BS EN 14718:2014

BSI Standards Publication

Influence of organic materials on water intended for human consumption — Determination of the chlorine demand — Test method

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National foreword

This British Standard is the UK implementation of EN 14718:2014. It supersedes BS EN 14718:2006 which is withdrawn.

At the time of publication, this standard is not currently included in the (UK) product testing to be used for materials in contact with drinking water as all the methodology in BS 6920, together with the pass/fail criteria, has not been replaced by EN standards. To ensure the correct methodology is being used, refer to the National Approval schemes for the UK before undertaking any testing. Further information can be obtained for UK approvals from the Drinking Water Inspectorate and the Water Regulations Advisory Scheme.

The UK participation in its preparation was entrusted to Technical Committee EH/6, Effects of materials on water quality.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Influence of organic materials on water intended for human consumption - Determination of the chlorine demand - Test method

Influence des matériaux organiques sur l'eau destinée à la consommation humaine - Détermination de la demande en chlore - Méthode d'essai

Einfluss organischer Materialien auf Wasser für den menschlichen Gebrauch - Bestimmung der Chlorzehrung - Prüfverfahren

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Foreword

This document (EN 14718:2014) has been prepared by Technical Committee CEN/TC 164 “Water supply”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document supersedes EN 14718:2006

In this second edition, along with editorial corrections, an error in Formula (2) in 11.2.3 has been corrected.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies a method for determining the chlorine demand of organic materials intended for use in contact with drinking water.

This European Standard is applicable to factory made and site applied products used for the distribution, transport and storage of drinking water.

This European Standard does not cover the use of high levels of chlorine to disinfect products when they are put into service.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 7393-2:2000, *Water quality - Determination of free chlorine and total chlorine - Part 2: Colorimetric method using N, N-diethyl-1, 4-phenylenediamine, for routine control purposes (ISO 7393-2:1985)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
chlorine demand
ability of a material in contact with chlorinated water to remove/reduce the concentration of free chlorine in the water compared with a reference sample

[SOURCE: EN ISO 7393-2:2000, 2.1]

3.2
test water
water used for testing purposes prepared with a free-chlorine content as described in 5.2

3.3
rinsing water
test water without added chlorine

3.4
contact water
test water (see 3.2) which has been in contact with a test piece under specified conditions

3.5
blank water
test water (see 3.2) which has been kept at the same specified conditions (e.g. temperature, contact time, contact with any sealing material) as contact water but without contact with the test piece

3.6
flushing water
tap water

3.7
product
manufactured item, in its finished form

3.8
sample
one or more units, or a specified quantity of a product, selected from a batch or lot

3.9
test piece
sample or portion of it which is tested to obtain a single test result

3.10
factory made product
product made in a factory under controlled conditions as part of the manufacturing process

3.11
site applied product
manufactured item for application on-site and subsequent contact with water

Note 1 to entry: In this context, the product is the final prepared surface that comes into contact with water.

4 Principle

Initially test pieces are pre-conditioned by washing and rinsing procedures.

Test pieces are then completely filled with or immersed in test water. This filling or immersion procedure is carried out three times on the same test pieces under specified conditions. After each contact period the contact water is immediately analysed to determine the residual content of free chlorine. Blank tests without test pieces are undertaken with the same test water to obtain blank water results.

NOTE If the reduction in the free-chlorine concentration of the test water in contact with the test material is particularly high, the test will have to be repeated using fresh test samples and a reduced *S/V* test ratio (see 8.3).

The chlorine demand of the material is based on the difference between the free chlorine content of the contact water (see 3.4) and of the blank water (see 3.5).

5 Reagents

5.1 Sodium hypochlorite solution

Sodium hypochlorite solution, with a concentration of about 0,1 % by mass of free chlorine determined in accordance with EN ISO 7393-2, to be prepared from a commercial solution of sodium hypochlorite (NaOCl).

As this sodium hypochlorite solution is unstable, it shall be prepared on the day of use.

5.2 Test water

Test water shall have a conductivity of < 2 mS/m and a total organic carbon content (TOC) of < 0,2 mg/l C (e.g. prepared by reverse osmosis, deionization or distillation, followed by activated carbon filtration) and the addition of sodium hypochlorite solution (see 5.1) to (1,0 ± 0,1) mg/l of free chlorine. The test water shall be stable in the absence of light, such that the depletion of free chlorine shall not exceed 0,1 mg/l during the contact period i.e. (72 ± 2) h at (23 ± 2) °C, when stored without contact with a test piece.

5.3 Rinsing water

Test water (see 5.2) without added chlorine.

5.4 Cleaning liquids for apparatus

Use one or more of the following cleaning liquids, if appropriate:

— biodegradable detergent;

— hydrochloric acid, 2 mol/l (analytical grade);

— hydrogen peroxide, 3 % vol/vol (analytical grade);

— nitric acid, 1,5 mol/l (analytical grade).

6 Apparatus for chlorine demand assessment

6.1 Materials

Vessels, containers, connectors and stoppers, shall be made of materials which do not consume free chlorine under the conditions of the test (see Annex A).

NOTE Suitable materials include glass and stainless steel.

6.2 Test vessels

Test vessels shall be designed for filling without headspace (ullage). They shall be reserved for chlorine demand testing only and cleaned separately from other items.

6.3 Equipment

Equipment, capable of maintaining the test temperature of (23 ± 2) °C, for the duration of the test.

7 Procedural constraints

Unlike migration tests, the chlorine demand test starts with a fixed concentration of free chlorine and a realistic surface area to volume (*S*/*V*) ratio according to Tables 1 and 2.

At the end of each contact period there shall be a minimum concentration of free chlorine (see 11.2.3).

NOTE To ensure the results are reliable it is necessary to limit the reduction of free chlorine by fixing a minimum concentration for free chlorine after the contact period. This is achieved by adapting the best surface area to volume (*S/V*) ratio.

8 Samples of products and test pieces

8.1 Factory made products

8.1.1 General

8.1.1.1 Sampling of products shall be performed in accordance with the relevant product standard, system standard or the national regulations, where applicable.

8.1.1.2 Care shall be taken that the transport conditions shall not influence the test results.

8.1.1.3 If it is necessary to store samples before testing, they shall be protected from contamination. If the manufacturer provides written storage instructions they shall be followed. The samples shall be stored in their original form as delivered.

Where appropriate, storage containers shall be cleaned using the same procedures used for the test containers.

8.1.1.4 For a product where only part of its surface will come into contact with drinking water, the test piece(s) shall be prepared so that only this part of its surface is exposed to the test water (see 5.2).

8.1.1.5 If the preparation procedure for a test piece of a particular type of product has not been covered in this standard, deviation from this procedure is permissible under the following conditions:

a) product and the test piece shall be produced in the same manner;

b) preparation of the test pieces before testing shall conform to the procedures, which are performed in practice before the system is put into operation, e.g. curing and cleaning procedures.

8.1.1.6 Ensure that the surface of the test piece(s), which are intended to come into contact with the test water shall be free from adhesive tapes, labels, ink or pencil marks.

8.1.1.7 The minimum age of the test pieces shall conform to the relevant product standard, system standard or, if not given in such a standard, a manufacturer recommendation that the product is ready for use.

8.1.2 Samples and test pieces of factory made products

8.1.2.1 Pipes

For each test, take a specimen of sufficient length from a pipe to give sufficient volume (V) of test water for analysis purposes.

If no difference in the material composition and the production process exists in the range of diameters produced, testing the smallest diameter, where appropriate and with regard to the quantity of test water and the necessary quantity of free chlorine, is sufficient.

8.1.2.2 Other factory made products

8.1.2.2.1 For each test take one or more test pieces of the product and immerse them in a volume of the test water sufficient to provide enough water for the chlorine demand assessment procedure.

Where it is not possible to reach the analytical limits given for the chlorine demand assessment, the procedure as described in 8.3 shall be applied, taking into account the calculated S/V ratio.

The test pieces shall have a sufficiently low S/V-ratio to conform the procedural constraints (see Clause 7).

8.1.2.2.2 If the outside and the inside surfaces of the product (including pipes) have a different material composition, the product may be tested in the form of a more convenient test piece, prepared under the same manufacturing and processing conditions as used for the product.

8.2 Site applied products

8.2.1 General

Test samples shall be prepared by a test laboratory, or under the supervision of a laboratory by the manufacturer or contractor, in accordance with the manufacturer's written instructions. Deviation from these instructions shall only occur with the prior agreement of the test laboratory and manufacturer or contractor.

The test laboratory shall keep a detailed written record of sample production and curing conditions.

If specialized equipment is required for site application of a material, the test samples shall be prepared by a competent contractor under realistic site conditions, e.g. onto wet surfaces.

Start the test procedure as soon as the curing period specified by the manufacturer is completed.

8.2.2 Samples and test pieces of site applied products

8.2.2.1 Preparation

The term site applied materials covers coatings, linings, paints, composite products and sealants.

8.2.2.2 Specific requirements

8.2.2.2.1 Site applied coatings, paints and their primers

Test pieces shall be prepared by coating plates.

8.2.2.2.2 Linings

For self-adhesive linings, apply the samples to the test panel(s) of the substrate for which it is intended.

For non-adhesive linings, test a sheet prepared in accordance with the manufacturer's instructions.

8.2.2.2.3 Composite products

Test pieces shall be prepared such that only the surface intended to come into contact with drinking water is exposed to the test water.

NOTE If it is necessary to seal cut the edges of test pieces, it is better to use a sealant that is inert under the specified test conditions.

8.2.2.2.4 Sealants

Apply the product to test plates of the substrate for which it is intended.

8.3 Surface-area-to-volume ratio (*S/V*)

The surface-area-to-volume ratio, *S*/*V*, shall be expressed per decimetre, i.e. dm^{-1}, which is dm^2/dm^3 or dm^2/l:

where:

S is the surface area of the test piece in contact with the test water, in square decimetres;

V is the volume of test water in contact with the test piece, in litres.

The surface area to volume ratio for pipes is determined by the pipe diameter. For other products Tables 1 and 2 give suitable values for the initial tests.

Table 1 — Factory made products

Item	Surface Area/Volume Test Ratio (dm^2/l)
Storage vessels	2,5
Fittings and Ancillaries	1,5
Adhesives, elastomeric seals	0,2

Table 2 — Site applied products

Item	Surface Area/Volume Test Ratio (dm²/l)
Reservoir floors, walls and baffles, paints, linings	2,5
Repair systems, sealants, and water tightness products	1,5
Water stops, resin anchors, adhesives and solvent cements, elastomeric seals	0,2

If the concentration of free chlorine in the test water is reduced to less than 0,4 mg Cl_2/l after (72 ± 2) h of contact with the test material, repeat the test using fresh test pieces with an *S*/*V*-ratio of one half of that previously used.

9 Preparation of test water and apparatus

9.1 Test water

Ensure that the water conforms to 5.2.

9.2 Preparation of apparatus

The vessels and other items necessary for the test shall conform to the requirements of Annex A. If this cannot be achieved then clean the apparatus as described in 9.3.

9.3 Cleaning of the glassware

9.3.1 Clean the glassware to be used, using detergent (see 5.4). Rinse the glassware with rinsing water (see 5.3) and then clean the inner surface (see 9.3.2).

9.3.2 Clean the inner surface of the glassware with hydrochloric acid (see 5.4) and rinse with rinsing water (see 5.3).

9.3.3 If further cleaning of the inner surface is necessary, repeat the cleaning using hydrogen peroxide (see 5.4) followed by rinsing with rinsing water (see 5.3).

9.4 Cleaning of stainless steel

Perform cleaning as described in 9.3.1 and 9.3.2, using nitric acid (see 5.4) in place of hydrochloric acid.

10 Test procedure

10.1 General

Perform the procedure in the following sequence: flushing, stagnation, pre-washing, exposure to the test water and finally calculation of the chlorine depletion of the blank water and of the contact water to determine chlorine demand.

The test temperatures shall be (23 ± 2) °C**.**

10.2 Flushing

10.2.1 For products that can be flushed such as pipes flush the test piece with flushing water (see 3.6) for (60 ± 10) min.

10.2.2 Place test pieces which cannot be flushed like pipes in an appropriate vessel (e.g. a bucket) having a water through flow from the bottom upwards for (60 ± 10) min.

NOTE For practical reasons, an alternative arrangement described in Annex B may be used when the flow of water required for large diameter products exceeds the available water supply.

10.3 Stagnation

10.3.1 Fill or immerse the test pieces (from 10.2) using rinsing water (see 5.3) and allow to stand at (23 ± 2) °C for (24 ± 1) h.

10.3.2 After this period discard the water and carry out pre-washing in accordance with 10.4.

10.4 Pre-washing

10.4.1 General

Pre-washing shall be carried out in two stages, flushing (see 10.2) and rinsing (see 10.4.3).

10.4.2 Flushing

Carry out in accordance with 10.2.

10.4.3 Rinsing

Rinse the test piece(s) three times with rinsing water (see 5.3).

10.5 Determination of chlorine demand

10.5.1 General

The procedure establishing the suitability of the apparatus and the test water is described in Annex A.

Carry out the following procedure in duplicate and in parallel.

Prepare a sufficient quantity of test water (see 5.2) and determine free chlorine concentration (*CI*) immediately prior to filling or immersing the test pieces (see 10.5.2).

10.5.2 Contact water

Fill or immerse the test pieces without headspace using test water and allow them to stand in the absence of light for (72 ± 2) h at (23 ± 2) °C. At the end of this period, collect the contact waters (see 3.4) and immediately measure the free chlorine concentration (*CT*) (see 10.6).

Take the necessary steps to ensure that there is no significant loss of free chlorine during the filling of test pipes or test vessels.

Repeat 10.5.1 and 10.5.2 two more times with the same test pieces.

10.5.3 Blank waters

Carry out duplicate blank tests at the same time as 10.5.2. Determine the free chlorine concentration (*CB*) of the blank waters (see 3.5) immediately after each test period (see 10.6).

10.6 Determination of free chlorine

Determination of free chlorine shall be carried out in accordance with EN ISO 7393-2.

11 Expression of results

11.1 Description of the calculation

For each of the three contact periods, the following values are recorded:

— *CI*: initial free chlorine concentration of the test water in mg/l;

— CT_A: free chlorine concentration in mg/l (test sample duplicate A);

— CT_B: free chlorine concentration in mg/l (test sample duplicate B);

— CB_A: free chlorine concentration in mg/l (blank duplicate A);

— CB_B: free chlorine concentration in mg/l (blank duplicate B).

Calculate the following average values *CT* and *CB* for each contact period.

Calculate the free-chlorine depletion *Cd* from (*CB* – *CT*) for each contact period.

Calculate the free-chlorine demand *CD*, for each contact period, using the following formula:

$$CD = \frac{Cd \times V}{S \times 3} \quad (1)$$

Where

Cd is expressed in mg Cl_2;

S is the surface area of the test piece in contact with the test water, in square decimetres;

V is the volume of test water in contact with the test piece, in litres;

CD is expressed in mg Cl_2/dm² x day.

Record the chlorine demand (*CD*) for each of the 3 contact periods [CD_1, CD_2, CD_3].

11.2 Validation of the test results

11.2.1 General

If any of the following conditions are not met the test is invalid. Any repeat testing shall be undertaken using fresh samples.

11.2.2 Validation of duplicate samples

The difference between the duplicate test results from the third 72 h test period shall not exceed 0,2 mg Cl_2/l.

11.2.3 Validation of blank tests

For the average of the blanks and for each contact period (10.5.1) the decrease of free chlorine shall not exceed 0,1 mg Cl_2/l when calculated using the following formula :

$$CI - \frac{(CB_A + CB_B)}{2} \leq 0{,}1 \text{ mg } Cl_2 / l \quad (2)$$

11.2.4 Validation of test samples

If the concentration of free chlorine of the contact waters (*CT*) after any of the third 72 h test periods is less than 0,4 mg Cl_2/l, the test shall be repeated using a reduced surface area to volume test ratio (see 8.3).

12 Test report

The dated test report shall include the following information.

a) Information on the product

The information on the product shall at least include:

— trade name of manufactured product;

— complete identification and date of receipt;

— details of the test piece preparation.

b) Information on the procedure

The information on the procedure shall include:

— levels of free-chlorine concentration in tap water; if > 0,2 mg/l corrective measures should be taken.;

— reference to this standard and to the referring standard or national regulation, if applicable;

— number of test pieces used together in a test, if applicable;

— volume of the test liquid (*V*) in litres;

— surface area of the test piece exposed to the test liquid (*S*) in square decimetres calculated from the actual dimensions of the test pieces;

— actual *S*/*V* ratio;

— any deviation from the test procedure specified in this standard;

— any factors which may have affected the results, such as any incidents or any operating details not specified in this standard;

— dates of start and completion of the test.

c) Test results

The test results shall include the calculated chlorine demand data for the three periods (CD_1, CD_2 and CD_3 - see 11.1).

Annex A
(normative)

Procedure for establishing the suitability of apparatus and test water

The apparatus used for testing shall conform with the requirement that free-chlorine depletion shall not exceed 0,1 mg/l for each contact period. If new glassware or related items are introduced then this requirement shall be satisfied by pre-testing (blank test procedure).

After the test procedure has been undertaken for the first time it is recommended that the test vessels are kept permanently filled with test water between tests to avoid deterioration of the surface with regard to the chlorine depletion.

After the third test exposure, the vessel shall be refilled completely with test water and stored under test conditions (room temperature, not exposed to light) until the next test starts in the following week (typically Thursday through Tuesday). During these five days, chlorine depletion shall not exceed 0,15 mg Cl_2/l, otherwise the results show the need to clean the vessel.

To obtain the depletion rates of the blanks (see 5.2) and the figures mentioned above for between tests, test water shall conform with 5.2. This shall be verified each time the tests are undertaken.

If the tests are not carried out continuously, or if the test vessels are not kept continuously filled with chlorinated water, each test shall be preceded by a controlled filling and evaluation of the actual chlorine depletion of the test vessels as described above.

Annex B
(informative)
Arrangement for flushing large diameters pipes

An alternative arrangement for flushing large diameter pipes is shown in Figures B.1 and B.2.

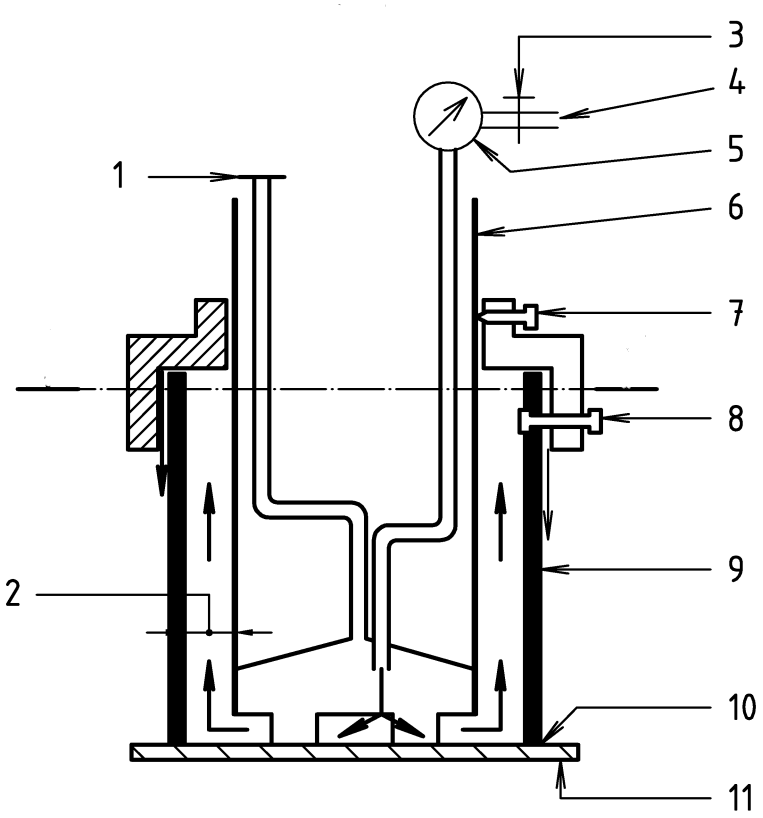
This arrangement is designed to produce the required flow rate over the surface of the test piece while using the minimum quantity of water.

The device is a cylinder made of inert material (see 6.1) with a diameter less than that of the internal diameter of the test piece.

It is essential for the diameter of the cylinder be at least 10 mm less than that of the internal diameter of the test piece. This will leave a gap of at least 5 mm between the wall of the cylinder and the test piece. If the gap is any smaller than this, there will possibly be too much resistance to the waterflow.

The wash water is delivered from a mains tap via a valve and flow meter through a pipe to a space at the bottom of the cylinder. The cylinder is supported on the base plate by three or four short legs. The space into which the pipe delivers the water should allow for equal flow of wash water over the whole inside of the test piece. The space has an air vent which is opened at the start of the washing period in order to let out the air which would otherwise be trapped in the distribution space. Most of the volume of the cylinder is empty space which can be filled with e.g. water or sand in order to stabilize the setup.

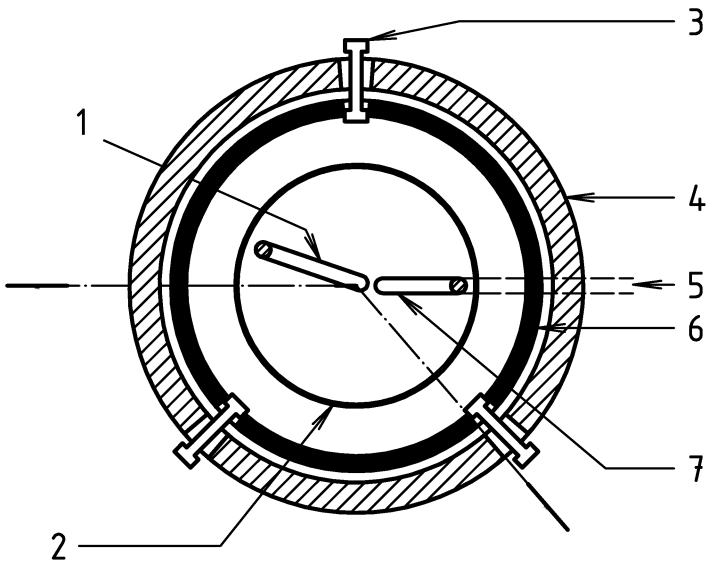
Towards the top of the cylinder there is an adjustable ring with three or four screws to adjust the height of the ring for different lengths of test pieces. There are also three or four screws which can be tightened into the outside of the test pieces in order to ensure that the cylinder is centred within the test piece, thus ensuring equal flows of wash water over the whole inside surface of the test piece. The position of the ring is adjusted to allow a free flow of water over the top edge of the test piece. A vertical gap of about 10 mm should be sufficient.



Key

1	air vent	5	flow meter	9	test piece
2	gap > 5 mm	6	plug	10	seal
3	valve	7	height adjusting screw	11	base plate
4	wash water	8	centering screw		

Figure B.1 - Example of an arrangement for flushing large diameter pipes, side view



Key

1	air vent	5	wash water
2	main cylinder	6	test piece
3	centering screw	7	water inlet
4	adjustable ring		

Figure B.2 - Example of an arrangement for flushing large diameter pipes, top view

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