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SRI LANKA STANDARD

MEHTODS OF TEST FOR AIR FILTERS USED ON INTENAL COMBUSION ENGINES

PART 1 – GENERAL REQUIREMENTS

SRI LANKA STANDARDS INSTITUTION

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Draft Sri Lanka Standard
METHODS OF TEST FOR AIR FILTERS USED ON INTERNAL COMBUSTION ENGINES
PART 1 - GENERAL REQUIREMENTS

FOREWORD

This standard was approved by the Sectoral Committee on Automotive and Related Products and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on..94/12/05

This standard has been formulated to cover dry type air filter elements and oil bath type air filters used on internal combustion engines and to present a uniform method to determine pressure differentials, dust retaining efficiency and dust capacity (service life) of air filters designed to clean the inlet air of internal combustion engines.

The data collected by this standard can be used to establish standards of performance for air filters tested in this manner. Variations in actual field operating conditions are difficult to duplicate. However,by use of these standard test methods, test conditions are controlled and comparsions of performace of filters may be made with a high degree of confidence.

This standard is published in four parts, namely:

Part 1 General requirements

Part 2 Dry type air filter elements used on automotive internal combustion engines.

Part 3 Industrial dry type air filter elements used on mobile and stationary internal combustion engines.

Part 4 Oil bath type air filters used on internal combustion engines.

The purpose of this standard is to establish and specify uniform test procedures, conditions, equipment and a performance report to permit direct comparison of laboratory performance of dry type air filter elements and also of oil bath type air filters.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or an analysis shall be rounded off in accordance with CS 102. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

The Sri Lanka Standards Institution gratefully acknowledges the use of the following publications of the Society of Automotive Engineers U.S.A. and the German Institute for Standardization in the preparation of this standard.

SAE J726 : Jun 1987 Air cleaner test code
DIN 24189 : Jan 1986 Testing of air cleaners for internal combustion engines and compresses

1 SCOPE

This standard provides the general requirements applicable to types of air filter elements/air filters covered in this standard.

2 REFERENCES

SLS 102 Presentation of numerical values,

3 DEFINITIONS

For the purpose of this standard the following definitions shall apply:

3.1 air filter : The air filters shall be of the dry type or oil bath type and may consist of one or more stages of filteration.

3.2 unit under test : Either a single air filter element or a complete air filter assembly.

3.3 precleaner : A device usually employing inertial or centrifugal means to remove a portion of the test dust prior to reaching the filter element.

3.4 single stage air filter : An air filter which does not incorporate a separate precleaner.

3.5 multi-stage air filter : An air filter consisting of two or more stages, the first usually being a precleaner followed by one or more filter elements. If two elements are employed, the first shall be called the primary element and the second, the secondary element.

3.6 **test airflow** : A measure of the quantity of air drawn through the air filter cleaner outlet per unit time. The rate of flow shall be expressed in cubic meters per hour corrected to standard conditions (scmh).

3.7 **rated airflow** : The rate of flow specified by the user or supplier may be used as the test air flow.

3.8 **scavenge air flow** : A measure of the quantity of air employed to remove the collected dust from a precleaner, expressed as a percentage of test airflow.

3.9 **pressure drop** : A measure, in kilo Pascals, of the difference in static pressure measured immediately up stream and down stream of the unit under test.

NOTE

Refer to Appendix A for correcting recorded pressure drop values to standard conditions.

3.10 **restriction** : A measure, in kilo Pascals gauge, of the static pressure measured immediately downstream of the unit under test.

3.11 **assembly restriction/pressure drop** : The air flow pressure resistance across the complete assembly (test shroud and/or housing and element).

3.12 **tare restriction/pressure drop** : The air flow pressure resistance across the test shroud and/or housing only (no element).

3.13 **element restriction/pressure drop** : The assembly restriction/pressure drop, minus the tare restriction/pressure drop.

3.14 **terminating restriction/pressure drop** : The air flow pressure resistance across the unit under test at which the capacity is measured.

3.15 **absolute filter** : The filter downstream of the unit under test to retain the contaminant passed by the unit under test.

3.16 dust holding capacity : Dust holding capacity of an air cleaner is the mass of dust which it is capable of retaining under specified test conditions until an agreed test terminal condition is reached.

3.17 dust retaining efficiency : Dust-retaining efficiency, is a measure of the ability of an air cleaner to protect the engine from the ingress of dust under specified conditions.
Dust-retaining efficiency is expressed as follows:

$$\text{Dust-retaining efficiency} = 100 \frac{d_1 - d_2}{d_1} \text{ in per cent}$$

where,

d_1	is the average dust concentration at the air cleaner inlet = S_1/V_1;
d_2	is the average dust concentration at the air cleaner outlet = S_2/V_2;
V_1	is the volume of air fed to the air cleaner;
V_2	is the volume of air leaving the air cleaner on the clean air side;
S_1	is the mass of dust fed to the air cleaner; and
S_2	is the mass of dust leaving the air cleaner on the clean air side.

If the air flow at the inlet of the cleaner is equal to the air flow at the outlet, i.e. if the air cleaner is not of the dust extraction type in which a proportion of the aspirated air is bled off for scavenging purposes, the dust-retaining efficiency can be calculated as follows :

$$= 100 \cdot \frac{S_1 - S_2}{S_1} \quad \text{in per cent}$$

3.18 standard condition : All air flow measurements are to be corrected to a standard condition of 27 ^{0}C $\pm$ 3 ^{0}C and 101.3 kPa.

3.19 oil carryover : The appearance of oil at the air filter outlet.

4 REQUIREMENTS

4.1 Measurement accuracy

4.1.1 Measure air flow rate within 2 per cent of the actual value.

4.1.2 Measure pressure drop and restriction within 0.025 kPa of the actual value.

4.1.3 Measure temperature within 0.5 ^{0}C of the actual value.

4.1.4 Measure weight within 1 per cent of the actual value except where specially noted.

4.1.4.1 Weigh the absolute filter(s) to $\pm$ 0.01 g.

4.1.5 Measure relative humidity with an accuracy of 2 per cent R.H.

4.1.6 Measure barometric pressure within 0.3 kPa.

4.2 Test conditions and material.

4.2.1 Test on all types of air filters shall be carried out using the standardized test dust of "Fine" or "Coarse" quality. A typical chemical analysis is given in Table 1.

TABLE 1 - Chemical analysis of test dust

Chemical	weight %
SiO_2	67 - 69
Fe_2O_3	3 - 5
Al_2O_3	15 - 17
CaO	2 - 4
MgO	0.5 - 1.5
Total Alkalis	3 - 5
Ignition Loss	2 - 3

4.2.2 The Particle size distribution by weight as measured with L and N Microtrac Analyzer shall be as follows :

TABLE 2A - Particle size distribution by volume (per cent)

Size (μ m) (1)	Fine grade (% less than) (2)	Coarse grade (% less than) (3)
5.5	38 ± 3	13 ± 3
11	54 ± 3	24 ± 3
22	71 ± 3	37 ± 3
44	89 ± 3	56 ± 3
88	97 ± 3	84 ± 3
125	100	100

This is the same contaminant that was previously measured with a Roller analyzer and described in per cent weight as follows:

TABLE 2B - Particle size distribution by weight (per cent)

Size (μ m) (1)	Fine grade (2)	Coarse grade (3)
0 - 5	39 ± 2	12 ± 2
5 - 10	18 ± 3	12 ± 3
10 - 20	16 ± 3	14 ± 3
20 - 40	18 ± 3	23 ± 3
40 - 80	9 ± 3	30 ± 3
80 - 200	- -	9 ± 3

4.2.3 *Absolute filter materials*

The absolute filter shall consist of fiberglass media with a minimum thickness of 12.7 mm and minimum density of 9.5 kg/m³. The fiber diameter shall be 0.76 um - 1.27 um and the moisture absorption shall be lessthan 1 per cent by weight after exposure to 49 °C and 95 per cent relative humidity for 96 h. The filter shall be installed with nap side facing upstream in an airtight holder that adequately supports the media. The face velocity shall not exceed 50 m/min to maintain media integrity.

4.2.4 *Absolute filter weight*

The absolute filter shall ne weighed to the nearest 0.01 g after the weight has stabilized and while in a ventilated oven at 107 ± 2 °C.

NOTE

If stabilization cannot be determined, a minimum time of 4 h is required.

4.2.5 *Temperature and humidity*

All tests shall be conducted with air entering the air filter at a temperature of 24 ± 8 °C and relative humidity of 50 ± 15 per cent

NOTE

Since atmospheric conditions affect test results, when comparing performance of filters designed for the same application, tests should be conducted within the narrowest range of temperature and humidity possible.

4.2.6 *Air dryer*

To prevent dust from caking and to prevent icing of the injector nozzle, an effective air dryer of sufficient size should be installed in the air supply line.

APPENDIX A

AIRFLOW AND RESISTANCE CORRECTION TO STANDARD CONDITIONS

A.1 Airflow restriction/pressure drop and dust capacity data shall be reported for standard conditions of 27 ^0C ± 3 ^0C and 101.3 kPa. The resistance (ΔP) of the air filter can be represented by the following expression :

$$\Delta P = K_1 \mu Q + K_2 \rho Q^2$$

where K_1 = Empirical constant
K_2 = Empirical constant
μ = Dynamic viscosity
ρ = Air density kg/m^3
Q = Volume flow m^3/h
M = Mass flow, kg/h

Substituting $\frac{M}{\rho}$ for Q

$$\Delta P = K_1 \mu \frac{M}{\rho} + K_2 \rho \left[\frac{M}{\rho}\right]^2$$

and rearranging terms

$$\rho \Delta P = K_1 \mu M + K_2 M^2$$

A.2 Thus by maintaining mass flow constant and limiting the variation in ambient temperature to keep the change in viscosity small, $\rho \Delta P$ will remain constant. Therefore,

$$\rho_o \Delta P_o = \rho \Delta P$$ (Subscript '0' equals standard condition)

$$\Delta P_o = \frac{\rho}{\rho_o} \Delta P$$

A.3 Observed restriction/pressure drop values shall therefore be corrected to standard conditions by using the following equation.

$$\Delta P_o = \frac{P}{100.0} X \frac{298.0}{(t + 273)} X P_r \text{ or } P_d$$

A.3.1 Where P and t are the observed ambient pressure and temperature, respectively, and P_r or P_d is the measured air cleaner restriction/pressure drop.

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