Task 2.6: Dustiness of Manufactured Nanomaterials

Introduction

Dustiness is a key parameter describing the ability of powder materials to generate dust during agitation. Released dust particles can lead to inhalation exposure risk and potentially create a combustible or explosive atmosphere (ATEX). Addressing the dustiness as a physico-chemical characteristic is needed to support the current and foreseeable future regulatory needs for the safety at workplaces, the registration for chemicals under REACH and the safety regarding ATEX. The goal of this task is to provide the scientific basis for the development of an OECD Test Guideline (TG) on dustiness testing of manufactured nanomaterials, which will cover both granular and fibrous nanomaterials. In addition, two accompanying Guidance Documents (GDs) will be developed: one on the application of dustiness data for occupational exposure assessment modelling and one on the application of data from dustiness tests for the assessment of explosion risks (ATEX).

Description of Work

Task 2.6, led by INERIS, NRCWE and BAuA, is composed of three subtasks:

1. *Dustiness testing of granular nanomaterials*

Six different dustiness test methods, four currently standardised and two not yet standardised (Figure 1), are being harmonised regarding parameters and operating conditions used for conducting the experiments. An inter- and intra-laboratory comparison (ILC) was performed using six different granular nanomaterials to provide the scientific basis for the OECD TG and to evaluate the reliability and repeatability of these dustiness test methods. This was made possible by the kind voluntary participation of eighteen international partners. The results of this ILC form the basis for the TG development and are reported in G4N deliverable D2.18 and will be further disseminated in a scientific publication.

Figure 1: Six different dustiness test methods were tested in the ILC.

2. *Use of dustiness data for exposure modelling*

A total of 47 worker exposure cases during powder agitation were compiled from literature. The cases compiled covered different particle sizes, shapes, chemistries and characteristics. Different modelling approaches using dustiness as a key input parameter were tested for accuracy. Testing was conducted by comparing model predicted exposure concentrations to actual reported concentrations from scientific literature in order to prove the concept of using dustiness data for model predictions of exposure.

3. *Assessment of ATEX and safe handling of nanomaterials*

The aim of this work on ATEX is to assess the applicability of the dustiness test protocols and of their data to assess and manage explosion risks in the framework

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement 814401

of EU ATEX Directive 1999/92/EC. Several communities emphasise that the concept of dustiness can support ATEX risk assessment, including the communities on safety at work, industrial safety, process design, and others. The current work focuses more specifically on combustible nanomaterials (e.g. carbon blacks, silicon carbide) and the associated risk of formation of an ATEX. This contributes more generally to the safe handling of nanomaterials. The results will constitute key inputs for a dedicated OECD guidance document (GD) related to the use of dustiness data for ATEX risk assessment.

Main Results

1. *Dustiness testing of granular nanomaterials*

The ILC has been accomplished in which six different dustiness test methods have been considered. The six materials tested covered different chemical compositions, dustiness levels and dimensions. A common template, harmonised with the eNanoMapper database, was established to report the obtained dustiness data. The ILC data was evaluated following the ISO 5725:2019. Laboratory variability was around or below 30% and results were considered "gratifying" according to the calculated z-score (ISO 13528:2022). Moreover, correlations between laboratories and differences between methods and material were assessed.

2. *Use of dustiness data for exposure modelling*

The testing was conducted by using a mathematical two-box mass-balance model and different publicly available exposure assessment tools. The use of dustiness for exposure modelling was improved by exploring the use of a factor that links the energy applied to the powder during the dustiness test with the energy during the specific process. This was conducted for 3 different dustiness test methods using 13 case studies. Accuracy in modelling of exposure concentrations was assessed for particle mass and particle number concentrations. Results highlight the usability of dustiness to predict exposure.

3. *Assessment of ATEX and safe handling of nanomaterials*

In a dust explosion, the whole spectrum of particle sizes can participate in the flame propagation. Tests were carried out in triplicate for five combustible nanomaterials. Depending on the product, the relative standard deviations range between 5 and 15 %. Total mass dustiness is helpful to strengthen the current qualitative ATEX risk assessment approaches. It can help to better quantify the expansion volume of the dust cloud and as a result the volume and place of each ATEX area.

Summary

In summary, the results obtained within this task will be used for the development of an OECD TG and two accompanying GDs. This will enable the harmonised use of dustiness test methods for assessing regulatory relevant information on dustiness, as well as the harmonised use of these data for exposure modelling and ATEX assessment. Thereby, it will allow moving beyond the current regulatory needs and requirements towards safer workplaces.

For more details about the Gov4Nano project please visit the Gov4Nano website (www.gov4nano.eu). Public deliverables will be made available in due time via this website.