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Road vehicles — Analysis of technical changes of ISO 5011:2020

Véhicules routiers — Analyse des changements techniques de l'ISO 5011:2020

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain and powertrain fluids*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes the major changes made to ISO 5011:2014 with the ISO 5011:2020 revision.

Road vehicles — Analysis of technical changes of ISO 5011:2020

1 Scope

This document analyses the impact of changes to ISO 5011:2020 as regards to the following:

— precleaner efficiency;

— elimination of two secondary element tests (collapse and blocking);

— revisions to the recommended ISO dust injector (Table 1);

— validation of the absolute filter weighing method; and

— inclusion of Annex H, "Penetration sensitivity".

These changes refine the precleaner efficiency calculation, eliminate seldom used tests, which were lengthy or costly, further clarify dust injector use, the validation of the absolute material, and the precision of the efficiency measurement.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5011:2020, *Inlet air cleaning equipment for internal combustion engines and compressors — Performance testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5011:2020 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Precleaner efficiency calculation

Background:

In ISO 5011:2014 it was possible, using just the gain on the primary, secondary, and absolute filters alone, to calculate the precleaner efficiency. This approach was logical, in so far as the measure of the precleaner efficiency was defined by that which actually loaded on the primary, regardless of whether it was removed entirely from the system.

This can occur:

— due to the casual removal of the elements (causing dust to fall off in the air cleaner and lowering the primary gain);

— due to dust trapped within the precleaner housing itself, which commonly occurs during the initial feed to a system.

It was felt that even if the dust did not reach the primary, and thus cause an increase in restriction, that it might potentially re-entrain at some point if dislodged and could thus reach the primary.

The new change to ISO 5011:2020, 7.8.2 makes this impossible, as it now includes specifically the gain in the air cleaner in the calculation (Figure 1).

ISO 5011:2020, 7.8.2 Precleaner efficiency

> The precleaner efficiency is defined by the dust removed from the air stream prior to the primary filter housing. Precleaner efficiency (E_{p1}) shall be determined during the dust capacity test, based on the total mass of dust fed to the air cleaner and the sum of the gain in mass of the primary, secondary elements, housing and the absolute filter. Calculate the precleaner full life efficiency, E_{p1} (expressed as a percentage), as follows:
>
> $$E_{p1} = \frac{m_D - (\Delta m_P + \Delta m_S + \Delta m_F)}{m_D} 100 \tag{1}$$
>
> where
>
> m_D is the total mass of dust fed;
>
> Δm_P is the increase in mass of the, primary element and primary housing, if present;
>
> Δm_S is the increase in mass of the secondary element, if present;
>
> Δm_F is the increase in mass of the absolute filter.

Initial Primary Wt. (g.):	885.45	Final Wt. (g.):	1917.11	Total Wt. Gain (g.):	1031.66	Dust Jar Wt. (g.):	9993.6
Initial Safety Wt. (g.):	200.04	Final Wt. (g.):	200.47	Total Wt. Gain (g.):	0.43	Dust in A/C. (g.):	79.9
Capacity Absolute #:	0	Gain (g.):	0.19	Cumulative Efficiency:	100.00%	Material Balance:	100.00%
Initial Absolute #	1	Gain (g.):	0.01	Initial Efficiency:	99.99%	Additional Mass Fed (g.):	0.00
				Separator Efficiency (2020):	**89.99%**	Based on Dust Downstream (penetration beyond PC)	
Test Time:	15:34:48	Total Dust Fed (g.):	11105.80	Separator Efficiency (2014):	**90.70%**	Based on Dust on Old method with just the pirmary/secondary/absolute and NOT the AC	
				Separator Efficiency:	**89.99%**	Based on Dust Jar Gain (removal)	
		Initial Eff. Dust Fed (g.)	71.28	Element Efficiency:	**99.94%**		

Figure 1 — Examples of using the older ISO 5011:2014 calculation versus ISO 5011:2020, and how this compares with the ‘dust ejected’ method

Impact:

1) If prior to this, only the gain on the primary, secondary, and absolute were used – then this changes the results of the precleaner efficiency.

2) With a 100 % material balance (all masses were measured and collected), the new method eliminates the difference between calculating using amount removed versus that which passes into the primary air cleaner housing.

3) It is anticipated to be easier, under some circumstances where the method of removal makes it difficult to measure the mass removed (dust ejected into the air for example), to calculate the efficiency.

NOTE A future standard for precleaner efficiency testing is under development.

5 Collapse and blocking tests

The elimination of: ISO 5011:2014, 7.9.2.2.7

ISO 5011:2014, 7.9.2.2.7 "At the end of the test, after measuring the efficiency, the flow rate shall be increased to produce a differential pressure across the housing of 12,5 kPa (125 mbar). The secondary element shall not rupture under these conditions."

Background: ISO 5011:2014, 7.9.2.2.7 was a test designed to challenge the secondary element at the end of a loading test, i.e. once the secondary had been subjected to the inefficiency of the primary loading.

This was done through increasing the airflow up to a preset differential pressure. The test required that the airflow be increased after the efficiency masses were taken (i.e. resulting in the removal and reinstallation of the primary). This is difficult to do without causing a change due to the loss of dust cake, and it could be messy. This test was eliminated from ISO 5011:2020.

Impact:

1) If the customer requests, then the test can be tested per ISO 5011:2014.

2) The lab can use ISO 5011:2020, 6.6 "Filter element pressure collapse test" as a substitute collapse challenge.

The elimination of: ISO 5011:2014, 7.9.4 "Secondary element blocking test"

Background: ISO 5011:2014, 7.9.4 was a method of measuring the effects of the gain on a secondary element which resulted from its repeated use with replacement/new primaries in a series of loadings. Since it was the inefficiency of the primary which determined the loading of the secondary, this reflected the 'real world' loading of a secondary element. However, due to the cost and time involved in the procedure, and lack of customer interest, it was eliminated from ISO 5011:2020.

Elements eliminated from ISO 5011:2014:

ISO 5011:2014, 7.9.4 "Secondary element blocking test"

7.9.4.1 General

The test determines the increase in restriction/differential pressure and mass of a secondary element, caused by the dust that has passed through the primary element.

7.9.4.2 Preparation

Use a clean primary element and secondary element in the housing normally employed. Determine the mass of the secondary element after conditioning in accordance with 7.5.2.1.

7.9.4.3 Test procedure

7.9.4.3.1 Set up the air cleaner as in 6.3 (restriction and differential pressure test). Measure and record the restriction/differential pressure of the unit at the rated flow only. Replace the later reference primary element by a new primary element.

7.9.4.3.2 Conduct a full life efficiency and capacity test as specified in 7.5.

7.9.4.3.3 Replace the primary element with the reference one used at the start of the test. Repeat the restriction and differential pressure test of 7.9.4.3.1. Note the result.

7.9.4.3.4 Remove the secondary element and reweigh.

Impact:

1) If the customer requests, then the test can be tested per ISO 5011:2014.

2) The lab can run ISO 5011:2020, 7.9.2 instead of ISO 5011:2014, 7.9.4. as a substitute method to challenge the secondary.

6 Revised recommended ISO dust injector table

The revision of: ISO 5011:2020, 6.2.3

The text in ISO 5011:2014, 6.2.3 reads as follows:

Use the dust injector described in Table 1 and shown in Figures B.2 and B.3.

Table 1 — Table 1 of ISO 5011:2014 "Recommended ISO dust injectors (see Figures B.2 and B.3)"

Dust feed rate (g/min)	0 to 26	26 to 45	>45
Injector type	ISO injector	ISO injector or ISO heavy-duty injector	ISO Heavy-duty injector

The specified ISO injector has been shown to feed dust satisfactorily at rates up to 45 g/min. Where dust feed rates greater than this are required, more than one injector will have to be used. It should be noted that the design of the system feeding test dust to the injector may affect this maximum rate of dust feed. The maximum attainable dust feed rate should therefore be determined prior to the dust feed/injector system being used for tests.

Injector nozzles are subject to natural erosion. Erosion may affect the distribution and delivery of test contaminant. Therefore, it is recommended to use a design with replaceable parts.”

The text in ISO 5011:2020, 6.2.3 reads as follows:

Use the dust injector described in Table 1 and shown in Figures B.2, B.3 and B.18.

Table 2 — Table 1 of ISO 5011:2020 "Recommended ISO dust injectors (see Figures B.2 B.3 and B.18)"

Dust feed rate per injector (g/min)	0 to 5	5 to 26	>26
Injector type	Light-duty injector	Light-duty injector or heavy-duty injectors (A or B)	Heavy-duty injectors (A or B)

If an array of injectors is used, special care shall be taken to make sure the dust fed is distributed evenly between each injector for two reasons: First, to get homogeneous dust distribution in the airstream and second, to make sure the maximum or minimum feed rate for the injectors being used is not exceeded.

Where dust feed rates greater than this are required, more than one injector will have to be used. It should be noted that the design of the system feeding test dust to the injector may affect this maximum rate of dust feed. The maximum attainable dust feed rate should therefore be determined prior to the dust feed/injector system being used for tests.

Injector nozzles are subject to natural erosion. Erosion may affect the distribution and delivery of test contaminant. Therefore, it is recommended to use a design with replaceable parts.

Background:

The recommended ISO dust injector table provides guidance on the amount of dust to be fed through the differing sized injectors. In the past, it was possible to use a light-duty injector (Figures B.2) in order to feed up to 45 g/min.

The table has been revised and it is now recommended that if the dust feed rate is > 26 g/min, that either a second light-duty injector is to be used, or one of the heavy-duty injectors A or B (see Figures B.2, B.3 and B.18).

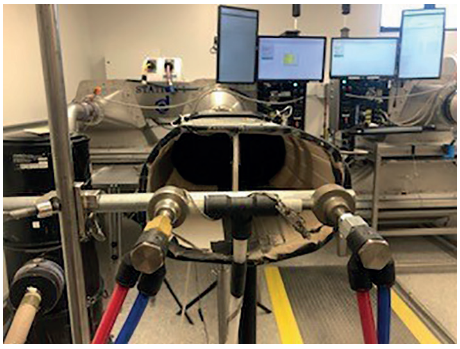

Figure 2 — A two-injector array

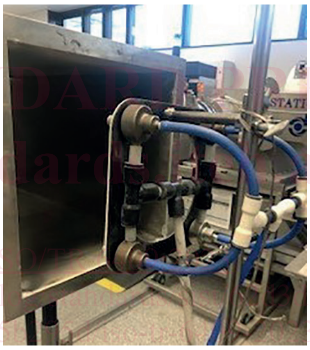

Figure 3 — A four-injector array

It is common in many labs to use and array (more than one) of light-duty dust injectors (see Figure 2 or 3d). These allow higher feed rates without going to a single heavy-duty injector and can be arranged in such a way that the dust is distributed evenly across the inlet, which is typically large due to airflow rate. When feeding >26 g/min, the principal issue becomes the problem of clogging. It is felt that this change helps eliminate that issue and that the expansion of the text clarifies the use of the table and important considerations in test setup.

Impact:

1) If labs use a single light-duty dust injector to feed between 26 g/min and 45 g/min, then this change recommends the use of either a heavy-duty injector, or an array of multiple light-duty injectors.

2) The change was implemented to reduce the chance of clogging. This change most likely will help to distribute the dust more evenly across a larger inlet.

7 Dust injector (ISO 5011:2020, Figure B.18)

Figure 4 shows a schematic of a new dust injector design.