two adjacent nozzles is \( A \geq 10d \).

The most significant data in respect of an air supply nozzle characterization is the turbulence number \( m \).

#### Throw distance of single supply air nozzle:

\[
L = \frac{d}{m} + \frac{d}{0.128} \times \left( \frac{\nu_0}{\nu_L} - 0.63 \right) \text{ (m)}
\]

#### Method of determining induction:

\[
i = 2m \frac{L}{d}
\]

### Table: Single Supply Air Nozzles VŠ-1

<table>
<thead>
<tr>
<th>Size</th>
<th>( m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>0.180</td>
</tr>
<tr>
<td>50</td>
<td>0.155</td>
</tr>
<tr>
<td>100</td>
<td>0.150</td>
</tr>
<tr>
<td>140</td>
<td>0.145</td>
</tr>
<tr>
<td>160</td>
<td>0.145</td>
</tr>
<tr>
<td>250</td>
<td>0.150</td>
</tr>
</tbody>
</table>

### Parameters:

- \( \nu_0 \) (m/s): Discharge air velocity (velocity in the air jet core)
- \( Q_s \) (m³/s): Air flow rate per single nozzle
- \( A_{ef} \) (m²): Effective nozzle cross-section area
- \( v_L \) (m/s): Desired velocity at the throw distance \( L \)
- \( L \) (m): Desired throw distance
- \( m \): Supply air nozzle turbulence number
- \( \Delta t_L \) (°C): Maximum difference between the jet core temperature and the room temperature
- \( \Delta t_z \) (°C): Temperature difference between supply air and room air
- \( i \): Induction, i.e. the ratio between the total air jet flow rate and supply air flow rate
- \( A \) (m): Distance between nozzles
- \( g \) (m/s²): Acceleration of gravity
- \( d \) (m): Nozzle diameter
- \( T_p \) (°K): Room air absolute temperature
Calculation of the throw distance as a function of the temperature quotient:

In non-isothermal conditions (temperature difference between the supply air and room air) the air jet rise or drop $y$ and temperature quotient shall be considered:

$$\frac{\Delta t_L}{\Delta t_Z}$$

$$y = 0.33d \times m \times Ar \left(\frac{L}{d}\right)^{3/4} (m)$$

where $Ar = Archimedian number$

$$Ar = \frac{d \times \Delta t_{L} \times g}{\nu_0^2 \times T_p}$$

Temperature quotient:

$$\frac{\Delta t_{L}}{\Delta t_{Z}} = \frac{3}{4} \times \frac{d}{m \times L} \times oz.$$  

$$\Delta t_{L} = \frac{3}{4} \times \frac{d}{m \times L} \times \Delta t_{Z} (^{\circ}C)$$
Arrangement of supply air nozzles in blocks:
When large throw distance or greater air flow rate is required, supply nozzles are installed arranged in blocks.

- $Q_0$ (m$^3$/s)  $Q_0 \times n$ supply air flow rate
- $n$ Number of nozzles in a block
- $Q_2$ (m$^3$/s) Air flow rate at $x_2$
- $v_2$ (m/s) Air velocity at $x_2$
- $b$ (m) Air jet width at $x_2$
- $h$ (m) Air jet height at $x_2$
- $L$ (m) Throw distance of the combined air jet
- $L_{cel}$ (m) Total throw distance
- $Q_{cel}$ (m$^3$/s) Air flow rate at the throw distance $L$

Calculation method applicable to isothermal conditions and a rectangular array nozzle blocks $b / h \leq 12$

1. Distance from the outlet to the joint air jet:

$$x_2 = 9.5 \times \left( A - \frac{d}{2} \right) \text{ (m)}$$

2. Increase of air flow rate due to induction:

$$Q_2 = \frac{2v_2}{x_2} \times Q_0 \text{ (m$^3$/s)}$$

3. Widening of air jet up to the distance $x_2$:

$$b = b' + 0.2x_2 \text{ (m)}
\quad h = h' + 0.2x_2 \text{ (m)}$$

$$F_2 = b \times h \text{ (m$^2$)}$$

4. Air jet velocity at $x_2$:

$$v_2 = \frac{Q_2}{F_2} \text{ (m/s)}$$

5. Air jet velocity at the throw distance $L$:

$$v_L = \frac{v_0 \times d \times \sqrt{n}}{m \times L} \text{ (m/s)}$$

6. Throw distance:

$$L = \frac{v_0 \times d \times \sqrt{n}}{m \times v_L} \text{ (m)}$$

7. Total throw distance:

$$L_{cel} = L + x_2 \text{ (m)}$$

8. Air supply nozzle block induction is calculated as follows:

$$i = \frac{Q_{cel}}{Q_2} \quad Q_{cel} = 2Q_2 \times v_0 \times d \times \sqrt{n} \text{ (m$^3$/s)}$$

Isothermal conditions - rectangular array nozzle block:
The indicated calculation method is applicable in isothermal conditions and for rectangular blocks of nozzles where $b \times h < 12$. In a case of non-isothermal conditions, the air jet rise or drop due to the temperature difference has to be calculated.
Calculation method applicable to isothermal conditions and a square or circular array nozzle blocks:

1. Square arrangement of supply air nozzles:
   \[ b = h = a \]
   \[ F_2 = a^2 \]

2. Circular arrangement of supply air nozzles:
   \[ b = h = d \]
   \[ F_2 = \pi \times d^2 / 4 \]
   \[ m = 0.20 \]

Calculation method applicable in non-isothermal conditions:

1. Rectangular arrangement of supply air nozzles:
   \[ y = 0.4h \times \sqrt{m \times Ar \times \left( \frac{L}{m} \right)^3} \]

2. Circular arrangement of supply air nozzles:
   \[ y = 0.33 \times m \times Ar \left( \frac{L}{m} \right)^3 \]

Archimedian number (Ar)

For rectangular supply air nozzle block:

\[ Ar = \frac{g \times h \times \Delta \cdot t_f}{v_t^2 \times T_p} \]

For circular supply air nozzle block:

\[ Ar = \frac{d \times \Delta \cdot t_f \times g}{v_t^2 \times T_p} \]

Isothermal conditions - square or circular array nozzle block:

In the cases of nozzle blocks not installed in a rectangular array, the adjustments indicated on the left shall be applied.

Non-isothermal conditions:

In non-isothermal conditions, the air jet rise or drop is calculated according to formulas indicated on the left.

The indicated calculation method provides an approximate result. In cases of sophisticated architectural demands, the designer is invited to consult our factory team for detailed design information. A model test can be carried out on request.
Pressure drop diagrams:

Pressure drop:

\[ p_a = 1.05 \frac{\rho}{2} v_0^2 \text{ (Pa)} \]

\( \rho \)—air density (kg/m\(^3\))

\( g \) (m/s\(^2\)) Acceleration of gravity
\( d \) (m) Circular air jet diameter at \( x_2 \)
\( h \) (m) Rectangular air jet height at \( x_2 \)
\( \Delta t \) (°C) Temperature difference between supply air and room air
\( T_a \) (°K) Absolute room air temperature
\( m \) Turbulence number (m=0.25 for rectangular block and m=0.20 for circular block)
\( L \) (m) Throw distance
Calculation example:
Required air flow rate into the hall: 15000 m³/h.
Room temperature: \( t_p = 20°C \)
Supply air temperature: \( t_z = 26°C \)
Air velocity in occupied zone: \( v_L = 0.5m/s \)

**Solution:**
52 pcs individually installed air supply nozzles VŠ-1 of size 100 are required. Air flow rate per each air supply nozzle is calculated as follows:

\[
Q_s = \frac{15000}{52} = 292m^3/h = 0.08011m^3/s
\]

1. Supply air velocity:

\[
V_0 = \frac{Q_s}{A_{ef}} = \frac{0.08011}{0.00785} = 10.2 \text{ m/s}
\]

2. Throw distance:

\[
L = \frac{0.1}{0.15} + \frac{0.1}{0.128} \left( \frac{10.2}{0.5} - 0.63 \right) = 16 \text{m}
\]

3. Archimedean number:

\[
Ar = \frac{(0.1) \times (-6) \times (9.81)}{(10.2)^2 \times 293} = -5.885 \times 10^{-4} = -1.931 \times 10^{-4}
\]

4. Air jet rise:

\[
y = 0.33 \times 0.1 \times 0.15 \times (-1.931 \times 10^{-4}) \times \left( \frac{16}{0.1} \right)^3 = -3.9m
\]

5. Temperature quotient:

\[
\Delta t_L = \frac{3}{4} \times 0.1 \times 0.15 \times 16 = 0.031
\]

6. Pressure drop:

\[
p_d = 1.05 \times \frac{1.15}{2} (10.2)^2 = 62.7 \text{ Pa}
\]

7. Self-noise level:

Determined from the diagram, at \( V_0 = 10.2 \text{ m/s} \)
\( L_{wa} = 25 \text{ dB (A)} \)