SLOVENSKI STANDARD
SIST CR 14061:2002

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Gnojila - Doloļ evanje koliļ ine prahu

Fertilizers - Determination of dust content

Engrais - Détermination de la teneur en poussiere

Ta slovenski standard je istoveten z: CR 14061:2000

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN REPORT **RAPPORT CEN** **CEN BERICHT**	**CR 14061:2000**
Fertilizers - Determination of dust content	
Date of approval: **Date d'approbation: 2000-11-11** **Annahme-Datum:**	**CEN/TC 260**

2000-12-06 WI: 00260007
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Sehr geehrte Mitglieder,

Beiliegend überreichen wir Ihnen in der offiziellen Englischen und Französischen Fassung den vom Technischen Büro, in Übereinstimmung mit der Geschäftsordnung Teil 2, 2.1.5, angenommenen CEN Bericht.

Wir bitten Sie diesen Bericht in Ihrem nationalen Katalog anzukündigen.

Mit freundlichen Grüßen,

Dear Members,

Please find enclosed the official English and French versions of this CEN Report approved by the Technical Board in accordance with Internal Regulations Part 2, 2.1.5.

You are requested to announce this CEN Report in your national catalogue.

Yours faithfully,

Chers Membres,

Veuillez trouver ci-joint ce Rapport CEN dans les versions officielles anglaise et française, comme approuvé par le Bureau Technique, conformément au Règlement Intérieur Partie 2, 2.1.5.

Nous vous prions d'annoncer ce Rapport CEN dans votre catalogue national.

Veuillez agréer, Chers Membres, l'expression de nos sentiments distingués.

G. HONGLER
Secretary General

Enclosures

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CEN REPORT

RAPPORT CEN

CEN BERICHT

CR 14061

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ICS

English version

Fertilizers - Determination of dust content

Engrais - Détermination de la teneur en poussière

This CEN Report was approved by CEN on 11 November 2000. It has been drawn up by the Technical Committee CEN/TC 260.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This CEN Report has been prepared by Technical Committee CEN/TC 260 "Fertilizers and liming materials", the secretariat of which is held by DIN.

This CEN Report is published by the European Committee for Standardization. It is published for information only and does not have the status of a European Standard.

The annexes A and B are informative.

Introduction

In production and handling of fertilisers dust generation is of great concern by both producers and users of the fertiliser products. For health and environmental reasons it is of great interest to control and reduce the amount of dust generation. In the fertiliser industries there exist a wide variety of apparatus for dust determination, most being used as "in-house" methods in plants and laboratories.

In order to develop a standard dust test CEN TC260 put the work item WI 00260007 on the agenda of WG2 who has worked in this field since November 1991. A spouting bed apparatus was designed for gravimetric determination of dust, and after two preliminary ringtests a conclusive ringtest involving six laboratories was carried out. Not being able to develop a statistical significant method for the determination of dust TC 260 decided by resolution 105/1997 to change the deliverable of this work item into a CEN Report. The change of deliverable has been approved by CEN/BT with its resolution BT C172/1999.

1 General

When handling fertiliser grains, dust is at every moment generated on the surface. The fertiliser thus contains more or less free dust, and has a potential for generating more dust (abrasion dust) when subject to subsequent handling.

In all existing gravitational test methods dust will be generated during the testing time, and the two types of dust will be measured simultaneously. The scope of the method is expressed in annex A and the aim is to:

*"...specify a method for the determination of the **dust potential** of solid fertilisers and is applicable to granular and prilled fertilisers.*

Dust particles which cause reduced visibility in air are too small to be determined by this method."

2 Background for choice of method

Fluidized particle powders are generally divided into four characterising groups (A,B,C,D) [1]. Group C particles are small, cohesive and are difficult to fluidize. Aeratable powders belong to group A, and many fluidized bed catalysts characterise this group. Sand typifies group B, in which inter-particle forces are negligible, in contrast with group A powders. Large and/or dense particles in general belong to group D, and fertiliser particles (2 mm to 4 mm) in air are in this group. A flow diagram can be used to broadly identify flow regimes appropriate to combinations of gas velocity and particle properties. It can be shown that the fertiliser system is in the lower part of the spouted bed regime.

A criterion that can be used to distinguish between group B and D is the numerical inequality that classifies a powder as spoutable if:

$$(\rho_p - \rho_g) \cdot d_p^{1,24} > 0,23$$

For a typical fertiliser this value will be about 1,4 and about 0,5 for an urea prill.

From previous experiments with other methods based on a fluidized bed and the above calculations, it was decided to base the method upon the spouted bed principle.

3 Symbols and abbreviated terms

3.1 Technical Symbols

C_D	- drag coefficient
d_p	- particle diameter, expressed in metres (m)
d_s	- average spout diameter, expressed in metres (m)
D_p	- average particle diameter, expressed in metres (m)
D	- diameter of spouting section, expressed in metres (m)
D_i	- inner orifice diameter, expressed in metres (m)
g	- gravity, expressed in kilograms per metres per square seconds (kg/m s^2)
H	- bed height, expressed in metres (m)
Re	- Reynolds number
v_t	- terminal velocity, expressed in metres per seconds (m/s)
v_{ms}	- minimum spouting height
ρ_p	- particle density, expressed in kilograms per metres to the third power (kg/m^3)
ρ_f	- fluid density, expressed in kilograms per metres to the third power (kg/m^3)
μ	- viscosity, expressed in Newton seconds per square metres (Ns/m^2)

3.2 Statistical symbols and abbreviations

df	- degrees of freedom
F	- mean square between groups/mean square within groups
F_{crit}	- tabulated value form the F-distribution for a significance level of 0.05 confidence interval
MS	- mean square
P-value	- significance level corresponding to a given F (should be less than 0,05 to reject the null-hypothesis)
SS	- sum of squares

4 Calculation of the spouting bed apparatus

4.1 Particle terminal velocity

A particle falling freely in a fluid will finally reach its terminal velocity. The forces acting on it are gravitational, accelerating, buoyancy force and drag (friction) force. The drag force can be expressed by a drag coefficient C_D, which is expressed by equation (1):

$$C_{\mathrm{D}} = \frac{4}{3}\frac{(\rho_{\mathrm{p}} - \rho_{\mathrm{f}})d_{\mathrm{p}}g}{\rho_{\mathrm{f}}v_{\mathrm{t}}^{2}}$$

By calculation and plotting log C_D against log *Re* (Reynolds number) the so-called "standard drag-curve" can be obtained which has three broad regions:

- Laminar region, $Re < 0.2$
- Transitional region (tr), $0.2 < Re_{tr} < 1000$
- Turbulent region, $Re > 1000$

The drag coefficient equation can be multiplied with $\rho_f^2 v_t^2 d_p^2/\mu^2$ and rearranged as

$$C_{\mathrm{D}}Re_{t}^{2} = \frac{4}{3}\frac{(\rho_{\mathrm{p}} - \rho_{\mathrm{f}})d_{\mathrm{p}}^{3}g}{\mu^{2}}$$

The group $C_D Re_{tr}^2$ is dimensionless containing only the physical properties of the particle/fluid system including the particle diameter d_p. The *Re*-number and the terminal velocity (v_t) can be estimated by graphical methods.

Calculations prove that transitional flow describes the system of fertiliser dust in air, thus giving Table 1:

Table 1 – System of fertiliser dust in air

Particle size d_p [µm]	$C_D Re_{tr}^2$	Re_{tr}	v_t [m/s]
100	88	3,0	0,5
150	300	7,7	0,8
200	704	15,0	1,3

The air velocity was chosen to be 0,75 m/s in the classification section (110 mm ø) of the apparatus, and irregular particles less than 150µm will then be carried over, according to calculations.

4.2 Spouting section

The spouting section is characterised by the "minimum spouting height", v_{ms} , that depends on the particle (fertiliser) properties, spouting column geometry and the inlet orifice diameter:

$$v_{ms} = \left(\frac{d_p}{D}\right)\left(\frac{D_i}{D}\right)^{1/3}\left(\frac{2gH(\rho_p - \rho_f)}{\rho_f}\right)^{1/2}$$

Based on 500 g fertiliser, v_{ms}=1,0 m/s and diameter D = 85 mm of spouting section, the theoretical expression of v_{ms} [1] was rearranged. Inner orifice diameter D_i:

$$D_i^{1/3} = 5,645\ 10^{-4}\ d_p$$

thus giving the figures:

d_p	2,0 mm	3,0 mm	4,0 mm
D_i	22,5 mm	6,6 mm	2,8 mm

Depending on the average particle diameter (d_p) the inner orifice diameter (D_i) should thus be varied, according to the theory.

4.3 Maximum spoutable bed height

The maximum spoutable bed height (H_s) can be estimated from the correlation:

$$H_s = 0,345\ (D^2 - d_s^2)\ .D^{0,384}\ .\ d_s^{-1,384}$$

where d_s is the average spout diameter. D = 85 mm and estimated d_s = 15 mm gives H_s ~ 38 mm, which is higher than the chosen bed height. However, the calculation assumes spherical particles, and practical maximum spoutable depth will therefore be lower than the theoretical value.

Based on the calculations above the spouting bed apparatus was designed and tested.

4.4 Design of apparatus

The column was designed with the dimensions according to Table 2.

Table 2 – Design of apparatus

Classification section		Spouting section	
column diameter	110 mm	column diameter	85 mm
column height	400 mm	column height	120 mm
outlet diameter	40 mm	cone height	85 mm
air velocity	1 m/s	Total height (incl. bottom inlet)	220 mm
fertiliser mass	400 g	cone inlet diameter	23 mm[b)]
air rate	25 m^3/h[a)]	air velocity (overall)	1,2 m/s

[a)] The air velocity in classification section was chosen to be 0,75 m/s in order to carry 150 · m particles over (see 4.1).
[b)] Adapters with diameters 7, 8, . . . ,18 mm were made to include most fertilisers. A 440 · m grid was fitted into the adapter inlet.

4.5 Flowmeter

A calibrated flowmeter is connected to the column. The flowmeter should have a capacity of approximate 40 m^3/h.

5 Initial testing

5.1 Determination of dust weight

Initially the dust was collected by a filter at the outlet of the apparatus. However, because of safety (pressurised air in the glass apparatus) and inaccuracy in measurements due to accumulation of dust on column walls it was decided to record the difference in weight of the fertiliser sample during the test.

5.2 Setting the test time

Initial tests were carried out in order to set the test-time. Dust generation of selected NP/NPK-fertilisers were measured at increasing time intervals.

Figure 1shows a decreasing slope at approximate 0,5 min test time which is due to a change from free dust to abrasion dust. In order to include approximate the same amount of free dust as abrasion dust, 2 min test time was chosen.