INTERNATIONAL STANDARD

ISO 7772-1

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Assessment of industrial laundry machinery by its effect on textiles —

Part 1:
Washing machines

Évaluation des machines à laver industrielles par leurs effets sur les textiles

Partie 1: Machines à laver rotatives

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 7772-1 was prepared jointly by Technical Committees ISO/TC 38, *Textiles*, and ISO/TC 72, *Textile machinery and machinery for dry-cleaning and industrial laundering.*

ISO 7772 consists of the following parts, under the general title *Assessment of industrial laundry machinery by its effect on textiles*:

— *Part 1: Washing machines*

— *Part 2: Extracting machines*

— *Part 3: Flatwork-ironing machines*

— *Part 4: Batch-drying tumblers*

Annexes A to D form an integral part of this part of ISO 7772, annex E is for information only.

Introduction

The rapid technical development of laundry machinery and the changes in the pattern of purchasing have led to an urgent need for a standard means of assessment of the effect of machine performance on textiles.

Two different approaches to the provision of the necessary information were considered:

a) definition of essential specifications for laundry machinery, for use by agreement between manufacturer and customer (see for example ISO 9398);

b) preparation of standard methods for rating and assessing the effect of the principal types of machine so that the test results obtained on machines of a similar type could be compared directly wherever the machines were located and whenever they were tested.

ISO 7772 deals with the second approach, since the urgent need was for procedures that could be used on a range of machines to evaluate their effect under reproducible conditions, including specification of the loads to be used.

Thus it will be possible to compare the basic effects of one machine against another, and a machine against a specification quoted in a contract. No performance level is set. Another advantage in the approach adopted is that the tests can be conducted at any location where the necessary services are available.

It is hoped that, with the advance of techniques, and widespread use of ISO 7772, updated methods can be incorporated.

Assessment of industrial laundry machinery by its effect on textiles —

Part 1:
Washing machines

1 Scope

This part of ISO 7772 specifies methods for the assessment of the effect on textiles of washing machines, including batch-washing machines, continuous-washing machines and washer-extractors.

Methods are described for determining mechanical effects due to the rotary action of the machine, the rinsing effectiveness, the mixing time and the consumption of water, heat and power. Certain other effects such as retention of whiteness may be evaluated using the methods specified in ISO 4312.

In the case of batch-washing machines, this part of ISO 7772 applies only to machines with a capacity in excess of 7 kg.

The methods described in this part of ISO 7772 can be used separately, and therefore any combination of them can be agreed on between the interested parties.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 7772. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 7772 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2267:1986, *Surface active agents — Evaluation of certain effects of laundering — Methods of preparation and use of unsoiled cotton control cloth.*

ISO 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

ISO 3801:1977, *Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area.*

ISO 6330:—[1)], *Textiles — Domestic washing and drying procedures for textile testing.*

ISO 7772-2:1996, *Assessment of industrial laundry machinery by its effect on textiles — Part 2: Extracting machines.*

IEC 60258:1968; 60258 am1:1976, *Direct acting recording electrical measuring instruments and their accessories.*

1) To be published. (Revision of ISO 6330:1984)

3 Definitions

For the purposes of this part of ISO 7772, the following definitions apply.

3.1
air-dry mass (ADM)
the total mass of clean textile articles, including the mass of the moisture absorbed from the ambient atmosphere (see also 3.4)

3.2
alkalinity
the concentration of alkali in a liquor

3.3
batch-washing machine
a washing machine that, in a washing sequence, discontinuously washes and rinses textile articles

3.4
bone-dry mass (BDM) (moisture content between 0,5 % and 1,0 %)
the mass of a textile article (or of a number of articles) after being dried in a specified manner, when successive determinations of mass after several drying procedures show no progressive change in mass of the textile greater than 0,5 %

NOTE — Specified drying procedures include repeated processing of the article or articles in a heated tumbler from which the exhaust air reaches a temperature of not less than 80 °C nor more than 120 °C, or repeatedly passing the article or articles through a flatwork ironing machine. These temperatures are appropriate to cotton fabrics which constitute the test loads and test pieces specified in this part of ISO 7772.

3.5
cage
that part of a washing machine which rotates and contains the load during the washing and rinsing processes

3.6
carrier
cotton fabric, complying with ISO 2267, cut into squares measuring 1 000 mm × 1 000 mm in which "windows" are cut for attachment of MA test pieces (see 3.18), to ensure proper movement during washing and for ease of identification after processing

3.7
compartment
a subdivision of a cage

3.8
continuous-washing machine
a washing machine in which textile articles pass continuously or intermittently from the loading point, through the machine, to the discharge point

3.9
dwell time
the time for which the cage is stationary during reversals in the direction of rotation

3.10
extraction
the mechanical removal of liquor from wet textiles

3.11
final extraction
in a washer-extractor, the final stage of a process during which the cage rotates at its highest speed in order to achieve low moisture retention within the load

3.12
gross cage volume
the theoretical volume within the major internal dimensions of the cage

3.13
hydro-extractor
a machine in which water is removed from wet textile articles by mechanical means

3.14
intermediate extraction
in a washer-extractor, the extraction between process stages

3.15
lifter
a step or ledge on the internal periphery of the cage, usually parallel to the cage axis

3.16
load
the textile articles with which a washing machine is loaded

3.17
loading factor
the air-dry mass of the load, expressed in kilograms per litre of net cage volume

3.18
MA test piece:
a cotton fabric of specified construction and dimensions, in which five circular holes of specified diameter and location are cut

3.19
MA figure
the number of unbroken loosened threads in the hole of the MA test piece after processing, giving an indication of the degree of mechanical agitation during processing

3.20
net cage volume
the gross cage volume less the total of the volumes occupied by lifters, recessed loading doors and the like

3.21
outer cylinder
the part of a washing machine that encloses the cage and the liquor

3.22
process time
the net total time taken for washing and associated rinsing in the agreed process

3.23
recovered water
effluent from a washing machine which is made available for re-use

3.24
reference washing machine
a washing machine of specified characteristics in which a reference washing process is carried out

3.25
laundry regain
the difference between air-dry mass and bone-dry mass, expressed as a percentage of bone-dry mass

NOTE — This term is used for practical purposes for industrial laundry machinery, but does not have the same meaning as “moisture regain” (see ISO 6348).

3.26
rinsing
the freeing of textile articles from wash products by dilution with water

3.27
running dip
the mean depth of liquor in the cage during any specific stage of a washing process, measured vertically through the cage axis and expressed as a percentage of the cage diameter

3.28
sheets
plain-weave white cotton sheets of mass per unit area 175 g/m^2 ± 10 g/m^2 (determined in accordance with ISO 3801)

3.29
standing dip
the depth of liquor in the cage, measured vertically through the cage axis when the cage is stationary and without load

3.30
steady state
in a continuous-washing machine, the state in which the rate of flow of textile articles, the temperature, the chemical conditions and the rates of flow of the appropriate services are stabilized to the conditions required for the specific tests to be carried out

3.31
transit time
the time that elapses in a continuous-washing machine between a textile article entering and leaving the cage

3.32
washer-extractor
a batch-washing machine in which liquors are centrifugally extracted from the textile articles

3.33
washing
the freeing of textile articles from dirt in an aqueous medium with the assistance of washing materials, heat and mechanical energy

4 Preliminary procedures

4.1 Machine identification

The data required for the identification of the test machine and of any other ancillary equipment directly associated with and necessary for the operation of the test machine shall be recorded as given in annex A. The reference numbers of any diagrams, drawings or photographs necessary to supplement these data shall also be recorded.

4.2 Availability of test loads and other materials

Sheets and all other materials required for a particular method shall be assembled in sufficient quantities to ensure that the complete test can be carried out without interruption.

4.3 Machine installation and test conditions

4.3.1 The manufacturer of the machine to be tested shall provide, wherever practicable, a complete statement of requirements in respect of the installation conditions of the machine and of the running conditions required. Wherever practicable, each requirement shall be expressed as a range of values within which the test procedure is acceptable, rather than as a single specific value.

4.3.2 The manufacturer shall be informed and invited to inspect, check and certify in the test report that the machine and all relevant aspects of its installation and functioning under test conditions are satisfactory.

4.3.3 If the installation and/or running conditions are outside the limits stated by the manufacturer, they shall be agreed to by him or his authorized representative. Failing such guidance or agreement, the installation and/or test conditions shall be acceptable to the party commissioning testing. Where appropriate spaces are not provided in the test report forms, particulars of any differences between the manufacturer's stated limits and the actual conditions as measured or observed during testing shall be clearly set out as an annex and attached to the test report.

4.3.4 The power rating of the electric motor or motors, the function which each motor performs and the manufacturer's stated peak loading and running load in kilovolt amps shall be recorded in a table with the format as given in table 5.

NOTE — See clause 7 for the measurements of the actual conditions of supply of services to the test machine during the tests and for the provision for the recording of such measurements in comparison with the figures recommended by the manufacturer.

4.3.5 The manufacturer's stated or recommended requirements in respect of electric-power supply, water, steam or heat-transfer fluid and any other external services (e.g. compressed air) shall be obtained and recorded as given in table 6.

NOTE — See clause 7 for the measurements of the actual conditions of supply of services to the test machine during the tests and for the provision for the recording of such measurements in comparison with the figures recommended by the manufacturer.

4.4 Tolerances

Tolerances are given for numerical values of dimensions, temperatures and times that are considered critical. If no tolerance is given, the precision of the measurements need be only that to be expected when using common instruments and reasonable care. The precision is further indicated by the number of significant figures in the values given.

5 Relationship between liquor quantity and dip level for open-drum washing machines

5.1 Principle

The quantity of liquor required to produce specified running-dip levels at different loading factors is determined by adding water through a meter and observing the water level through a sight glass.

5.2 Apparatus and materials

5.2.1 Indicating sight glass, fitted to the washing machine (see figure 1).

5.2.2 Water meter.

5.2.3 Cotton test sheets, which have been laundered previously, in sufficient number to load the machine to the recommended loading factors of 0,100 kg/l, 0,083 kg/l and 0,067 kg/l to within an accuracy of ± 5 %.

5.3 Procedure

5.3.1 Add water at 15 °C ± 10 °C through the meter to the machine, with the cage stationary, until the water is level with the bottom of the cage.

5.3.2 Mark the sight glass, denoting this level as zero, and make two further marks to represent 10 % and 33 % of machine cage diameter.

5.3.3 Record the quantity of water, in litres, added to reach the zero level (V_0).

5.3.4 Prepare a test load such that its air-dry mass corresponds to the recommended loading factor of 0,100 kg/l. Add this test load to the machine.

5.3.5 Allow the machine cage to rotate. This will cause the water level in the sight glass to fluctuate. Add water slowly until the maximum height in the indicating sight glass above the zero mark ($h_{10,max}$) corresponds to 10 % of the machine cage diameter.

Allow the cage to continue rotating for 5 min, adding further water, if necessary, to maintain the maximum height of the water level. Record the minimum height of the water during this time ($h_{10,min}$).

5.3.6 Calculate the midpoint between the maximum and minimum heights as

$$\frac{h_{10,max} - h_{10,min}}{2}$$

5.3.7 For the mark at 10 % level to represent the mean water level h_{10}, add water slowly whilst the cage is rotating until the maximum level in the sight glass corresponds to

$$h_{10,max} + \frac{h_{10,max} - h_{10,min}}{2}$$

Record the quantity of water added (V_{10}).

5.3.8 Add further water slowly, with the cage rotating, until the maximum height in the sight glass above the zero mark ($h_{33,max}$) corresponds to 33 % of the machine cage diameter. Allow the cage to continue rotating for 2 min, adding further water, if necessary, to maintain the maximum height of the water level. Record the minimum height of the water ($h_{33,min}$).

5.3.9 Calculate the midpoint between the maximum and minimum heights as

$$\frac{h_{33,max} - h_{33,min}}{2}$$

5.3.10 For the mark at 33 % level to represent the mean water level (h_{33}), add water slowly, whilst the cage is rotating, until the maximum level in the sight glass corresponds to

$$h_{33,max} + \frac{h_{33,max} - h_{33,min}}{2}$$

Record the quantity of water added (V_{33}).

NOTE — V_{33} is the total quantity of water added in 5.3.8, 5.3.9 and 5.3.10.

5.3.11 Repeat 5.3.4 to 5.3.10, using test loads with air-dry masses corresponding to the other two recommended loading factors of 0,083 kg/l and 0,067 kg/l (see 5.2.3).

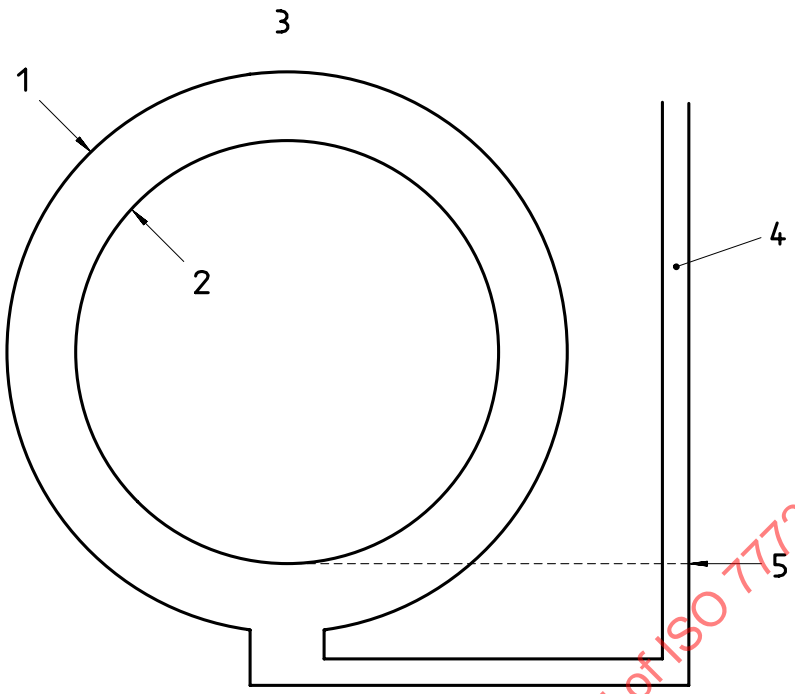
5.4 Expression of results

From 5.3.3 to 5.3.7:

Quantity of water required to 10 % dip level = $V_0 + V_{10}$

From 5.3.3, 5.3.7 and 5.3.10:

Quantity of water required to 33 % dip level = $V_0 + V_{10} + V_{33}$



Key

1 Outer cylinder
2 Inner cage
3 Washing machine
4 Sight glass
5 Zero level

Figure 1 — Indicating sight glass

6 Mechanical agitation (MA)

6.1 Principle

Prepared MA test pieces are subjected to agitation in the washing machine for a fixed time period under specified conditions. Evaluation of the number of unbroken threads which are loosened from previously cut areas of the test pieces gives an indication of the degree of agitation.

6.2 Apparatus and materials

6.2.1 Test pieces, 96 for batch machines or 24 for continuous machines, prepared as described in annex C.

6.2.2 Carriers, 96 for batch machines or 24 for continuous machines, prepared as described in annex C.

6.2.3 Weighing machine, accurate to ± 1 %, for determining the mass of the load.

6.2.4 Stopwatch, or other means of measuring time, accurate to 1 s or better.

6.2.5 Test loads of used cotton sheets.

6.3 Test procedure

6.3.1 Batch machines

6.3.1.1 Prepare eight carriers, each with one MA test piece attached, for inclusion in each load after the wetting-out stage (see 6.3.1.3).

6.3.1.2 Prepare a test load such that its air-dry mass, together with that of the carriers and test pieces, corresponds to the loading factor of 0,100 kg/l.

6.3.1.3 Load the machine with the test load only. Wet out the load by adding a suitable quantity of water at a temperature of 15 °C ± 10 °C and running the machine for 5 min.

6.3.1.4 Introduce the carriers and test pieces and rapidly adjust the water level to a running dip equivalent to 33 % of the machine cage diameter.

6.3.1.5 Allow the cage to rotate for 20 min, then immediately stop the machine, drain without agitation, spin for 1 min to 5 min and empty the machine. Remove the carriers and test pieces. Detach the test pieces from the carriers and dry the test pieces on a laundry press.

Do not tumble-dry the MA test pieces.

6.3.1.6 Repeat 6.3.1.4 and 6.3.1.5 with the same load, without drying or other treatment, but using new test pieces.

6.3.1.7 Repeat 6.3.1.4 to 6.3.1.6 using a water level equivalent to 10 % of the machine cage diameter.

6.3.1.8 Repeat 6.3.1.2 to 6.3.1.7 using test loads together with carriers and test pieces such that the values of their air-dry mass correspond to loading factors of 0,083 kg/l and 0,067 kg/l.

6.3.2 Continuous-washing machines

6.3.2.1 Include eight carriers, each holding one MA test piece, in a compartmental load and process through the machine three times at 5 min intervals, operating the machine with a normal load of lightly soiled white work and weighing the load carefully to be equivalent to a loading factor recommended by the manufacturer. Record the following data:

a) The compartment dip levels for the prewash, main wash and rinse stages. (All dip level settings shall be checked by the manufacturer to ensure that they are within recommended limits for a medium-soil white-cotton process.)

b) The quantity of fresh water fed to the machine, measured using a fitted water meter or the manufacturer's flow-measuring device, if fitted. (The total quantity of fresh water supplied to the machine shall be between 8 litres and 12 litres per kilogram of load processed.)

c) The maximum temperature, measured by taking water samples from the appropriate compartment.

d) The machine transit time. (Carry out the tests with the transit time set at 30 min ± 1 min.)

e) The loading factor used.

6.3.2.2 Remove the carriers and test pieces immediately before the final hydro-extraction stage and dry on a normal laundry press.

6.4 Measurement of MA figure

Examine each test piece on each side and count all the unbroken loose threads, including those that are merely connected by a single fibre and those that are just slightly loosened (to qualify as loose, a thread shall be free by more than 2 mm).

6.5 Calculation and expression of results

6.5.1 Calculate the MA figure for each test piece as described in annex C, and record in table 1 for batch machines and table 3 for continuous-washing machines.

6.5.2 Calculate the mean value and the standard-deviation value of the corresponding MA figures at 33 % dip and 10 % dip for each test and record in the appropriate section of table 2.

Calculate the standard deviation s using the following equation:

$$s = \sqrt{\frac{\sum_{i=1}^{i=8} \left(MA_i - \overline{MA}\right)^2}{8-1}}$$

where

$\overline{MA}$ is the mean of the MA figures;

MA_i is the MA figure for the ith measurement (i = 1,2,3..., 8).

NOTE — The equation given above is a special case, for n=8, of the general equation

$$s = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} \left(MA_i - \overline{MA}\right)^2\right]}$$

6.5.3 In order to establish whether the MA value for the machine under test is significantly different from (i.e. better or worse than) that for a reference machine, the significant difference between the two means [of all the MA values for the same percentage dip and loading factor conditions obtained during tests (see 6.5.2 and table 1) at the 0,05 probability level (95 % confidence limit)] is assessed using the t-test as follows:

6.5.3.1 Calculate the standard deviation s of the means for both machines using the equation

$$s = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

where

n_1 and n_2 are the numbers of test pieces in the test machine and reference machine, respectively;

s_1 and s_2 are the standard deviations of the MA figures for the test machine and reference machine, respectively.

6.5.3.2 Calculate t using the equation

$$t = \frac{|x_1 - x_2|}{s\left(\frac{1}{n_1} + \frac{1}{n_2}\right)^{0,5}}$$

where

x_1 is the mean MA figure for the test machine;

x_2 is the mean MA figure for the reference machine;

$|x_1 - x_2|$ is the absolute difference between the mean MA figures for the test machine and the reference machine.

6.5.6 Consult ISO 2602:1980, table 1, and obtain the tabulated value of t for $n_1 + n_2 - 2$ degrees of freedom at the 0,05 probability level.

6.5.7 If the calculated value of t is less than the tabulated value of t, then it can be considered that there is no significant difference between the mechanical agitation of the machines.

6.5.8 If the calculated value of t is greater than the tabulated value, then it can be considered that the mechanical agitation of the test machine is greater or less (depending on the MA figure) than that of the reference machine.

6.6 Test report

The results shall be recorded in tables with the formats shown in tables 1 and 3. The means and standard deviations shall be recorded in a table with the format shown in table 2.

If a continuous-washing machine was used, include in the test report the washing conditions recorded in 6.3.2.1.

Table 1 — Record of results for batch machines

Load factor kg/l	Test piece	MA figure	
		33 % dip	10 % dip
0,100	**Test 1:** MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	Test 2: MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
0,083	**Test 1:** MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	Test 2: MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
0,067	**Test 1:** MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	Test 2: MA test piece 1		
	2		
	3		
	4		
	5		
	6		
	7		
	8		

Table 2 — Calculated mean values and standard-deviation values

Load factor kg/l	Test piece	33 % dip	10 % dip
0,100	**Test 1:** mean standard deviation		
	Test 2: mean standard deviation		
0,083	**Test 1:** mean standard deviation		
	Test 2: mean standard deviation		
0,067	**Test 1:** mean standard deviation		
	Test 2: mean standard deviation		

Table 3 — Record of results for continuous-washing machines

Test piece		MA figure
Test 1:		
MA test piece	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
Test 2:		
MA test piece	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
Test 3:		
MA test piece	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	

7 Rinsing effectiveness

7.1 Principle

The alkalinity of the water remaining in textile articles after the last rinse of a washing process is compared with the alkalinity of the liquor in the last wash in the same process and compared to the fresh-water supply.

NOTE — This is a theoretical test of the rinsing effectiveness of a machine, since it does not take into account souring or other chemical treatments.

7.2 Apparatus

7.2.1 Three sampling vessels, each of 500 ml capacity.

7.2.2 Apparatus and reagents as described in annex C.

7.3 Test washing processes and test loads

7.3.1 Load the machine with sufficient cotton test sheets to achieve a loading factor of 0,1 kg/l.

Using only cold fresh water to supply the machine, carry out the following wash process:

	Dip level (% cage diameter)	**Temperature** °C	**Time** min
Wash 1	10	40	5
Wash 2	10	71	5
Interspin	—	—	2
Rinse 1	33	cold	5
Rinse 2	33	cold	5
Extract	—	—	8

NOTE — These conditions have been shown to provide adequate thermal disinfection during normal laundry processing. The test conditions may need to be modified to satisfy local conditions.

7.3.2 Used sheets shall be used for all test loads. Sheets which have never been laundered shall not be used.

7.3.3 Any sheets received for processing in an obviously damp condition shall not be used for test purposes.

7.3.4 The air-dry mass on which the loading of the test machine is based shall be that of used sheets having a moisture content of between 4 % and 8 % based on the bone-dry mass. If the sheets available for test loads have a moisture content measured as described in annex D of ISO 7772-2:1996 which is not within these limits, the mass used for testing shall be that of the equivalent test load as defined in annex D of ISO 7772-2:1996.

7.4 Procedure

Set up the machine to work on a normal sequence for processing white cotton sheets (see 7.3.1).

7.4.1 Continuous-washing machines

7.4.1.1 Feed the machine with used sheets for 60 min, at the rate agreed upon by the parties concerned, using the facilities normally employed.

Use used sheets, or a category of load requiring a similar process, at a loading factor of 0,020 kg/l.

Operate the machine at a steady state prior to the start of the test and for the duration of the test, using the conditions given in 7.4.1.2 to 7.4.1.5.

In the case of intermittently loaded machines, the timed period shall be that which most closely approximates to 60 min and which includes a whole number of loading sequences.

7.4.1.2 Set the transit time of the machine to 30 min ± 1 min.

7.4.1.3 Set the dip levels to those recommended by the manufacturer for a medium-soil cotton sheet process.

7.4.1.4 Ensure that the temperature settings are such that a minimum temperature of 71 °C is maintained in the wash section for at least 3 min (excluding mixing time).

7.4.1.5 Set the fresh-water flow to rinse at 8 l ± 1 l per kilogram of load.

7.4.1.6 Repeat 7.4.1.1, using the same conditions but load factors of 0,025 kg/l and 0,030 kg/l.

7.4.2 Machines other than continuous-washing machines.

7.4.2.1 Carry out the test washing process described in 7.3 at the lowest loading factor specified in 5.2.3.

7.4.2.2 Start the machine and time the washing process from the moment that the loaded machine is started until the process is complete and the machine ready for unloading.

7.4.2.3 Unload the machine using the unloading facilities normally employed.

7.4.2.4 Repeat the procedure described in 7.4.2.1 to 7.4.2.3 using the other two loading factors specified in 5.2.3.

7.4.3 Procedure for collecting samples of water

7.4.3.1 Take a 500 ml sample of the water supplied to the machine for rinsing.

7.4.3.2 For continuous-washing machines, take a 500 ml liquor sample from the last wash compartment prior to the rinsing sections of the machine. For those machines from which liquor samples can be taken whilst the machine is in operation, take the sample across a period equivalent to the cycle time of the machine. Start sampling half-way through one cycle and continue to half-way through the succeeding cycle, taking the sample from the liquor of the last wash while the machine is draining after the last wash of the test process at about the middle of the drain period.

7.4.3.3 Take a 500 ml sample of the water remaining in the sheets after completion of the last rinse of the test process. Take the sample, according to the type of washing machine being tested, as described in 7.4.3.3.1 to 7.4.3.3.3.

7.4.3.3.1 With batch-washing machines, transfer the rinsed sheets from the washing machine to a hydro-extractor. If the hydro-extractor is of the centrifugal type, collect the effluent sample approximately 2 min after the machine has attained full speed. If the hydro-extractor is of the batch-compression type, collect the sample 1 min after the pressure in the container reaches its maximum.

7.4.3.3.2 With washer-extractors, collect the sample at the drain outlet 2 min after the machine has reached final extract speed.

7.4.3.3.3 With continuous-washing machines, where the means of water removal is an integral part of the function of the machine and takes the form of centrifugal or batch-compression extraction, take effluent samples as described in 7.4.3.3.1.

7.4.3.4 Determine the alkalinity of the samples obtained as specified in 7.4.3.1 to 7.4.3.3 in accordance with the method given in annex D.

7.4.3.5 Carry out procedures 7.4.3.1 to 7.4.3.4 in duplicate for each of the loading factors under test and record the alkalinities determined.

7.5 Calculation and expression of results

7.5.1 Calculate the mean alkalinities of the following:

a) the water supplied for rinsing;

b) the liquors of the last washes;

c) the water remaining in the sheets after the last rinse.

7.5.2 Evaluate M_w and M_d using the following equations:

$$M_w = M_2 - M_0$$

$$M_d = M_1 - M_0$$

where

M_w is the net value of the alkalinity of the liquor of the last wash, expressed in milligrams of Na_2CO_3 per litre;

M_d is the net value of the alkalinity of the water remaining in the sheets after the last rinse, expressed in milligrams of Na_2CO_3 per litre;

M_0 is the alkalinity of the water supplied to the machine for rinsing, expressed in milligrams of Na_2CO_3 per litre;

M_1 is the alkalinity of the effluent extracted from the rinsed sheets, expressed in milligrams of Na_2CO_3 per litre;

M_2 is the alkalinity of the liquor of the last wash, expressed in milligrams Na_2CO_3 per litre;

7.5.3 Express M_d as a percentage of M_w.

7.6 Test report

Report the value of M_d as calculated in 7.5.2, and the percentage value derived from 7.5.3, for each of the three load factors employed.

8 Mixing time

8.1 General

This method determines the time lapse that occurs, after introduction of washing materials into a washing machine, before the optimum chemical conditions for the washing process are achieved by the uniform distribution of these materials throughout the fibres of the load and the water in which the load is immersed. The method is applicable to batch-washing machines only.

8.2 Principle

A quantity of reagent solution is introduced into a test machine which already contains a quantity of textiles in water. The changes in concentration of this chemical as it mixes with the water within the machine are measured with respect to time. From these measurements, the time taken to attain a specific degree of distribution of the chemical (i.e. the "mixing time") is determined.

8.3 Apparatus and reagents

8.3.1 Glass flasks (26) or **beakers** (26), each of 100 ml capacity.

8.3.2 Stopwatch.

8.3.3 Means of measuring water quantities added to the machine.

8.3.4 Receptacle, for preparing solutions.

8.3.5 Means for weighing the load.

8.3.6 Sodium carbonate, anhydrous.

8.3.7 Sheets (3.28).

8.3.8 Additional apparatus and reagents, as described in annex D.

8.4 Provision for sampling liquors

The washing machine shall be fitted with a small drain cock in a position from which representative samples of the free liquor within the machine can be drawn. Where continuous flow from the cock during a 20 min sampling period results in not more than 2,5 % of the total liquor being drawn off, it is satisfactory to take samples from such a continuous flow. Otherwise, samples shall be drawn off intermittently, taking care to discharge liquor in any dead leg leading to the cock before the sample is taken.

8.5 Procedure

8.5.1 Load the machine with sheets (3.28) to one of the loading factors given in 5.2.3, as agreed between the parties concerned, and start the machine.

8.5.2 Introduce into the machine sufficient cold water to give the manufacturer's recommended running dip for washing, and measure the quantity of this water in litres.

8.5.3 Run the machine for at least 12 min after all the water has been added in order to ensure thorough saturation of the load, and then stop the machine. If, during this period, the water level falls below that recommended as the washing running dip, add further quantities of water as necessary to achieve this dip. The quantities of any water so added shall be measured, in litres, and added to that measured as described in 8.5.2.

8.5.4 Take a 100 ml sample of the water in the machine from the drain cock, as described in 8.4.

8.5.5 Prepare a solution of sodium carbonate by weighing out 1,5 kg of anhydrous sodium carbonate (8.3.6) and dissolving in 14 l of water. Introduce into the machine 1,4 l of this solution per 10 kg of load.

8.5.6 Immediately after introducing the sodium carbonate solution, re-start the machine and take 100 ml samples of the liquor in the machine from the drain cock, as described in 8.4, at 0,5 min intervals up to the tenth minute and thereafter at 2 min intervals up to the twentieth minute. Identify each sample with the time at which it is taken.

8.5.7 Determine the alkalinities of the samples taken in 8.5.4 and 8.5.6 by the method described in annex D. Record these alkalinities in milligrams per litre.

8.5.8 Carry out the processes described in 8.5.1 to 8.5.7 three times, using a different load of clean sheets on each occasion.

8.6 Calculation and expression of results

8.6.1 Calculate the mean of the total quantities of water introduced in each of the three tests (see 8.5.2 and 8.5.3) and calculate the liquor/load ratio, R, expressed in litres per kilogram, using the following equation:

$$R = \frac{V}{m}$$

where

V is the quantity of water, in litres;

m is the mass of the load, in kilograms.

8.6.2 Calculate the net alkalinity of each sample by deducting the alkalinity of the sample obtained as described in 8.5.4 from the alkalinities of each of the remaining samples.

8.6.3 Plot on a graph the net alkalinity of each sample against the time at which it was taken. Draw a smooth curve through or between the plotted points and extend it to intersect the alkalinity axis at zero time (see figure 2).

8.6.4 From the curve, calculate the difference between the alkalinity at zero time and the alkalinity at its constant minimum. Using this difference to represent 100 % mixing, establish the alkalinity which represents 95 % mixing and draw a line on the graph, parallel to the time axis, which corresponds to this value. Record the time corresponding to the point of intersection of this line with the curve as the mixing time of the test machine.

NOTE — Figure 2 illustrates a typical alkalinity/time curve for a mixing-time test and shows the progressive change from maximum alkalinity at zero time to a constant minimum alkalinity where, for all practical purposes, the curve becomes parallel to the time axis, signifying a state of complete mixing. This figure also illustrates the basis for determination of the time taken to achieve 95 % complete mixing.

8.7 Test report

Enter the results for running dip, the total water added, the load factor, the liquor/load ratio (see 8.6.1) and the time taken to achieve 95 % mixing (see 8.6.4) in a table with the format given in table 4.

Table 4 — Mixing time

Test	Running dip cm	Total water added l	Load factor kg/l	Liquor/load ratio l/kg	Mixing time (time to achieve 95 % mixing) min
1 2 3					

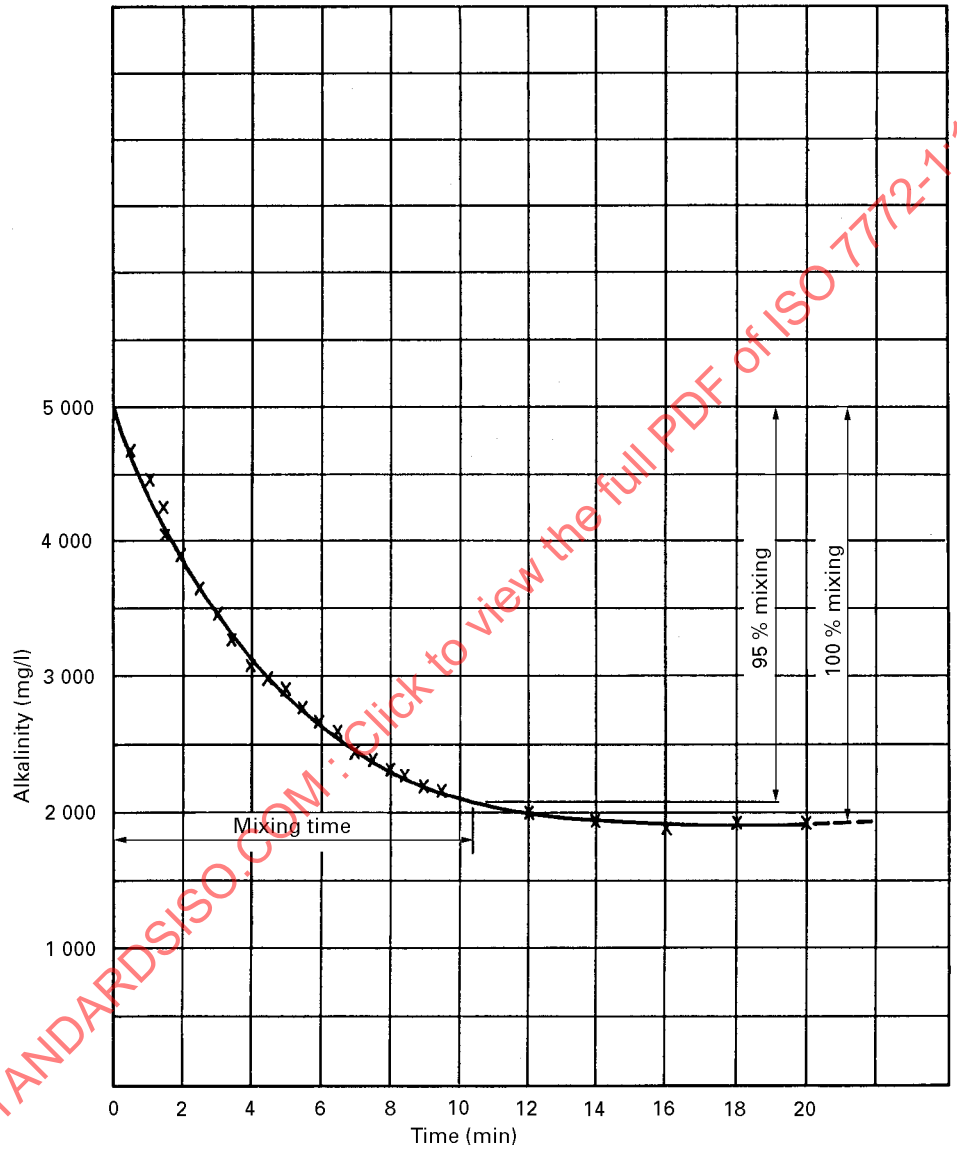


Figure 2 — Example of typical alkalinity/time curve for mixing test

9 Water and energy consumption

9.1 Principle

The quantities of water and energy consumed by a test machine are measured. By relating these measured quantities to the mass of the sheets processed during the test, the consumption of water and energy per 100 kg of bone-dry mass of sheets is calculated. Additionally, certain conditions under which water, heat and power are supplied to the machine during the tests are recorded so that due account may be taken of the effects of differences between the conditions recommended by the manufacturer and those applying to the test.

9.2 Apparatus

9.2.1 For measurements on the water supply

9.2.1.1 Water meter or meters, one for each water supply connected to the machine, capable of measuring to an accuracy of ± 100 litres.

9.2.1.2 Thermometer or thermometers, one for each water supply connected to the machine.

9.2.1.3 Pressure gauge or gauges, one for each water supply connected to the machine.

9.2.2 For measurements on the steam supply

9.2.2.1 Steam meter, having an accuracy of ± 0,5 %.

9.2.2.2 Pressure gauge.

9.2.3 For measurements on the heat-transfer fluid

9.2.3.1 Fluid-flow meter, having an accuracy of ± 0,2 %.

9.2.3.2 Thermometers, one each for the inlet and the outlet temperature.

9.2.4 For measurements on the electrical-power supply

9.2.4.1 Voltmeter, accurate to ± 0,1 %.

9.2.4.2 Ammeter, recording type, with response characteristics in accordance with IEC 60258 and a trace rate of not less than 250 mm/h.

9.2.4.3 Integrating kilowatt-hour meter, accurate to ± 0,1 %, for measuring the electrical-energy consumption.

9.2.4.4 Kilowatt-hour meter.

9.2.5 Other apparatus

9.2.5.1 Stopwatch.

9.3 Procedure

9.3.1 During the test period during which water, heat and power-consumption data are measured, operate the machine under the test conditions specified in clause 7. Carry out tests for water, heat and power consumption using all three loading factors detailed in these test conditions. Include in the final report, details of utilities consumption under each of the loading factors measured.

9.3.2 Before proceeding with any test, observe and record, in the appropriate sections of the test report as given in tables 5 to 11, the manufacturer's recommended conditions applying to the utilities connected to the machine.

9.3.3 Record all integrating-meter readings at the beginning and at the end of each test.

9.3.4 Observe and note at appropriate intervals throughout the test the pressure and/or temperature, where required, of the water and steam supply services and the voltage of the electricity supply. The tester shall be satisfied of the stability of the supply services over the duration of the test. Unreasonable variations shall render the test null and void.

9.3.5 Observe and record the maximum electrical demand, in kilovolt amps per

0,5 h period, over a minimum of five complete cycles for a batch-washing machine or for a period of 1h for a continuous-washing machine.

9.3.6 Obtain data for estimating the rate of flow provided by services supplying water and/or steam to the test machine.

Rates of flow may be estimated from meter readings over a measured time interval. Where the demand for a particular service is over a short period of time, it is permissible to measure rates of flow by this or any other convenient method as a separate procedure, provided that the relevant service conditions are similar to those appertaining to the test period.

9.3.7 For batch machines, carry out the above procedures three times, using the procedure described in 7.4.2.

9.3.8 For continuous-washing machines, make measurements of consumption over the test period, using the procedure described in 7.4.1.

9.4 Calculation and expression of results

9.4.1 Express the consumption of heat, water and power as the quantities required to process 100 kg of load. Calculate the peak load (in kilovolt amps) and the running load (in kilovolt amps) from readings of the voltmeter and the trace obtained from the recording ammeter.

9.4.2 For batch-washing machines and washer-extractors, record the incoming-water temperatures and the final temperature achieved in the main wash. This shall be a minimum of 71 °C, as laid down in the reference process. Calculate the temperature increase $\Delta\theta$, expressed in degrees Celsius, as follows:

$$\Delta\theta = \theta_1 - \theta_0$$

where

θ_0 is the incoming-water temperature, in degrees Celsius;

θ_1 is the final hot wash temperature, in degrees Celsius.

Express the heat consumption as a figure per unit of temperature increase as follows:

$$H_1 = \frac{H_{\Delta\theta}}{\Delta\theta}$$

where

H_1 is the heat requirement per degree Celsius temperature increase, in kilojoules per degree Celsius;

$H_{\Delta\theta}$ is the heat used, in kilojoules, in the reference cycle.

9.4.3 For continuous-washing machines, record the incoming-water temperature and the highest temperature achieved in the wash section. This shall be a minimum of 71 °C, as laid down in the reference process. Calculate the temperature increase as shown in 9.4.2. Measure the heat consumed during the test. Express the rate of heat consumption ΔH, expressed in kilojoules per minute, as follows:

$$\Delta H = \frac{H_t}{t}$$

where

H_t is the heat consumed, in kilojoules, during the test;

t is the length, in minutes, of the test.

Express the heat requirement per unit temperature increase as follows:

$$\Delta H_i = \frac{\Delta H}{\Delta \theta}$$

where

ΔH_i is the rate of heat consumption per degree Celsius temperature increase, expressed in kilojoules per minute degree Celsius [kJ/(min·°C)].

9.5 Test report

Enter the observations made in 9.3 and the results of the calculations made in 9.4 in the appropriate sections of the test report forms shown in tables 5 to 11. Report the loading factor employed.

Table 5 — Electric motors — Power and peak loading (see 9.3.1)

Process stage	Motor power	Peak electric loading as stated by manufacturer	Running load		
			as tested	as stated by manufacturer	as tested
	kW	kVA	kVA	kVA	kVA
Wash					
Drain					
Intermediate extract					
Final extract					

Table 6 — Pressures of water and steam supply services (see 9.3.1)

Type of service	Pressure	
	manufacturer recommended kPa[1)]	as tested kPa[1)]
Cold water		
Hot water		
Recovered water		
Steam		
Washing-material solutions		
NOTE — The water pressures recorded shall be the static pressures at the points of entry into the machine.		
1) 1 kPa = 10^{-2} bar		

Table 7 — Other external services

Type of service	Manufacturer recommended	As tested
NOTE — Details to be entered as appropriate		

Table 8 — Flow rates of services

Type of service	Manufacturer recommended	As tested
Cold water (l/min)		
Hot water (l/min)		
Recovered water (l/min)		
Steam (kg/min)		
Washing-material solutions (l/min)		
Heat-transfer fluid (kg/min)		

Table 9 — Electricity supply

Property	Manufacturer recommended	As tested
Voltage (V)		
Phase		
Frequency (Hz)		

Table 10 — Consumption of water, heat and power

Service	Result obtained
Electrical-current recording Maximum electrical demand: a) power (kVA) b) heat (kVA) Heat transferred: a) rate of flow (kg/h) b) specific heat [kJ/(kg·°C)] c) mean temperature at entry to machine (°C) d) mean temperature at exit from machine (°C)	Append chart to the test report

Table 11 — Consumption of water, heat and power per 100 kg of air-dry load processed

Service	Result obtained	Consumption per 100 kg
Cold water a) volume consumed (litres) b) temperature (°C) Hot water a) volume consumed (litres) b) temperature (°C) Recovered water a) volume (litres) b) temperature (°C) Steam a) amount (kg) b) pressure (kPa) Heat (from heat-transfer fluid) (kJ) Electrical-power consumption a) power (kWh) b) heat (kWh)		

10 Moisture retention

For washer-extractors only, the moisture retention shall be determined by the procedure given in ISO 7772-2.

11 Test report

The test report shall contain at least the following information:

a) reference to this part of ISO 7772, i.e. ISO 7772-1:1998;

b) all details necessary to identify the test machine (see annex A);

c) the quantity of water required to 10 % dip level and 33 % dip level (see 5.4);

d) the results obtained from individual tests (see 6.5, 7.6, 8.7, 9.5 and clause 10).

Annex A
(normative)

Identification of the test machine

The following details of the machine shall be recorded:

a) class of machine;

b) manufacturer's name and address;

c) manufacturer's type and serial number;

d) year of manufacture;

e) material of cage;

f) material of outer cylinder;

g) design of cage (e.g. peripheral or end loading);

h) internal cage diameter, in centimetres;

i) internal cage length, in centimetres;

j) number and arrangement of compartments;

k) number of lifters;

l) dimensions of lifters, in centimetres;

m) type of lifter (e.g. open or closed);

n) net cage volume, in litres;

o) description of controls and instruments.

Annex B
(normative)

Reference machine

The reference machine details are as follows:

inner-cage diameter	1 000 mm ± 20 mm
g-factor	0,75 to 0,85

In the construction of the machine, sheet metal in contact with the washing liquors shall not contain copper or copper alloys.

Any other machine may be used for reference purposes if agreed between the parties concerned.