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Road vehicles — Brake lining friction materials — Dynamometer metal pick-up generation procedure for disc brakes

Véhicules routiers — Matériaux de friction des garnitures de freins — Procédure de génération de métal aggloméré sur freins à disque par dynamomètre

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics and chassis components*.

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.

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Introduction

Metal pick-up (MPU) is a phenomenon/issue observed in automotive disc brakes during the braking process. Worn metallic particles may agglomerate under specific conditions and embed in the friction material. It may deteriorate brakes' appearance by scoring (grooves) on the surface of brake discs. MPU is also suspected to be a root cause of brakes NVH (noise, vibrations and harshness) issues as brake squeal or wire brush.

There is no single mechanism for creation of MPU in the automotive brakes so it cannot be only one specific condition for testing it. While the so-called NAO (non-asbestos-organic) friction materials are sensitive to high temperature and pressures, low metallic materials may create MPU under wet conditions or even more under the saltwater influence.

This document describes and covers all known critical conditions for generating MPU, it specifies which conditions are critical for a given friction material type. The methods described apply not only in the development of the material composition, but also in the selection of the materials for new brake applications and optimization of components for a recognised MPU issue.

This document includes three test procedures:

1. MPU generation under water/saltwater influence (typical for low metallic friction materials);
2. MPU generation at low temperatures and low brake pressures (typical for low metallic friction materials);
3. MPU generation at high brake temperatures and brake pressures (typical for NAO friction materials).

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Road vehicles — Brake lining friction materials — Dynamometer metal pick-up generation procedure for disc brakes

1 Scope

This document describes test procedures for assessing the influence of pressure, temperature and water/salt water on the generation of metal pick-up (MPU) for a given friction material in combination with a specific brake disc. There are multiple tests to investigate the MPU generation issue for different types of friction materials (so called NAO and low metallic materials) under critical environmental and working conditions: influence of water and salt water, high temperatures and high pressures and low temperatures and low pressures.

This document supports the friction material development process and selection of friction materials for new brake applications.

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 611, *Road vehicles — Braking of automotive vehicles and their trailers — Vocabulary*

ISO 21920-2, *Geometrical product specifications (GPS) — Surface texture: Profile — Part 2: Terms, definitions and surface texture parameters*

ISO 15484, *Road vehicles — Brake lining friction materials — Product definition and quality assurance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 611, ISO 15484 and the following 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/

3.1
MPU
metal pick-up
disc material agglomeration or compaction of high hardness on or in the pad material surface

Note 1 to entry: The MPU shapes could be different (flakes, grains with different aspect ratio, colloquially called “fishes”) and have different sizes (up to several millimetres).

3.2
groove
mechanical disc surface defect in the circumferential direction caused by *metal pick-up (MPU)* (3.1) collected in the pad material with a depth of more than several tens of micrometres

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3.3
friction value
μ
average by time of all *instantaneous friction values* (3.4)

Note 1 to entry: See Formula (1) for calculation and evaluate after the brake application reaches 95 % of the set point value (pressure or deceleration) until it falls below 95 % of the set point level.

3.4
instantaneous friction value
μ^*
ratio of instantaneous output torque to instantaneous input pressure at any specific point in time

Note 1 to entry: For calculation, see also Formula (1).

3.5
step
sequence number of labelling the different *sections* (3.6) during the test

Note 1 to entry: 1to entry: Sequence number ensures the test conduction in the prescribed order.

3.6
section
group of similar brake applications under similar conditions or following a specific logic

Note 1 to entry: The brake applications can be stopped.

Note 2 to entry: The specific logic can be increasing brake pressure, increasing initial speed, or increasing brake temperature.

3.7
brake stop
brake application where the brake slows down the test inertia until the equivalent linear speed is 0,5 km/h

Note 1 to entry: Project dependent the final speed can be increased to 5 km/h max.

3.8
brake snub
brake application where the brake slows down the test inertia to an equivalent linear speed above 5 km/h

3.9
burnish section
series of *brake stops* (3.7) or *brake snubs* (3.8) to condition the friction couple by developing a steady coefficient of friction and create friction film and brake dust between the brake pads and disc

3.10
water and salt water section
series of *brake snubs* (3.8) while water or salt water is added between pads and disc surface

Note 1 to entry: Water sections are used to create *metal pick-up (MPU)* (3.1) and evaluate friction level under wet conditions.

3.11
heat and pressure section
section (3.6) of test procedure with a series of *brake snubs* (3.8) at elevated initial brake disc temperatures (above 300 °C) and increased brake pressure (up to 50 bar/5 MPa) to simulate heavy braking or overloaded conditions

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3.12
low load and pressure section
section (3.6) of test procedure with a series of *brake snubs* (3.8) to generate a significant amount of wear debris at low load and brake pressure

4 Symbols and abbreviated terms

4.1 Symbols

Symbol	Definition	Unit
A_p	Total piston area	mm^2
I	Test inertia reflected at the brake	$kg{\cdot}m^2$
$M_{d,brake}$	Measured torque	N·m
P	Applied pressure	kPa
$p_{threshold}$	Threshold pressure or minimum pressure required to develop braking torque	kPa
R_{eff}	Brake effective radius	mm
R	Dynamic tyre effective rolling radius	m
V_p	Prescribed or braking speed for the brake application	km/h
Z	Deceleration	m/s^2
μ	Average by time friction value for disc brakes	—
μ^*	Instantaneous friction value for disc brakes	—
η	Brake efficiency	%

4.2 Abbreviated terms

DTV Disc Thickness Variation

IBT Initial Brake Temperature (disc)

GVM Gross Vehicle Mass

LRO Lateral Run-Out

MPU Metal Pick-Up

NAO Non-Asbestos Organic

NVH Noise, Vibration and Harshness

5 Test conditions and test preparation

5.1 Inertia for the brake testing

Use inertia calculated based on the real brake force distribution for a deceleration level of 0,3 *g* (2,94 m/s^2) and GVM vehicle mass conditions.

Option: if the nominal brake force distribution is not known, use the following approach:

— front inertia: calculate the inertia for the front axle using 75 % of half the gross vehicle mass, and the tyre rolling radius;

— rear inertia: calculate the inertia for the rear axle using 25 % of half the gross vehicle mass and the tyre rolling radius.

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