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TESTING COMMITTEE

Wood chips for pulp production

Bulk density

1 Scope

This SCAN-test Method describes the procedure for determining the bulk density of wood chips, intended for the production of chemical or mechanical pulps. The Method also describes the apparatus used for determining the bulk volume of the chip sample, i. e. the volume of loosely packed chips.

The bulk density is important in the trade of wood chips on a volume basis, as well as in pulp production where it influences the inflow of wood to a digester or to a refiner.

> *Note* – The bulk density is affected by many factors, such as the chip dimensions (10), the chip moisture content, the size of the sample and the procedure used to determine the height of the chip column in the tube.

2 References

SCAN-CM 39 Wood chips for pulp production – Dry matter content
SCAN-CM 41 Wood chips for pulp production – Sampling
SCAN-CM 43 Wood chips for pulp production – Basic density

3 Definitions

For the purpose of this Method, the following definitions apply:

3.1 *Bulk volume* – The volume of a sample of loosely packed chips.

3.2 *Bulk density* – The oven-dry mass of a sample of wood chips divided by the bulk volume of the sample, when the chips are packed without compression as described in this Method.

3.3 *Basic density* – The oven-dry mass of a wood sample divided by its green volume, i.e. the volume of a wood sample when in equilibrium with surrounding water (see SCAN-CM 43).

3.4 *Solid volume content* – The ratio of the bulk density of the wood chips to the basic density of the wood itself.

4 Principle

The bulk density is calculated on the basis of the measured weight and the bulk volume.

The bulk volume is determined by means of a tube where a chip sample is allowed to fall to the bottom of the tube under the influence of the gravity. The height of the chip column thus formed is multiplied by the inner cross-section area of the tube. When the chip sample is weighed and the dry matter content is determined, the bulk density is calculated.

5 Apparatus

5.1 *Equipment giving the volume of loosely packed chips*. The equipment consists of the following components, *Figure 1*.

5.1.1 *A cylindrical tube* of transparent acrylic plastic (Plexiglass), open at both ends and standing on one end in a collecting tray. The internal diameter of the tube is 290 mm, the wall thickness is about 5 mm and the length is 1500 mm. At a distance of 1000 mm from the bottom of the tube, the tube is sawn through to half of its circumference, making a slot. The tube is equipped with two measuring devices placed on opposite sides of the tube to enable measurements to be made from the bottom to the slot.

> *Note 1* – If a tube with an internal diameter of 290 mm is not available, a tube with a larger diameter may be used. In such a situation, the dimensions of the remaining equipment must be adjusted accordingly. The length of the tube and the distance between the bottom and the slot must not be changed.

5.1.2 *A pull-out slide* made of suitable material (such as aluminium). The slide shall be such that it can be inserted into the slot in such a way that the whole tube is closed. The slide can quickly be removed allowing the chips to fall.

5.1.3 *A wooden lid* with a diameter of 285 mm, a thickness of about 90 mm and a weight of 4,0 ± 0,1 kg, *Figure 2*. The lid is perforated with eight holes, with a diameter of 25 mm, to allow air to pass. The holes are uniformly distributed with their centres 50 mm from the circumference.

> *Note 2* – The weight of the wooden lid may be adjusted by a small lead weight placed in the centre on the top of the lid.

5.1.4 *A collecting tray* large enough to hold a test volume of about 30 litres.

5.2 *Balance,* capacity about 20 kg, accurate and readable to 1 g.

6 Sampling and preparation of sample

The sampling procedure is not covered by this Method. Ensure that sampling has been carried out in a manner that ensures representative samples. A suitable sampling procedure is described in SCAN-CM 41.

The upper part of the tube (5.1.1) is to be filled with chips, which means that the test portion for each determination is about 35 litres. If the sample needs to be subdivided to obtain test portions of that size, take precautions to avoid any fractionation of the material.

> *Note* – The chips must not be compressed into the tube when this is being filled.

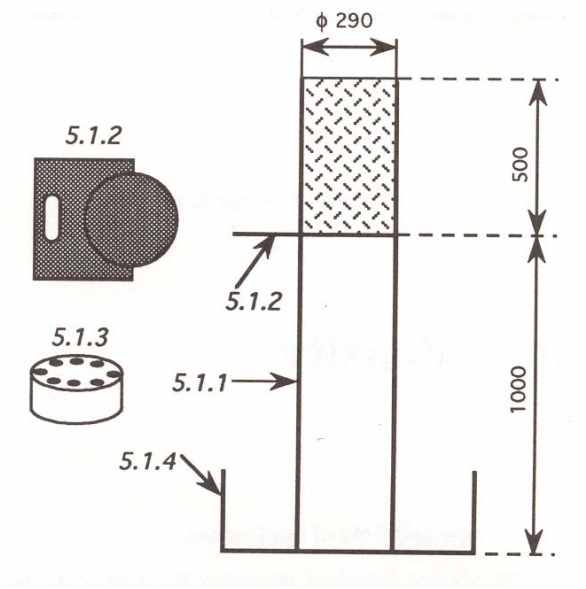

Figure 1. Equipment for determination of the bulk volume of a chip sample:
5.1.1 cylindrical, transparent tube;
5.1.2 pull-out slide;
5.1.3 wooden lid, see also Figure 2;
5.1.4 collecting tray.

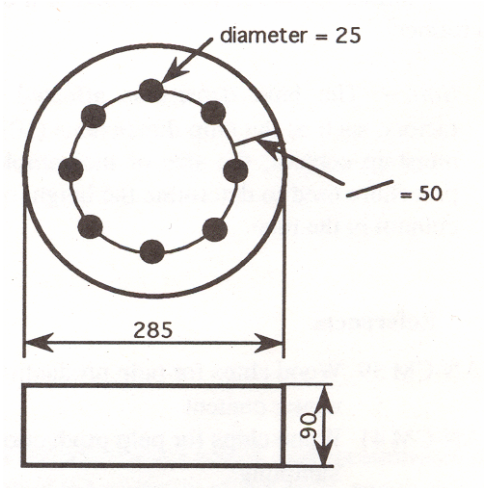

Figure 2. Wooden lid (5.1.3), perforated with eight holes, dimensions in millimetres.

7 Procedure

7.1 Weigh the collecting tray.

7.2 Close the upper section of the tube (5.1.1) by inserting the pull-out slide (5.1.2) into the slot in the tube. Scoop the chip sample into the top section of the tube, until it is filled with chips. Any chip surplus must be removed without applying pressure to flatten the chip column.

> *Note* – A suitable scoop has a volume of 2 litres. The use of a bucket is not recommended since an uneven distribution of the chips in the tube can be obtained.

Withdraw the slide quickly to allow the chips to fall. Take the wooden lid (5.1.3), hold it level with the top of the tube, and let it fall down inside the tube. Measure the height of the chip column formed, from the bottom of the tube to the lower edge of the lid, in two positions opposite to each other. Remove the tube and weigh the chips in the pre-weighed collecting tray (5.1.4).

7.3 From the collecting tray, take a chip sample for the determination of dry matter content as rapidly as possible after the weighing. Determine the dry matter content as described in SCAN-CM 39.

7.4 Repeat the procedure according to items 7.1 - 7.3 with chips from the same original test portion. To replace those chips removed for determination of the dry matter content, add more chips from the original sample.

8 Calculation and report

8.1 *Bulk density*

Calculate the bulk density for the two determinations separately from the expression:

$$X = \frac{10\ w\ y}{h\ A} \qquad [1]$$

where
X is the bulk density, in kilograms oven-dry wood per cubic metre;
w is the mass of the sample, in grams;
y is the dry matter content, as a percentage;
h is the mean height of the chips in the tube, in centimetres;
A is the cross section area of the tube, in square centimetres.

Calculate and report the mean bulk density to the nearest whole number.

8.2 *Solid volume content*

If the basic density of the wood sample is known (see SCAN-CM 43) the solid volume content can be calculated from the ratio of the bulk density to the basic density:

$$Y = \frac{100\ X}{Z} \qquad [2]$$

where
Y is the solid volume content, as a percentage;
X is the bulk density, in kilograms oven-dry wood per cubic metre;
Z is the basic density, in kilograms per cubic metre.

Report the solid volume content to the nearest whole number.

The test report shall include reference to this SCAN-test Method and the following particulars:

(a) date and place of testing;
(b) identification mark of the sample tested;
(c) the results;
(d) the coefficient of variation;
(e) any departure from the procedure described in this Method and any other circumstances that may have affected the test results.

9 Precision

Three wood chip samples were tested 10 times in two laboratories. The repeatability and the reproducibility, measured as the coefficients of variation within and between laboratories, are given in the *Table*.

Chip sample	Lab	Number of observa-tions	Bulk density kg/m^3	CV* within lab %	CV* between labs %
Softwood	1	10	153	1,1	1,8
	2	10	157	1,3	
Hardwood	1	10	202	1,6	2,8
	2	10	210	1,3	
Sawmill	1	10	154	1,7	2,7
	2	10	160	2,0	

* CV is the coefficient of variation

10 Literature

Edberg U., Engström L., Hartler N.: The influence of chip dimensions on chip bulk density,
Svensk Papperstidning *76* (1973)14: 529-533.

SCAN-test Methods are issued and recommended by KCL, PFI and STFI-Packforsk for the pulp, paper and board industries in Finland, Norway and Sweden.
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