DIN EN ISO 18854:2015-08 (E)

Small craft - Reciprocating internal combustion engines exhaust emission measurement - Test-be d measurement of gaseous and particulate exhaust emissions (ISO 18854:2015)

Contents

Page

Foreword 6

Introduction 7

1 Scope 8

2 Normative references 8

3 Terms and definitions 8

4 Symbols and abbreviations 10
4.1 General symbols 10
4.2 Symbols for fuel composition 12
4.3 Symbols and abbreviations for the chemical components 12
4.4 Abbreviations 13

5 Test conditions 14
5.1 Engine test conditions 14
5.1.1 Test condition parameter 14
5.1.2 Test validity 14
5.2 Engines with charge air cooling 14
5.3 Power 15
5.4 Specific test conditions 15
5.4.1 Engine air inlet system 15
5.4.2 Engine exhaust system 15
5.4.3 Cooling system 15
5.4.4 Lubricating oil 16
5.4.5 Adjustable carburettors 16
5.4.6 Crankcase breather 16

6 Test fuels 16

7 Application of the engine family concept and choice of parent engine 16

8 Measurement equipment and data to be measured 17
8.1 General 17
8.2 Dynamometer specification 17
8.3 Exhaust gas flow 17
8.3.1 General 17
8.3.2 Direct measurement method 17
8.3.3 Air and fuel measurement method 18
8.3.4 Fuel flow and carbon balance method 18
8.3.5 Tracer measurement method 18
8.3.6 Air flow and air-to-fuel ratio measurement method 19
8.3.7 Total dilute exhaust gas flow 20
8.4 Accuracy 20
8.5 Determination of the gaseous components 21
8.5.1 General analyser specifications 21
8.5.2 Gas drying 22

8.5.3 Analysers ... 22
8.5.4 Sampling for gaseous emissions ... 24
8.6 Particulate determination ... 25
8.6.1 General ... 25
8.6.2 Particulate sampling filters ... 26
8.6.3 Weighing chamber and analytical balance specifications ... 27

9 Calibration of the analytical instruments ... 27
9.1 General requirements ... 27
9.2 Calibration gases ... 28
9.2.1 General ... 28
9.2.2 Pure gas ... 28
9.2.3 Calibration and span gases ... 28
9.2.4 Use of gas dividers ... 28
9.2.5 Oxygen interference gases ... 29
9.3 Operating procedure for analysers and sampling system ... 29
9.4 Leakage test ... 29
9.5 Calibration procedure ... 29
9.5.1 Instrument assembly ... 29
9.5.2 Warm-up time ... 29
9.5.3 NDIR and HFID analyser ... 29
9.5.4 GC and HPCL ... 30
9.5.5 Establishment of the calibration curve ... 30
9.5.6 Alternative calibration methods ... 30
9.5.7 Verification of the calibration ... 30
9.6 Calibration of tracer gas analyser for exhaust flow measurement ... 30
9.7 Efficiency test of the NOx converter ... 31
9.7.1 General ... 31
9.7.2 Test setup ... 31
9.7.3 Calibration ... 31
9.7.4 Calculation ... 32
9.7.5 Adding of oxygen.25 9.7.6 Activation of the ozonator ... 32
9.7.7 NOx mode ... 32
9.7.8 Deactivation of the ozonator ... 32
9.7.9 NO mode ... 32
9.7.10 Test interval ... 32
9.7.11 Efficiency requirement ... 32
9.8 Adjustment of the FID ... 33
9.8.1 Optimization of the detector response ... 33
9.8.2 Hydrocarbon response factors ... 33
9.8.3 Oxygen interference check ... 33
9.8.4 Efficiency of the Non-Methane Cutter (NMC) ... 34
9.8.5 Methanol response factor ... 35
9.9 Interference effects with CO, CO2, NOx, O2, NH3, and N2O analysers ... 35
9.9.1 General ... 35
9.9.2 CO analyser interference check ... 36
9.9.3 NOx analyser quench checks ... 36
9.9.4 O2 analyser interference ... 37
9.9.5 Cross-interference check compensation for NH3 and N2O measurement channels using IR and UV measurement techniques ... 38
9.10 Calibration intervals ... 41

10 Calibration of the particulate measuring system ... 41
10.1 General ... 41
10.2 Calibration procedure ... 41
10.2.1 Flow measurement ... 41
10.2.2 Exhaust gas analysers ... 41
10.2.3 Carbon flow check ... 41
10.3 Checking the partial-flow conditions ... 41
10.4 Calibration intervals ... 41

11 Calibration of the CVS full-flow dilution system ... 41

11.1 General 41
11.2 Calibration of the Positive Displacement Pump (PDP) 41
11.2.1 General 41
11.2.2 Data analysis 41
11.3 Calibration of the Critical-Flow Venturi (CFV) 42
11.3.1 General 42
11.3.2 Data analysis 42
11.4 Calibration of the Subsonic Venturi (SSV) 43
11.4.1 General 43
11.4.2 Data analysis 43
11.5 Total system verification 44
11.5.1 General 44
11.5.2 Metering with a critical flow orifice 44
11.5.3 Metering by means of a gravimetric technique 44

12 Test cycles (running conditions) 45
12.1 Requirements 45
12.2 Test cycles 45
12.2.1 Applications 45
12.2.2 Test modes and weighting factors 46
12.2.3 Performing the test 47

13 Test run 47
13.1 Preparation of the sampling filters 47
13.2 Installation of the measuring equipment 47
13.3 Starting the dilution system and the engine 47
13.4 Adjustment of the dilution ratio 47
13.5 Determination of test points 48
13.6 Checking of the analysers 48
13.7 Test cycles 48
13.7.1 Test sequence 48
13.7.2 Analyser response 49
13.7.3 Particulate sampling 49
13.7.4 Engine conditions 49
13.8 Re-checking the analysers 49
13.9 Test report 49

14 Data evaluation for gaseous and particulate emissions 49
14.1 Gaseous emissions 49
14.2 Particulate emissions 50

15 Calculation of the gaseous emissions 50
15.1 General 50
15.2 Determination of the exhaust gas flow 51
15.3 Dry/wet correction 51
15.4 NOx correction for humidity and temperature 53
15.5 Calculation of the emission mass flow rates 54
15.5.1 Raw exhaust gas 54
15.5.2 Dilute exhaust gas 55
15.5.3 Determination of the NMHC concentration 57
15.6 Calculation of the specific emission 58

16 Calculation of the particulate emission 58
16.1 Particulate correction factor for humidity 58
16.2 Partial-flow dilution system 59
16.2.1 Isokinetic systems 59
16.2.2 Systems with measurement of CO2 or NOx concentration 59
16.2.3 Systems with CO2 measurement and carbon balance method 59
16.2.4 Systems with flow measurement 60
16.3 Full-flow dilution system 60
16.4 Calculation of the particulate mass flow rate 60
16.5 Calculation of the specific emissions 61

16.6 Effective weighting factor 61

17 Determination of the gaseous emissions 62
17.1 General 62
17.2 Main exhaust components CO, CO2, HC, NOx, O2 62
17.3 Ammonia analysis 67
17.4 Methane analysis 68
17.4.1 Gas chromatographic (GC) method (Figure 6) 68
17.4.2 Non-methane cutter (NMC) method (Figure 7) 70
17.5 Methanol analysis 71
17.6 Formaldehyde analysis 72

18 Determination of the particulates 74
18.1 General 74
18.2 Dilution system 74
18.2.1 Partial-flow dilution system (Figures 10 to 18) 74
18.2.2 Full-flow dilution system 86
18.3 Particulate sampling system 89

Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2013/53/EC 93

Bibliography 94