

Determination of the response time of electronic micro-manometer transducer type pressure measurement devices used for the measurement of differential pressure

(previously available as EGOLF SM2:1998)

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Foreword

This document has been prepared by EGOLF and the method adopted by all EGOLF member laboratories for use when determining the response time of electronic micro-manometer transducer type pressure measurement devices to be used for the measurement of differential pressure in fire resistance and reaction to fire testing.

It is recommended to other organisations and laboratories that it should be universally accepted for this purpose.

It is particularly recommended to CEN Technical Committee TC127, plus other CEN Technical Committees with an interest in fire testing of materials and products, that it should be adopted for use in support of all European standard reaction to fire and fire resistance tests where the determination of the response time of electronic micro-manometer transducer type pressure measurement devices to be used for the measurement of differential pressure in fire resistance and reaction to fire testing is important.

1 Scope

This test method establishes a procedure for measuring the response time of electronic micro-manometer transducer type pressure measurement devices intended for measurement of differential pressure during fire resistance or reaction to fire tests.

The test method is applicable to electronic micro-manometer transducer type differential pressure measurement devices used for measuring over-pressures and under-pressures, without limit of magnitude of pressure.

The test method is only applicable to electronic micro-manometer transducer type differential pressure measurement devices which have the capability of continuously recording measured differential pressure and/or those with a recording time interval not exceeding 0.2 seconds or one-tenth the expected response time, whichever is the lower.

2 References

EN 13823 Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item

EN 1363-1 Fire resistance tests. General requirements

3 Definitions

3.1 Response time

The time taken for a pressure measurement device to respond to a step change in pressure from an initial value to a final value.

Note : The response time of a pressure measurement device may also sometimes be referred to as its time constant or transient response characteristic.

4 Symbols and designations

Symbol	Designation
e	the base of natural logarithms (e = 2.718).

P_1	starting pressure used for the calculation of the response time, [in Pa].
P_2	end pressure used for the calculation of the response time, [in Pa].
t_1	time when the starting pressure P_1 used for the calculation of the response time is reached, in minutes and seconds.
t_2	time at which the end pressure P_2 used for the calculation of the response time is reached, in minutes and seconds.
τ	Response time of the pressure measurement device.

5 Principle of the method

The electronic micro-manometer transducer type pressure measurement device under test is subjected to a pressure, appropriate to the test and application for which it is to be used.

The applied pressure is accurately measured and continuously checked over a period of time of sufficient length to ensure that it is stable.

The pressure is suddenly released.

The output of the electronic micro-manometer is recorded continuously as the pressure falls from its initial pressure to its final pressure.

The results are graphically presented.

The time ($t_2 - t_1$) taken for the pressure to fall from a chosen starting point P_1 to a chosen end pressure P_2 is determined.

From this the response time τ is calculated according to a given equation.

6 Equipment and environment

6.1 Test pressure source

The test pressure source may be generated by any suitable means.

The test pressure shall be accurately measured using an instrument with traceable calibration. It shall be sufficiently stable, such that any occurring fluctuations do not invalidate the test.

6.2 Test equipment

The test pressure source and pressure measurement device should be connected to a two-way tap or other device for instantaneous isolation of the test pressure source and simultaneous exposure of the pressure measurement device to the background pressure. The complete test arrangement can be seen in figure 1.

The volume of pipework joining the pressure measurement device to the pressure source shall be as small as possible to avoid undue damping influence on the test result.

6.3 Test environment

The test room or that portion of the test room in which the test is to be carried out shall be draught free and of constant temperature of $(20 \pm 10) ^\circ\text{C}$. Any disturbances which would cause rapid local changes of pressure and temperature during the test shall be eliminated.

7 Test specimen

7.1 Pressure measurement device

The pressure measurement device shall be that normally used for the measurement of pressure, in its entirety, including all tubes, connections, condensation trap, electronic reading and recording devices, see figure 1.

Note : Use of the condensation trap as shown in figure 1 is optional.

7.2 Micro-manometer output recording device

The micro-manometer output recording device used shall :

- a) be capable of recording output data with an accuracy of better than 1.0% of its full scale reading over the required pressure range.
- b) be capable of responding to a full scale reading in a time equal to or less than one half of the response time of the pressure measurement device.
- c) be capable of assimilating the incoming data and producing a permanent record of the pressure at intervals of less than 0.2 second or one-tenth of the expected response time, whichever is the lower.
- d) permit clear interpretation of the pressure data recorded.

8 Number of tests

At least six tests shall be carried out, one at each of six different stepwise pressures covering the operating range of the instrument.

9 Test procedure

9.1 Background pressure measurement

Open the two way tap and confirm the differential pressure registered by the pressure measurement device under test to be zero.

If the indicated pressure is not zero, adjust the zero or offset to give zero reading.

The causes of any non-adjustable zero reading or non-correctable fluctuations in pressure must be identified and eliminated before proceeding further with the test.

9.2 Background temperature measurement

Measure and confirm the acceptability of the background temperature to the criteria of clause 6.3.

The causes of any fluctuations in background temperature must be identified and eliminated before proceeding further with the test.

9.3 Application of pressure to the pressure measurement device under test

Connect the test pressure source to the pressure measurement device under test.

Apply the test pressure.

9.4 Stabilisation of test pressure applied to the pressure measurement device

Verify that the correct pressure is being applied to the pressure measurement device.

Monitor and confirm that the pressure recorded by the pressure measurement device is stable, according to 6.1.

9.5 Measurement procedure

Activate the micro-manometer pressure output recording device.

Confirm the continued stability of the applied pressure by monitoring the recorded pressure for a further period of at least 10 seconds.

Rapidly, in less than 0.2 seconds, release the pressure applied to the pressure measurement device under test by opening the two-way tap to the background pressure condition.

Continue to monitor the pressure registered by the pressure measurement device under test, until the output of the micro-manometer is below 2% of the applied test pressure.

Terminate the recording of pressure output data information.

10 Test results

10.1 Interpretation of data and analysis of results

The recorded data shall be graphically presented and the following assessment method be employed.

The response time τ shall be determined from :

$$T = \frac{(t_2 - t_1)}{\ln\left(\frac{P_1}{P_2}\right)}$$

The value of t_1 shall be chosen such that it occurs at the top of the pressure / time curve, but after the time when the two-way tap is completely opened. The corresponding pressure P_1 shall be determined.

Time, t_2 shall be determined at the bottom of the pressure / time curve, after time t_1 but before the output of the micro-manometer reaches 2% of the applied test pressure. Again the corresponding pressure P_2 shall be determined (see figure 2).

10.2 Criteria for acceptance of results

The acceptability of the results shall be determined from the results obtained from the six tests carried out according to clause 9.

- a) If the spread of results over the six tests is less than the measurement error defined in 10.3, then the mean value shall be used as the response time of the pressure measurement device under test.
- b) If the spread of results over the six tests is greater than the measurement error defined in 10.3, then consideration shall be given to performing additional tests until the above criteria are met.
- c) If the spread of results remains greater than the measurement error defined in 10.3, a statement shall be made that a response time for the pressure measurement device under test could not be established by this method.

d) If the variation cannot be explained in a systematic manner, consideration should be given to the rejection of the device.

10.3 Measurement errors

Measurement errors depend upon the magnitude of the measurement being made. Laboratories should determine for themselves the likely measurement errors to be expected.

The measurement error in time depends largely on where the times t_1 and t_2 were set. It should be possible that the relative error in time measurement could be better than 1%. Measurement errors in output values from the micro-manometer should be better than 2%.

Therefore, an achievable measurement error for response time is estimated at 2.5% or less.

11 Test report

The test report shall describe fully the pressure measurement device tested.

The test report shall describe fully the pressure source, pipework and equipment used to carry out the test, including dimensions, measured pressures and pressure checks as described in clauses 6, 7 and 8.

The test report shall give the temperature at which the test was carried out.

The test report shall give the results of all determinations of measured pressure response time for the pressure measurement device, including reproducibility of results, the mean value of pressure response time measured and the acceptability or any limitations to the results, according to clause 10.

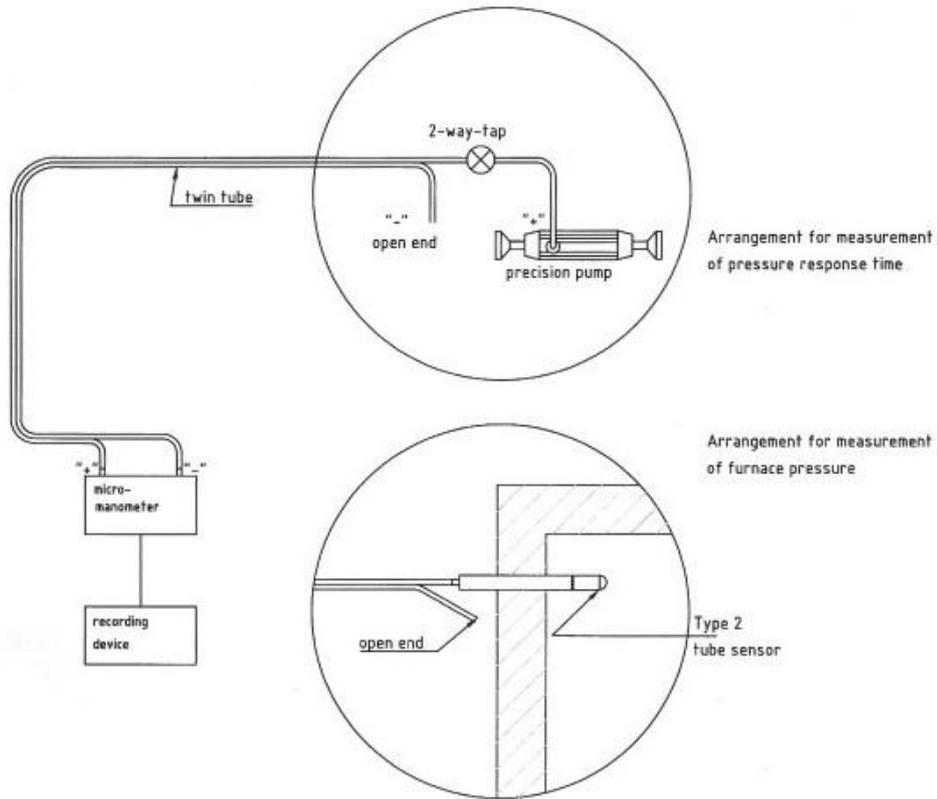


Figure 1: Description of apparatus (typical fire resistance furnace use)

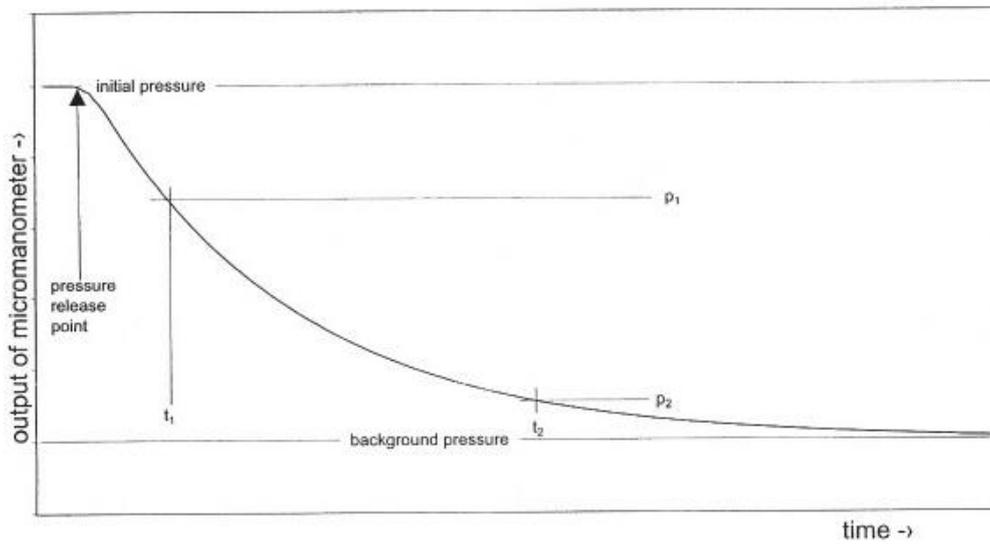


Figure 2: Description of analysis of data