

PRINCIPLES AND REQUIREMENTS FOR THE SOIL TEXTURE  
ANALYSIS ACCORDING TO METHODS RECOMMENDED BY  
INTERNATIONAL STANDARD ORGANISATION (ISO)

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**A b s t r a c t.** For several years now the Polish Normalisation Committee (PKN) has been engaged in the process of introduction (and implementation) of international standards complying with the International Standard Organisation (ISO) into the set of Polish Standards. At present, in the PKN Commission of Soil Physics, a number of such standards are being prepared (translated) including a very comprehensive standard dealing with particle size distribution determination in soil material - ISO 11277 [6].

Some principles and requirements included in this standard differ significantly from those commonly accepted and widely in use now in numerous pedologic laboratories in Poland [7,8]. Below there are some of the most important differences: (1) the requirement to remove organic matter from test samples (using 30% v/v solution of H<sub>2</sub>O<sub>2</sub>), (2) the requirement to remove water soluble salts and gypsum (to electrical conductivity 0.4 dS/m), (3) sample dispersion process must be longer than 18 hours. Many other requirements, of relatively lesser importance, in many cases also do not correlate with those commonly accepted in our laboratories.

**K e y w o r d s:** particle size distribution, methods, ISO.

INTRODUCTION

The International Standard - ISO 11277 introduced in 1998 [6] specifies a basic method for the determination of particle size distribution applicable to a wide range of mineral soils materials (including mineral fraction of organic soils). It also offers procedures to deal with specific soils, e.g. developed from recent volcanic deposits, highly weathered tropical soils and very cohesive soils.

Particle size distribution is determined by a combination of sieving and sedimentation starting from air-dried soil (for specific soils - a method of undried soil are recommended).

Particles not passing a 2 mm sieve are determined by dry sieving. Particles passing such a sieve, but retained on a 0.063 mm sieve, are determined by a combination of wet and dry sieving. Particles with the diameter lower than 0.063 mm are determined by sedimentation.

Two methods: pipette (which is preferred) and hydrometer are described in details. A combination of sieving and sedimentation enables construction of continuous particle size distribution curve.

The International Standard requires that amount of fraction (in proportion or percentage) separated by sieving and sedimentation to be determined from the masses of fraction obtained only by weighing.

Both the pipette and hydrometer methods assume that settling of particles in the sedimentation cylinder agrees with the Stokes' law with some reservations, namely:

- particles are rigid, smooth spheres,
- particle settle in laminar flow, i.e. the Reynolds number is less than about 0.2,
- suspension of particles is sufficiently diluted to ensure no particle interferes with the setting of any of the particles,
- there is no interaction between the particle and the fluid,
- diameter of the suspension column is large, i.e. fluid is of "infinite extent",
- particle has reached terminal velocity,
- particles are of the same specific density.

#### FIELD SAMPLING AND SAMPLE PREPARATION

The mass of sample taken in the field shall be representative of particle size distribution, especially if the amount of the larger particles is to be determined reliably. The minimum re-commended masses are given in Table 1.

**Table 1.** Mass of soil sample to be taken for sieving

Maximum size of material forming > 10% of the soil (given as test sieve aperture, in mm)	Minimum mass of sample to be taken for sieving
63	50
50	35
37.5	15
28	6
20	2
14	1
10	0.5
6.3	0.2
5	0.2
2 or smaller	0.1

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Samples shall be prepared in accordance with the methods given in ISO 11464 [5].

#### APPARATI AND REAGENTS

“Special requirements” for the apparatus are as follows:

(1) The test sieves with apertures comply with ISO 565 [2]. Tolerances shall meet the requirements of ISO 3310-1 [3] and ISO 3310-2 [4]. Brass sieves are particularly liable to splitting and distortion and steel sieves are strongly recommended for larger apertures. Round-hole sieves shall not be used;

(2) A constant-temperature room or bath, where temperature can be maintained at between 20 and 30 °C  $\pm$  0.5 °C. If a bath is used, it shall include a sedimentation tube immersed to the 500 ml mark, and shall not vibrate the contents of the tube (similarly, if a room is used).

Recommended pipettes and hydrometers are shown on Figs 1 and 2.

All reagents shall be of a recognised analytical grade. Use water conforming to class 2 of ISO 3696 [1] i.e. having an electrical conductivity no greater than 0.1 dS/m at 25 °C, at the time of use.

#### DISPERSION PROCEDURE

Before dispersion, two processes are obligatory:

(1) Destruction of organic matter (by 30% v/v hydrogen peroxide solution),

(2) Removal of soluble salts and gypsum. This process follows organic matter destruction and shall be continuous until electrical conductivity ( $E_c$ ) in the suspension of soil:water ratio between 1:4 to 1:6 by volume will be smaller than 0.4 dS/m.

The removal of carbonates and iron/aluminium oxides are not obligatory.

The dispersion process is carried out in centrifuge bottle with sufficient amount of water and dispersing agent on shaker. The total shaking time is 18 h.

The preferred dispersing agent is that prepared by dissolving 33 g of sodium hexametaphosphate and 7 g anhydrous sodium carbonate in water to make 1 l of solution. This solution is unsuitable and shall be stored in a dark bottle and replaced after one month.

Buffered sodium hexametaphosphate is commonly referred to in literature as “Calgon”. This is a trade name. The substance sold as such name is often not the

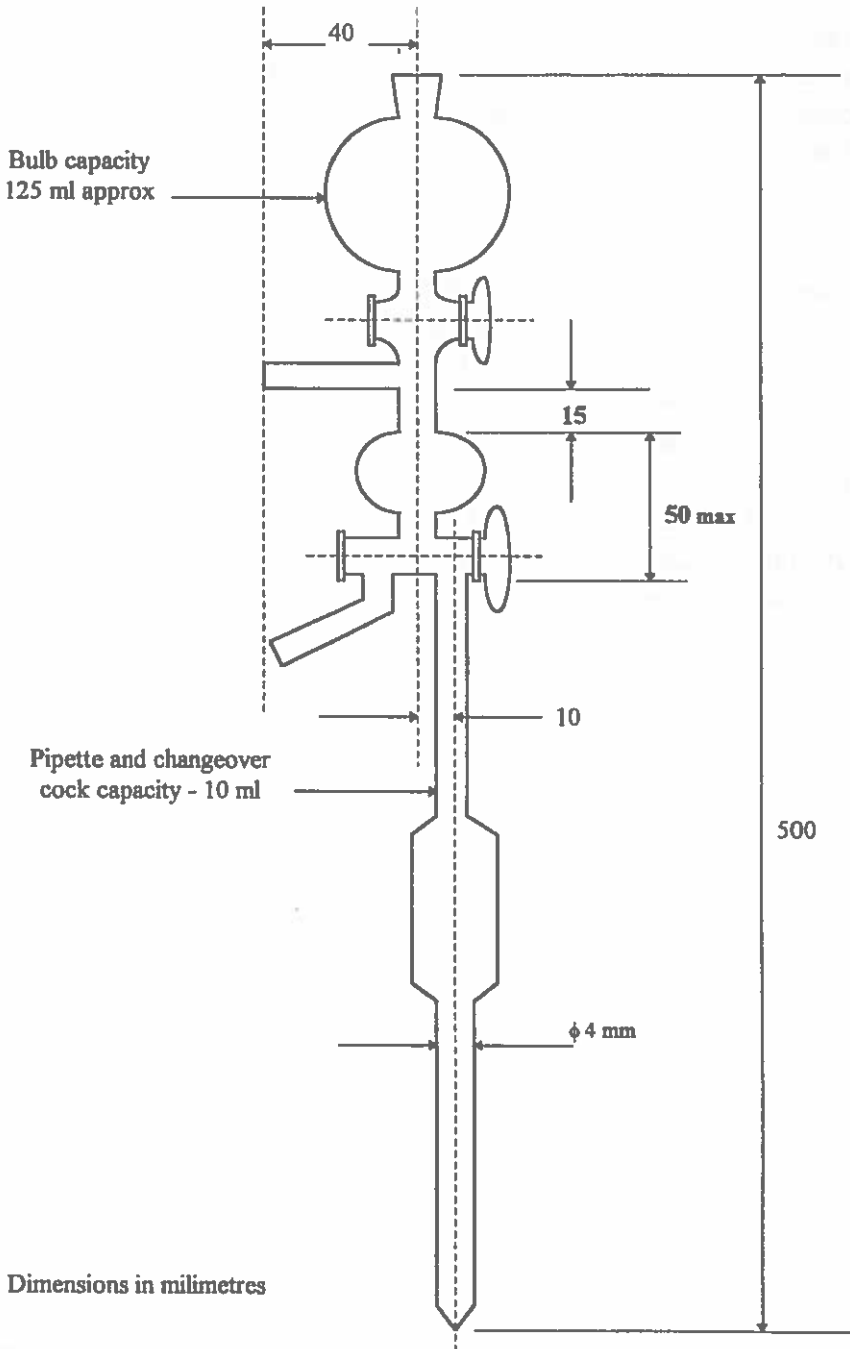
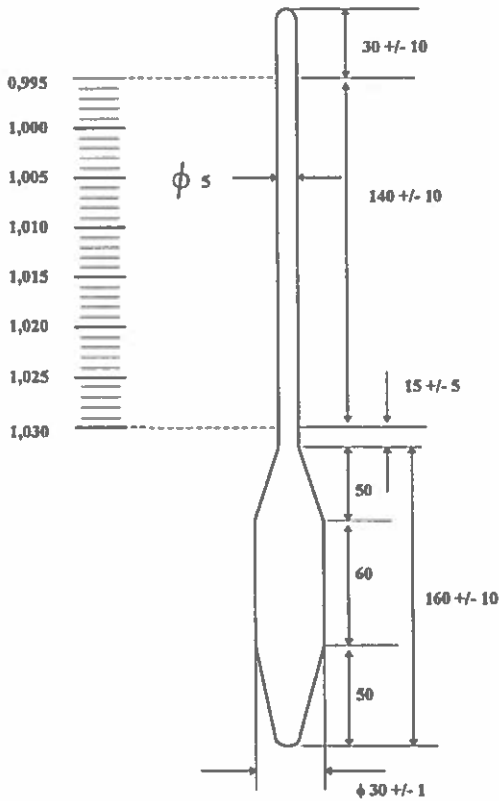


Fig. 1. Sampling pipette for sedimentation test.



NOTE - Calibrations in g/ml at 20°C

Fig. 2. Hydrometer for determination of fine particle size.

reagent described above and shall not be used as a dispersing agent.

## CONCLUSIONS

1. The pipette and hydrometer methods for the determination of particle-size distribution described in ISO 11277, differ significantly from those commonly accepted and widely in use now in numerous pedologic laboratories in Poland [7,8]. The most important differences are: (i) the requirement to remove organic matter from test sample (also for hydrometer methods), (ii) the requirement to remove water soluble salts and gypsum, (iii) the sample dispersion process (shaking) must last minimum 18 h.

2. There is an urgent need to compare in detail the methods proposed by ISO with those recommended by the Polish Soil Science Society and Polish Standard with the aim to adjust them as far as it is possible or to introduce to Polish laboratories the ISO methods.

## REFERENCES

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3. ISO 3310-1: Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth. Geneve, Switzerland, 1990.
4. ISO 3310-2: Test sieves - Technical requirements and testing - Part 1: Test sieves of perforated metal plate. Geneve, Switzerland, 1990.

5. ISO 11464: Soil quality - Pretreatment of samples for physico-chemical analyses. Geneve, Switzerland, 1994.
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