

DIN EN ISO 9300:2023-11 (E)

Measurement of gas flow by means of critical flow nozzles (ISO 9300:2022)

Contents		Page
European foreword		4
Foreword		5
1	Scope	7
2	Normative references	7
3	Terms and definitions	7
3.1	Pressure	7
3.2	Temperature	8
3.3	Nozzle	8
3.4	Flow	9
3.5	Flow rate	10
3.6	Gas	11
4	Symbols and abbreviations	12
5	Basic equations	15
5.1	Gas behaviour	15
5.1.1	Isentropic process	15
5.1.2	State equation	15
5.2	Isentropic flow of a perfect gas	15
5.2.1	Flowing area	15
5.2.2	Static pressure	15
5.2.3	Static temperature	16
5.3	Theoretical variables at the critical point	16
5.3.1	General	16
5.3.2	Critical pressure	16
5.3.3	Critical temperature	16
5.3.4	Critical density	16
5.3.5	Critical velocity	16
5.4	Theoretical mass flow rates	16
5.4.1	General	16
5.4.2	Theoretical mass flow rate of a perfect gas	16
5.4.3	Theoretical mass flow rate of real gas	17
5.5	Mass flow rate	17
6	General requirements	17
7	Applications for which the method is suitable	18
8	CFN	18
8.1	General requirements for both the standard CFN types	18
8.1.1	General	18
8.1.2	Materials	18
8.1.3	Contraction and throat	19
8.1.4	Diffuser	19
8.2	Requirements for each standard types of CFN	20
8.2.1	Standard CFNs	20
8.2.2	Toroidal-throat CFN	21
8.2.3	Cylindrical-throat CFN	22

9	Installation requirements	24
9.1	General requirements for both the standard configurations	24
9.1.1	Standard configurations	24
9.1.2	Upstream pressure tapping	24
9.1.3	Downstream pressure tapping	25
9.1.4	Temperature measurement	25
9.1.5	Density measurement	26
9.1.6	Drain hole	26
9.1.7	Downstream condition	26
9.2	Pipe configuration	27
9.2.1	General	27
9.2.2	Upstream pipe	27
9.2.3	Pressure measurement	28
9.2.4	Temperature measurement	28
9.3	Chamber configuration	29
9.3.1	General	29
9.3.2	Upstream chamber	29
9.3.3	Pressure measurement	29
9.3.4	Temperature measurement	29
9.3.5	Back-pressure ratio	29
10	Calculations	29
10.1	General	29
10.2	Calculation of mass flow rate, q_m	29
10.3	Calculation of discharge coefficient, C_d	30
10.4	Calculation of critical flow function, C^* or C^*D	31
10.5	Conversion of measured pressure into stagnation pressure	31
10.6	Conversion of measured temperature into stagnation temperature	31
10.7	Calculation of viscosity	31
11	Estimation of critical back-pressure ratio	32
11.1	For a traditional diffuser at Reynolds numbers higher than 2×10^5	32
11.2	For any diffuser at low Reynolds numbers	33
11.3	For CFNs without diffuser or with very short diffuser	34
12	Uncertainties in the measurement of flow rate	34
12.1	General	34
12.2	Practical computation of uncertainty	35
12.3	Correlated uncertainty components	36
	(informative) Discharge coefficient values	38
	(informative) Critical flow function	40
	(informative) Critical flow function values -- Pure gases and air	43
	(informative) Computation of critical mass flux for critical flow nozzles with high nozzle throat to upstream pipe diameter ratio, $> 0,25$	68
	(informative) Diameter correction method	72
	(informative) Adjustment of discharge coefficient curve on a data set	77
	(informative) Discharge coefficient	85
	(informative) Critical back pressure ratio	90
	(informative) Viscosity values - Pure gases and air	98
	(informative) Supplement	114
	Bibliography	123