ISO 5801:2007-12 (E)

Industrial fans - Performance testing using standardized airways

Contents

Page

Foreword vii

Introduction viii

1 Scope 1

2 Normative references 1

3 Terms and definitions 1

4 Symbols and units 16
4.1 Symbols 16
4.2 Subscripts 19

5 General 19

6 Instruments for pressure measurement 20
6.1 Barometers 20
6.2 Manometers 21
6.3 Damping of manometers 21
6.4 Checking of manometers 21
6.5 Position of manometers 22

7 Determination of average pressure in an airway 22
7.1 Methods of measurement 22
7.2 Use of wall tappings 22
7.3 Construction of tappings 22
7.4 Position and connections 23
7.5 Checks for compliance 23
7.6 Use of Pitot-static tube 23

8 Measurement of temperature 24
8.1 Thermometers 24
8.2 Thermometer location 24
8.3 Humidity 24

9 Measurement of rotational speed 25
9.1 Fan shaft speed 25
9.2 Acceptable instruments 25

10 Determination of power input 25
10.1 Measurement accuracy 25
10.2 Fan shaft power 25
10.3 Determination of fan shaft power by electrical measurement 25
10.4 Impeller power 26
10.5 Transmission systems 26

11 Measurement of dimensions and determination of areas 26
11.1 Flow-measurement devices 26
11.2 Tolerance on dimensions 26
11.3 Determination of cross-sectional area 27

12 Determination of air density, humid gas constant and viscosity 27
12.1 Density of air in the test enclosure at section x 27
12.2 Determination of vapour pressure 28
12.3 Determination of air viscosity 30

13 Determination of flow rate 31
13.1 General 31
13.2 In-line flowmeters (standard primary devices) 31
13.3 Traverse methods 32

14 Calculation of test results 34
14.1 General 34
14.2 Units 34
14.3 Temperature 34
14.4 Mach number and reference conditions 36
14.5 Fan pressure 40
14.6 Calculation of stagnation pressure at a reference section of the fan from gauge pressure, pex, measured at a section x of the test duct 43
14.7 Inlet volume flow rate 44
14.8 Fan air power and efficiency 44

15 Rules for conversion of test results 52
15.1 Laws on fan similarity 52
15.2 Conversion rules 54

16 Fan characteristic curves 57
16.1 General 57
16.2 Methods of plotting 58
16.3 Characteristic curves at constant speed 58
16.4 Characteristic curves at inherent speed 58
16.5 Characteristic curves for adjustable-duty fan 59
16.6 Complete fan characteristic curve 60
16.7 Test for a specified duty 61

17 Uncertainty analysis 62
17.1 Principle 62
17.2 Pre-test and post-test analysis 62
17.3 Analysis procedure 62
17.4 Propagation of uncertainties 62
17.5 Reporting uncertainties 63
17.6 Maximum allowable uncertainties measurement 63
17.7 Maximum allowable uncertainty of results 64

18 Selection of test method 65
18.1 Classification 65
18.2 Installation categories 65
18.3 Test report 65
18.4 User installations 66
18.5 Alternative methods 66
18.6 Duct simulation 66

19 Installation of fan and test airways 66
19.1 Inlets and outlets 66
19.2 Airways 66
19.3 Test enclosure 67
19.4 Matching fan and airway 67
19.5 Outlet area 67

20 Carrying out the test 67
20.1 Working fluid 67
20.2 Rotational speed 67
20.3 Steady operation 67

20.4 Ambient conditions 68
20.5 Pressure readings 68
20.6 Tests for a specified duty 68
20.7 Tests for a fan characteristic curve 68
20.8 Operating range 68

21 Determination of flow rate 68
21.1 Multiple nozzle 68
21.2 Conical or bellmouth inlet 68
21.3 Orifice plate 68
21.4 Pilot-static tube traverse (see ISO 3966 and ISO 5221) 69

22 Determination of flow rate using multiple nozzles 69
22.1 Installation 69
22.2 Geometric form 69
22.3 Inlet zone 70
22.4 Multiple-nozzle characteristics 70
22.5 Uncertainty 72

23 Determination of flow rate using a conical or bellmouth inlet 73
23.1 Geometric form 73
23.2 Screen loading 74
23.3 Inlet zone 75
23.4 Conical inlet performance 75
23.5 Bellmouth inlet performance 75
23.6 Uncertainties 77

24 Determination of flow rate using an orifice plate 77
24.1 Installation 77
24.2 Orifice plate 77
24.3 Ducts 81
24.4 Pressure tappings 81
24.5 Calculation of mass flow rate 81
24.6 Reynolds number 82
24.7 In-duct orifice with D and D/2 taps [see Figure 20 a) and ISO 5167-1] 82
24.8 Outlet orifice with wall tappings [see Figure 20 c) and e)] 86

25 Determination of flow rate using a Pitot-static tube traverse 88
25.1 General 88
25.2 Pitot-static tube 88
25.3 Limits of air velocity 93
25.4 Location of measurement points 93
25.5 Determination of flow rate 94
25.6 Flow rate coefficient 94
25.7 Uncertainty of measurement 95

26 Installation and setup categories 95
26.1 Category A: free inlet and free outlet 95
26.2 Category B: free inlet and ducted outlet 95
26.3 Category C: ducted inlet and free outlet 96
26.4 Category D: ducted inlet and ducted outlet 96
26.5 Test installation type 96

27 Flow straighteners 96
27.1 Types of straightener 97
27.2 Rules for use of a straightener 98

28 Common-segment airways for ducted fan installations 99
28.1 Common segments 99
28.2 Common segment at fan outlet 99
28.3 Common segment at fan inlet 101
28.4 Outlet duct simulation 103

28.5 Inlet duct simulation 103
28.6 Loss allowances for standardized airways 104

29 Standardized test chambers 107
29.1 Test chamber 107
29.2 Variable supply and exhaust systems 112
29.3 Standardized inlet test chambers 112
29.4 Standardized outlet test chambers 115

30 Standard methods with test chambers -- Category A installations 118
30.1 Types of fan setup 118
30.2 Inlet-side test chambers 118
30.3 Outlet-side test chambers 131

31 Standard test methods with outlet-side test ducts -- Category B installations 136
31.1 Types of fan setup 136
31.2 Outlet-side test ducts with antiswirl device 137
31.3 Outlet chamber test ducts without antiswirl device 149

32 Standard test methods with inlet-side test ducts or chambers -- Category C installations 156
32.1 Types of fan setup 156
32.2 Inlet-side test ducts 157
32.3 Inlet-side test chambers 170

33 Standard methods with inlet- and outlet-side test ducts -- Category D installations 180
33.1 Types of fan setup 180
33.2 Installation category B with outlet antiswirl device and with an additional inlet duct or inlet-duct simulation 184
33.3 Installation category B without outlet antiswirl device nor common segment, modified with addition of an inlet duct or inlet-duct simulation 190
33.4 Installation category C with common inlet duct, modified with the addition of an outlet common segment with antiswirl device 193
33.5 Installation category C, modified with the addition of an outlet-duct simulation without antiswirl device 197

Annex A (normative) Fan pressure and fan installation category 205

Annex B (normative) Fan-powered roof exhaust ventilators 209

Annex C (informative) Chamber leakage test procedure 211

Annex D (informative) Fan outlet elbow in the case of a non-horizontal discharge axis 217

Annex E (informative) Electrical input power consumed by a fan installation 220

Annex F (informative) Preferred methods of performance testing 227

Bibliography 228