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Zračni filtrski sistemi rotacijskih strojev - 4. del: Preskusne metode za statične filtrirne sisteme v obalnih in priobalnih okoljih (ISO/DIS 29461-4:2024)

Air intake filter systems for rotary machinery - Part 4: Test methods for static filter systems in coastal and offshore environments (ISO/DIS 29461-4:2024)

Ansaugfiltersysteme von Rotationsmaschinen - Prüfverfahren - Teil 4: Prüfverfahren für statische Filtersysteme in Meeres- und Offshore-Umgebungen (ISO/DIS 29461-4:2024)

Systèmes de filtration d'air d'admission pour machines tournantes - Partie 4: Méthodes d'essai des systèmes de filtration statique en milieu côtier et offshore (ISO/DIS 29461-4:2024)

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Air intake filter systems for rotary machinery —

Part 4: Test methods for static filter systems in coastal and offshore environments

Systèmes de filtration d'air d'admission pour machines tournantes —

Partie 4: Méthodes d'essai des systèmes de filtration statique en milieu côtier et offshore

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Contents

Foreword

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This document was prepared by Technical Committee ISO/TC 142 *Cleaning equipment for air and other gases.*

A list of all parts in the ISO 29461 series can be found on the ISO website.

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

The use of gas turbines in the oil & gas industry represents one of the most challenging applications for this engine technology. The major constraint of the oil and gas business is to run 24/7 at full load with minimum downtime. In oil & gas activity, it is of prime importance to run the installation as close as possible to 100 % of the time with the highest level of efficiency (current production compared to nominal production).

An additional challenge for oil and gas applications lies in the absence of a back-up on site especially for mechanical-drive gas turbine configurations.

The coastal and offshore environment probably represents the harshest conditions for gas turbines. Humidity, rainfall and seasonal dust are the most obvious visible conditions that operators face on site. Hidden in the combustion air, alkali such as potassium, sodium or magnesium, as well as sulfur, soot, volatile hydrocarbons, oily vapors, and particles all generate gas turbine issues including compressor fouling, air-cooling passage fouling, vane and blade erosion, and compressor corrosion. Combined with sulfur in fuels, these alkali in combustion air create hot corrosion. Finally, heavy rainfall may induce filter washings that release filtered particles into the compressor. All these phenomena impact the gas turbine availability on site. An operating company aiming for excellence has to strive to minimize lack of availability and performance deterioration in order to make the asset more energy efficient.

The role of a highly efficient air filtration system is to maintain the engine cleanliness by preventing the introduction of contaminants into the gas turbine air intake. Achieving a high level of engine cleanliness helps maintain engine integrity and efficiency and reduces the need for water washes which generate avoidable downtime.

Currently, high efficiency filter elements are characterized by a limited number of parameters, namely filter efficiency and MPPS (Most Penetrating Particle Size). These parameters, related to a single filter element, are measured in laboratory conditions close to favorable inland conditions with synthetic dust. Consequently, these conditions are far from the reality observed on site, offshore or near coast, where filter elements are usually part of a system. The test results do not therefore provide a basis for predicting either operational filter performance or service life.

The objective of this document is to close the gap between the current filter element characterization conditions (e.g.: ISO 29641 – Part 1) and the site environment. As a first criterion, the standard considers the effect of humidity and alkali such as salt changing its structure with humidity. The tested air flow passing through the filter element is close to the air flow operated on site for the three different concepts: low, medium or high velocity filter elements.

Soot, volatile hydrocarbons, oily vapours and particles also have impact on filter characterization. Particles are covered in separate parts of ISO 29461, while soot, volatile hydrocarbons and oily vapours will have to be addressed in future revisions of this document. The work on the current revision has revealed that current test methods are not mature enough for inclusion of soot, volatile hydrocarbons and oily vapours.

The ageing of a filter element installed offshore and near coast is addressed to allow the prediction of operational filter performance and its associated service life. It is of paramount importance to understand how filter elements perform during different cycles representing typical site conditions such as heavy rainfall, low and high humidity, filter element unloaded and loaded.

Depending on the gas turbine applications, the service life of the filter element is also a criterion to take into consideration. A minimum service life of 3 years is required, especially for LNG applications. In this case the robustness, loading capacity and pressure drop characteristics of the filter elements become key parameters for design and testing.

Air intake filter systems for rotary machinery —

Part 4:
Test methods for static filter systems in coastal and offshore environments

1 Scope

This document defines test methods for performance testing of individual filter elements and of the complete filtration system1). This procedure is intended for filter elements and filter systems which operate at flow rated up to 8 000 m^3/h per filter element.

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 2813, *Paints and varnishes — Determination of gloss value at 20°, 60° and 85°*

ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

ISO 16890-2:2016, *Air filters for general ventilation — Part 2: Measurement of fractional efficiency and air flow resistance*

ISO 29461-1:2021, *Air intake filter systems for rotary machinery — Test methods — Part 1: Static filter elements*

ISO 29461-2:2022, *Air intake filter systems for rotary machinery — Test methods — Part 2: Filter element endurance test in fog and mist environments*

ISO 29463-1, *High efficiency filters and filter media for removing particles from air — Part 1: Classification, performance, testing and marking*

ISO 29464:2017, *Cleaning of air and other gases — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 29464 and the following apply.

ISO and IEC maintain terminological 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/

1) Note: The Filters will be loaded with ultra-fine salt particles of a size mostly < 0,1 micron during variable humidity to simulate real offshore and costal conditions hence filter with an initial conditioned efficiency lower than 50 % for the $e\mathrm{PM}_1$ particles (filter class T7) are likely to under perform and would not be suited as a single stage filter.

3.1 Air flows

3.1.1
air flow rate
volume of air flowing through the filter per unit time

[SOURCE: ISO 29464:2017, 3.1.24]

3.1.2
test air flow rate
air flow rate used for testing

3.1.3
nominal air flow rate
air flow rate specified by the manufacturer

3.2 Efficiencies

3.2.1
salt removal efficiency
measure of the ability of a filter to remove salt from the air passing through it

3.2.2
water removal efficiency
ratio of water found downstream and upstream of filter element

3.3
salt
sodium chloride (NaCl)

4 Symbols and abbreviated terms

c_{wm}	water fog mass concentration, g/m^3
d	saturated wet air moisture content, g/kg
d_0	ambient air moisture content, g/kg
dP	pressure drop, Pa
m_p	water mass penetrated through tested filter at the end of the test, kg
m_{tot}	total water fog generation amount, kg
CV	coefficient of variation
Na	sodium
NaCl	sodium chloride
RH	relative humidity
SFP	sodium flame photometer
SG	salt generator
SSA	solid salt aerosol

5 Description of test method

The following test method is designed to challenge the air intake test object (the test object could be a complete system, a single filter or a multi-stage filter system) with sub-micron salt to ensure that the fiber structure is challenged deep within the filter and not only on the surface. This allows simulation of salt loading, and the cycling of relative humidity allows simulation of aging because the salt particulates will transform from dry to liquid phase. In real life the filters are exposed to both sub-micron and larger salt particles and water droplets.

The main "failure" modes or weaknesses to be detected by using this test procedure/method are:

a) Bypass of salt and water through not properly sealed construction.

Example Too little glue between frame parts causing leakage.

b) Penetration of salt and water through the filter media.

Example Construction is sealed good, but the filter media has poor water repellency causing leaks through media.

c) Adverse pressure reaction to moisture and/or salt loading.

6 Test rig and equipment

6.1 General

6.1.1 Test rig

The test rig can be configured in multiple different ways depending on the object being tested, the main part of the standard is aimed at testing individual filter elements.

NOTE To perform a multi-stage test an appropriate test procedure is under preparation and will be defined later.

In case of circular cartridges, the test setup (mounting of the filters in the test duct) shall be as close to the real application as possible. This must however be analyzed specifically for each construction, taking into consideration possible jetting effect that can affect the velocity and aerosol concentration in the test duct cross section (see ISO 29461-1:2021, 5). The intended orientation (horizontal/vertical) should be noted in the report.