A 11 b - Particle Density, Occluded Air and Interstitial Air by Petroleum Ether

GEA Niro Method No. A 11 b

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1. Definition

Particle density (g/ml) is defined as the mass of particles having a total volume of 1 ml.

Occluded air (ml/100g) is defined as the difference between the volume of a given mass of particles and the volume of the same mass of air-free solids.

Interstitial air (ml/100g) is defined as the difference between the volume of a given mass of particles and the volume of the same mass of powder tapped 100 times (100x tapped powder).

2. Scope

This method may to be used for all powders.

3. Principle

The weighted amount of powder is added to petroleum ether in a measuring cylinder. The weight of the powder divided by the volume increase of the petroleum ether gives the particle density.

4. Apparatus

1. Analytical balance, capable of weighing to 0.1 mg.
2. Calibrated 100 ml measuring cylinder with glass stopper.
3. Rubber spatula.
4. Pipettes – 10 ml and 50 ml

5. Reagents

Petroleum ether.

6. Procedure

1. Weigh out 25 g powder into the measuring cylinder.
2. Add 50 ml petroleum ether with a pipette and shake the measuring cylinder gently until all the powder is suspended.
3. Using the rubber spatula, scrape down all the powder particles on the wall of the measuring cylinder. Rinse with a further 10 ml of petroleum ether from a pipette.
4. Read the total volume of petroleum ether with suspended powder.

5. Determine the moisture content (Method A1a), the fat content (Method A9a) and the 100x tapped powder bulk density (Method A2a).

1. The particle density $D_{particle}$ is calculated as:

$$D_{particle} = \frac{W_{sample}}{V_{ether} - 60} \quad [g/ml]$$

W_{sample} = Weight of the sample in g.

V_{ether} = Volume of petroleum ether with suspended powder in ml.

2. The theoretical density of powder solids D_{solids} in milk powder is calculated as:

$$D_{solids} = \frac{100}{\%F/_{0.94} + \%SNF/_{1.52} + \%W} \quad [g/ml]$$

%F = fat content

%SNF = solid non-fat content

%W = moisture content

For whey powder of normal composition the following formula can be used:

$$D_{solids} = \frac{100}{\%F/_{0.94} + \%SNF(whey)/_{1.58} + \%W} \quad [g/ml]$$

%F = fat content

%SNF = solid non-fat content in whey powder

%W = moisture content

3. Occluded air content V_{oa} is calculated as:

$$V_{oa} = \frac{100}{D_{particle}} - \frac{100}{D_{solids}} \quad [ml/100g]$$

$D_{particle}$ = particle density (from 7.1)

D_{solids} = density of powder solids (from 7.2)

4. Interstitial air content is calculated as:

$$V_{ia} = \frac{100}{D_{powder}} - \frac{100}{D_{particle}} \quad [ml/100g]$$

D_{powder} = Powder bulk density, tapped 100x (from 6.10)

$D_{particle}$ = particle density (from 7.1)

7. Result

8. Reproducibility

Particle density ± 0.03 g/ml

9. Remarks

1. When calculating powder of different compositions, the density and the amounts of the constituents must be taken in consideration. For this purpose, the following values may be used.

Powder material, moisture free	Density at 20° C
Whole milk powder (28% fat)	1.280
Non-fat milk solids	1.520
Milk fat in powder	0.940
Ca-caseinate phosphate complex	1.390
Amorphous lactose	1.520
Beta-lactose	1.590
Alpha-lactose monohydrate	1.545
Anhydrous alpha-lactose	1.545
Spray dried whey powder	1.580
Residual whey components	1.800
Demineralized whey powder	1.525

10. Literature

- GEA Niro Research Laboratory
- Buma T.J.: 'The true density of spray milk powder and of certain constituents' (Netherlands Milk and Dairy Journal, 1965, 19, pp. 249-265)