Burner Swirl Number from Vane Angle

Swirl number of an annular axial-vane swirler from the vane angle and the hub and outer diameters (Beér and Chigier), to judge recirculation and flame stability.

Method: Beér and Chigier; Combustion Aerodynamics: S = (2/3)[1 − (d_h/d)³]/[1 − (d_h/d)²] tan θ for flat axial vanes

Input parameters

Unit system: SI

Parameter	Value	Unit
Vane angle (from the burner axis) Measured from the burner axis: 0° gives no swirl. An angle measured from the radial direction must be converted (90° minus it).	45.000	°
Hub diameter	100.00	mm
Outer diameter	300.00	mm

Calculated results

Parameter	Value	Unit
Swirl number	0.72222	

Notes for this case

- Swirl above about 0.6 (the strong-swirl threshold of Beér and Chigier) forms a central recirculation zone that stabilises the flame.

Formula and method

$$S = \frac{2}{3}\frac{1-(d_h/d)^3}{1-(d_h/d)^2}\tan\theta$$

Variables

θ	Vane angle	rad
d_h	Hub diameter	m
d	Outer diameter	m
S	Swirl number	-

Method and standards

Beér and Chigier, Combustion Aerodynamics: the flat-vane swirl number of an annular axial swirler, with about 0.6 as the threshold of strong swirl and central recirculation.

Assumptions and limits

- Thin flat vanes; vane angle from the burner axis. Real vanes have thickness and the flow does not follow them exactly, so the actual swirl is lower than the flat-vane value; no correction is applied.

References

- Beér and Chigier
- Combustion Aerodynamics: S = (2/3)[1 − (d_h/d)³]/[1 − (d_h/d)²] tan θ for flat axial vanes

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/combustion/burner-swirl-number

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.