

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Tumble dryers for household use – Methods for measuring the performance

Sèche-linge à tambour à usage domestique – Méthodes de mesure de l'aptitude à la fonction



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX



ICS 97.060

ISBN 978-2-8322-0936-3

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**TUMBLE DRYERS FOR HOUSEHOLD USE –
METHODS FOR MEASURING THE PERFORMANCE**

FOREWORD

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International Standard IEC 61121 has been prepared by subcommittee 59D: Home laundry appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

This fourth edition cancels and replaces the third edition published in 2002 and Amendment 1 (2005). This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) General:

- more terms have been defined and some previous definitions have been streamlined, in addition to the correction of some symbols and equations;
- where possible, definitions and terms have been used in common with IEC 60456:2010;
- the content has been organised into a more logical and simple structure, and repetitive sections have been removed.

b) Conditions of measurement:

- the wording of various sections has been revised to reduce ambiguity;
- limits have been defined for water characteristics for automatic tumble dryers that are sensitive to conductivity as well as methods to adjust these characteristics where necessary.

c) Reproducibility and repeatability of test results:

- revision of the specification for the cotton **test load** to include suitable test materials which are currently available on the market;
- more careful definition of the process and conditions for **pre-treatment, conditioning and normalization**.

d) Test methods:

- accuracy of measurement has been defined for all instruments;
- limits and interpretations of the allowable **final moisture content** for each type of dryer are now defined;
- practical advice regarding the test procedure has been given with the aim of reducing ambiguity.

Words in **bold** in the text are defined in Clause 3.

This bilingual version (2013-07) corresponds to the monolingual English version, published in 2012-02.

The text of this standard is based on the following documents:

FDIS	Report on voting
59D/393/FDIS	59D/395/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This fourth edition has been developed in light of experience with use of the third edition of IEC 61121. The structure has been revised to ensure that this remains harmonised with the IEC 60456:2010 for clothes washers.

TUMBLE DRYERS FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This International Standard is applicable to household electric **tumble dryers** of the **automatic** and **non-automatic** type, with or without a cold water supply and incorporating a heating device. This excludes **tumble dryers** which use gas or other fuels as a heating source.

The object is to state and define the principal performance characteristics of household electric **tumble dryers** of interest to users and to describe standard methods for measuring these characteristics.

NOTE This International Standard applies also to **tumble dryers** for communal use in blocks of flats or in launderettes. It does not apply to **tumble dryers** for commercial laundries.

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.

IEC 60335-2-11:2008, *Household and similar electrical appliances – Safety – Part 2-11: Particular requirements for tumble dryers*

IEC 60456:2010, *Clothes washing machines for household use – Methods for measuring the performance*

IEC 60734:-1, *Household electrical appliances – Performance – Water for testing*

IEC 62053-21:2003, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 62301:2011, *Household electrical appliances – Measurement of standby power*

ISO 5167-1:2003, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 1: General principles and requirements*

ISO 80000-1:2009, *Quantities and units – Part 1: General*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

¹ To be published.

3.1.1**tumble dryer**

appliance in which textiles are dried by tumbling in a rotating drum, through which air is passed

3.1.2**air vented tumble dryer**

tumble dryer that draws in fresh air which is passed over the textiles and where the resulting moist air is exhausted into the room or vented outside

3.1.3**condenser tumble dryer**

tumble dryer which includes a device for removing moisture from the air used for the drying process

3.1.4**automatic tumble dryer**

tumble dryer which switches off the drying process when a certain **moisture content** of the load is reached

Note 1 to entry: This may include systems that use conductivity or temperature sensing.

3.1.5**non-automatic tumble dryer**

tumble dryer which does not switch off the drying process when a certain **moisture content** of the load is reached, usually controlled by a timer, but may also be controlled manually

3.1.6**test load**

textile load used for testing

3.1.7**pre-treatment**

processing of a new **test load** prior to its first use to avoid rapid changes of characteristics during the tests

3.1.8**conditioning**

bringing the **test load** into thermodynamic equilibrium with the defined ambient air conditions of temperature and humidity

Note 1 to entry: The process of **conditioning** is not the same as "wetting" which is described in 6.5.7.

3.1.9**test run**

single performance assessment

3.1.10**test series**

group of **test runs** on a **tumble dryer** which, collectively, are used to assess the performance of that **tumble dryer**

3.1.11**operation**

each performance of a function that occurs during the **tumble dryer** drying process such as heating up, drying, cooling, anti-creasing

3.1.12

programme

series of **operations** which are pre-defined within the **tumble dryer** and which are declared by the manufacturer as suitable for drying certain types of textiles

3.1.13

end of the programme

moment in time when the **tumble dryer** indicates the **programme** is complete and the load is accessible to the user

Note 1 to entry: Where there is no such indicator and the door is locked during **operation**, the **programme** is deemed to be complete when the load is accessible to the user. Where there is no indicator and the door is not locked during **operation**, the **programme** is deemed to be complete when the power consumption of the appliance drops to a steady state condition and it is not performing any function. For **non-automatic tumble dryers**, the **programme** is deemed to be complete when it is stopped by the operator.

Note 2 to entry: An indication of the **end of the programme** may be in the form of a light (on or off), a sound, an indicator shown on a display or the release of a door or latch. In some **tumble dryers** there may be a short delay from an **end of the programme** indicator until the load is accessible by the user.

3.1.14

programme time

period of time from the initiation of the **programme** (excluding any user programmed delay) until the **end of the programme**

3.1.15

cycle

complete drying process, as defined by the selected **programme**, consisting of a series of **operations** including any **operations** that occur after the **end of the programme**

Note 1 to entry: Examples of **operations** that may occur after the completion of the **programme** are monitoring and anti-creasing **operations** (where applicable).

3.1.16

cycle time

period of time from the initiation of the **programme** (excluding any user programmed delay) until all activity ceases. Activity is considered to have ceased when the power consumption reverts to a steady state condition that persists indefinitely without user intervention. If there is no activity after the **end of the programme**, the **cycle time** is equal to the **programme time**

Note 1 to entry: **Cycle time** includes any activity that may occur for a limited period after the **end of the programme**. Any cyclic event that occurs indefinitely is considered to be steady state.

3.1.17

normalization

processing of a **test load** after a pre-determined number of **cycles** to bring the **test load** to a normal state prior to testing

3.1.18

rated capacity

maximum mass in kg of dry textiles of a particular defined type, which the manufacturer declares can be treated in a specific **programme**

3.1.19

test load mass

actual mass of the **test load**

3.1.20**nominal test load mass**

mass of dry textiles of a particular type for which the performance of the **tumble dryer** will be tested (**rated capacity** or part load). Target value toward which the conditioned **test load mass** will be adjusted

3.1.21**moisture content**

ratio of the difference between **test load mass** and the conditioned **test load mass** to the conditioned **test load mass** expressed in percent

3.1.22**initial moisture content**

moisture content of a **test load** prior to a test run

3.1.23**final moisture content**

moisture content of a **test load** at the end of a test run

3.1.24**off mode**

condition where the product is switched off using appliance controls or switches that are accessible and intended for **operation** by the user during normal use to attain the lowest power consumption that may persist for an indefinite time while connected to a mains power source and used in accordance with the manufacturer's instructions.

Note 1 to entry: Where the **tumble dryer** has no controls or switches that can bring it to the **off mode** condition, it is left to revert to a steady state power consumption by its own accord.

3.1.25**left on mode**

the lowest power consumption mode that may persist for an indefinite time after the completion of the **programme** and unloading of the machine without any further intervention of the user

Note 1 to entry: In some products this mode may be an equivalent power to **off mode**.

3.1.26**rated voltage**

voltage assigned to the appliance by the manufacturer

3.2 List of symbols

The symbols are listed in Table 1.

Table 1 – List of symbols

Symbol	Unit	Definition
a	-	constant part of the regression line
$\overline{A}$	-	weighted average age of the test load expressed as the number of test runs
A_k	-	age of item after conditioning
b	-	slope part of the regression line
C	%	arithmetical average of the condensation efficiency of all valid test runs
C_j	%	condensation efficiency for test run j
d	kg/l	density of water
E	kWh	arithmetical average of the corrected energy consumption of all valid test runs
E_j	kWh	corrected electric energy consumption for test run j
E_{mj}	kWh	measured electric energy consumption for test run j
E_s	kWh/kg	specific energy consumption
F	m ³ /min	volumetric flow rate
j	-	test run number
k	-	test load item number
K	-	constant = $1,9 \cdot 10^{-3} \text{ Pa h}^2/\text{m}^6$
L	l	arithmetical average of the corrected water consumption of all valid test runs
L_j	l	corrected water consumption for test run j
L_{mj}	l	measured water consumption for test run j
L_s	l/kg	specific water consumption
m_c	g	Conditioned mass of textile sample (Figure H.1)
n	-	number of test runs
N	-	number of items in the test load
p	Pa	static pressure
P_{off}	W	off mode power
P_{on}	W	left on mode power
S	-	standard deviation of measured results
S_b	-	standard deviation of the measured final moisture content for all valid test runs
S_w	-	arithmetical average of the evenness of drying of all valid test runs
s_{wj}	-	evenness of drying for a single test run
t	min	arithmetical average of the programme time of all valid test runs
t_s	min/kg	specific programme time
t_j	min	corrected programme time for test run j
t_{mj}	min	measured programme time for test run j
V_c	l	clothes container volume
V	m ³	exhaust air volume
W	g	rated capacity for the type of load tested
W_0	g	mass of the conditioned test load
W_{0k}	g	mass of conditioned test load item k

Symbol	Unit	Definition
W_f	g	mass of the test load after drying
W_{fj}	g	mass of test load after drying for test run j
W_{fk}	g	mass of test load item <i>k</i> after drying
W_i	g	mass of the test load after wetting
W_{wj}	g	mass of water collected in the condenser reservoir during test run j
x_i	-	<i>i</i> -th term of parameter <i>x</i>
$\bar{x}_i$	-	mean of all terms of parameter <i>x</i>
Y	-	performance parameter (energy consumption or programme time)
y_b	-	number of table tennis balls
μ_f	%	arithmetical average of the measured final moisture content of all valid test runs
μ_{fjav}	%	arithmetical average final moisture content of all the individual items in the test load
μ_{f0}	%	target final moisture content
μ_{fj}	%	measured final moisture content after test run j
μ_{fjk}	%	measured final moisture content of the test load item <i>k</i> for each valid test run j
μ_{ij}	%	measured initial moisture content for test run j
μ_{i0}	%	nominal initial moisture content

4 Requirements

4.1 General

This international standard does not specify minimum performance requirements for **tumble dryers**. This International Standard does however set methods for the measurement of following performance parameters:

- Electric energy consumption;
- Water consumption;
- **Programme time**;
- Condensation efficiency;
- Evenness of drying;
- Volumetric flow rate of exhaust air;
- **Off mode** power and **left on mode** power.

Any claims of performance referring to this International Standard for these parameters shall be measured in accordance with the requirements of this standard. Any claims of performance referring to this document at other than **rated capacity** shall be qualified with load type and capacity used for the test (refer to Clause 7 for details).

4.2 Rated capacity

The manufacturer or supplier shall declare the **rated capacity** at 0,5 kg intervals for each relevant textile type. Relevant textile types are cotton and synthetic/blends.

The **rated capacity** for any textile type shall not exceed the maximum mass of dry laundry, in kilograms, to be used in the appliance in accordance with 3.1.9 of IEC 60335-2-11:2008.

If the **rated capacity** is not declared by the manufacturer, the **rated capacity** shall be deduced from the clothes container volume (see 4.3) as described in Annex E.

Where the manufacturer gives a range of values for the **rated capacity** for a particular textile type, the maximum value shall be used.

NOTE For different textiles the **rated capacity** of an appliance may be different.

4.3 Dimensions

Where a manufacturer declares dimensions, these shall be in accordance with the following requirements, as applicable. The dimensions shall be given in cm and shall be rounded to the nearest whole cm.

- Height = vertical dimension measured from the lower edge (on the floor) to the upper edge of the top, with the door/lid closed. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.
- Max height = maximum vertical dimension measured from the lower edge (on the floor) to a horizontal plane at the maximum height of the **tumble dryer** with the door/lid open. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.
- Width = horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the **tumble dryer**, including all projections.
- Depth = horizontal dimension as measured from a vertical rear plane against the **tumble dryer** and the most prominent part of the front, knobs and handles not being taken into account, with the door/lid closed, including all projections.
- Max depth = horizontal dimension as measured from a vertical rear plane against the **tumble dryer** and the most prominent part of the front knobs and handles not being taken into account, with the door/lid open (generally when at right angles to the machine front), including all projections.
- Clothes container volume = the volume of the container in which textiles are placed, where required, shall be determined in accordance with Annex E.

NOTE Dimension max height is generally only applicable to top access **tumble dryers** while dimension max depth is generally only applicable to front access **tumble dryers**.

5 Test conditions, materials, equipment and instrumentation

5.1 General

The tolerances specified for parameters within this International Standard, using the symbol '±', indicate the allowable limits of variation from the specified parameter outside which the test or results shall be invalid. The statement of tolerance does not permit the deliberate variation of these specified parameters.

5.2 Ambient conditions

5.2.1 Electricity supply

The supply voltage at the power outlet to each **tumble dryer** shall be maintained at the **rated voltage** ± 2 % throughout the test. If a voltage range is indicated, then the supply voltage shall be the nominal voltage of the country in which the appliance is intended to be used.

The supply frequency to each **tumble dryer** shall be maintained at the rated frequency ± 1 % throughout the test. If a frequency range is indicated, the test frequency shall be the nominal frequency of the country in which the machine is intended to be used.

The measured voltage and frequency of the power supply used during testing shall be reported.

Voltage stabilisers shall ensure that the normal **operation** of the **tumble dryer** does not cause undue distortion of the voltage waveform.

5.2.2 Water supply

5.2.2.1 General

This section describes the specifications for water to be used for preparing **test loads**, wetting **test loads** and for use in water cooled condensers.

In all cases the water supply shall meet the requirements given in 5.2.2.2 and 5.2.2.3.

Water used for normalising **test loads** and wetting **test loads** shall meet the requirements of 5.2.2.2, 5.2.2.3 and 5.2.2.4.

Water used for wetting **test loads** for testing conductivity controlled **automatic tumble dryers** shall meet the requirements of 5.2.2.2, 5.2.2.3, 5.2.2.4 and 5.2.2.5.

NOTE The performance of a dryer may differ according to the quality of the water used to wet the **test load**.

5.2.2.2 Water temperature

The temperature of the cold water supply shall be (15 ± 2) °C. The measured water temperature shall be reported.

5.2.2.3 Water pressure

The pressure of the water supply during water intake at each appliance water inlet shall be maintained at (240 ± 50) kPa. The measured water pressure shall be reported.

5.2.2.4 Water hardness

Either standard hard water with a total hardness of $(2,5 \pm 0,2)$ mmol/l or standard soft water with a total hardness of $(0,5 \pm 0,2)$ mmol/l shall be used. If available, naturally occurring water of the correct total hardness may be used. Alternatively, water of the correct total hardness shall be prepared according to IEC 60734.

The water used for wetting a load shall always be of the same hardness as the water which is used for the previous **normalization**.

The total hardness of the water used shall be reported.

5.2.2.5 Water alkalinity and conductivity

When testing conductivity controlled **automatic tumble dryers**, the characteristics of the water used for wetting the **test load** can have a large influence on the test results. The water characteristics are defined in terms of hardness, alkalinity and conductivity.

For the purpose of testing **automatic tumble dryers** the water for wetting the **test load** shall have the characteristics of water prepared according to Method B of IEC 60734.

If water characteristics need to be adjusted, Method B or Method C3 of IEC 60734 shall be followed.

The alkalinity and conductivity of the water used shall be reported.

NOTE Method B of IEC 60734 describes how to prepare artificial water based on demineralised water. Method C3 of IEC 60734 describes how to produce water with the same characteristics as with Method B but based on natural water.

5.2.3 Ambient temperature and humidity

5.2.3.1 Ambient temperature and relative humidity for tumble dryer testing

The ambient temperature of the test room shall be maintained at $(23 \pm 2) ^\circ\text{C}$ throughout the **tumble dryer** test. The ambient temperature shall be measured in the vicinity of the **tumble dryer** being tested. The maximum and minimum measured temperatures shall be reported and rounded to the nearest 0,5 $^\circ\text{C}$.

The ambient relative humidity of the test room shall be maintained at $(55 \pm 5) \%$ throughout the **tumble dryer** test. The ambient relative humidity shall be measured in the vicinity of the **tumble dryer** being tested. The maximum and minimum measured ambient relative humidity for **tumble dryer** testing shall be reported rounded to the nearest whole percentage.

The ambient temperature and relative humidity shall not be influenced by the appliance itself or other appliances in the laboratory.

5.2.3.2 Ambient temperature and ambient relative humidity for conditioning of test load items

Where an ambient controlled room or chamber is used for **conditioning** the **test load**, the following conditions shall be maintained:

- ambient temperature: $(20 \pm 2) ^\circ\text{C}$;
- ambient relative humidity: $(65 \pm 5) \%$.

The measured ambient temperature and relative humidity for **conditioning test load** items shall be reported. The ambient temperature shall be rounded to the nearest 0,5 $^\circ\text{C}$, the ambient relative humidity shall be rounded to the nearest whole percentage.

NOTE Requirements for **conditioning** the **test load** are specified in 6.5.5.2.

5.3 Test materials

5.3.1 General

This section sets out the specifications for test materials required for **tumble dryer** testing to this International Standard, including:

- **Test loads** (load items);
- Detergent.

NOTE Suitable sources of test materials are given in A.8.

5.3.2 Test loads

5.3.2.1 Cotton test load

Where a cotton load is specified for testing, the cotton **test load** shall consist of sheets, pillowcases and towels as specified in A.2.

5.3.2.2 Synthetics/blends test load

Where a synthetics/blends load is specified for testing, the synthetics/blends **test load** shall consist of men's shirts and pillowcases as defined in A.2.

5.3.3 Detergents

The specification for the IEC 60456:2010 reference detergent A* base powder is defined in A.1. Detergent dosage is specified in 6.5.4.2 and 6.5.4.3.

5.4 Equipment

5.4.1 Equipment for normalization

The specification for the reference washing machine which is used for the **normalization** of **test loads** is defined in A.9.

NOTE Other clothes washing machines can be used provided that they have the same washing and rinsing performance according to IEC 60456:2010 or better in the relevant **programme**. They may be used up to their **rated capacity**.

5.4.2 Equipment for conditioning the test load

This International Standard requires **test load** items to be treated in a controlled manner prior to their use in performance tests in order to determine their mass under standardised ambient conditions. The alternative methods of **conditioning** the **test load** items are:

- Leaving the **test load** items in a room or chamber with a controlled ambient temperature and humidity (refer to 5.2.3.2) until their remaining **moisture content** is in equilibrium with the ambient conditions. Refer to 6.5.5.2 for details.
- Treating the **test load** items in a clothes dryer of specified performance to ensure that the **test load** items are in a “bone dry” state. Refer to 6.5.5.3 for details. Annex A.3 sets out the method and the specifications for a **tumble dryer** which is used for this method.

5.4.3 Equipment for wetting the test load prior to a test

Any washing machine may be used to wet the load prior to a test, provided it has the following features:

- a **rated capacity** which is equal to or greater than the load being wetted;
- at least one rinse **operation** with a duration of at least five minutes;
- the rinse shall consist of a volume of water in litres at least three times the mass of the **test load** in kilograms;
- a spin drying **operation** capable of achieving the desired **initial moisture content**.

5.4.4 Other equipment

This International Standard requires the measurement of a range of parameters during testing of a **tumble dryer**. These parameters include the following:

- mass;
- electrical parameters (voltage, energy, power and frequency);
- temperature of water and air;
- relative humidity;
- water pressure;
- total water hardness;
- conductivity of water (conductivity sensing dryers only);
- alkalinity of water (conductivity sensing dryers only);
- time.

The specifications of instruments used to take the measurements for some of these parameters are explicitly defined in 5.5.

NOTE Several different instruments for the measurement of mass are likely to be required for tasks such as mass of load items and the whole **test load** and mass of detergent.

5.5 Instrumentation and accuracy

Instruments used for this International Standard shall comply with the specifications set out in Table 2.

Devices using viscosity to measure water volume shall be calibrated at the nominal temperature $\pm 5\text{ }^{\circ}\text{C}$, and the nominal flow rate.

Table 2 – Specification of instruments

Parameter	Unit	Resolution	Accuracy	Additional requirements
Masses above 3 000 g	g	1 g	$\pm 5\text{ g}$	-
Masses in the range between 100 g and 3 000 g	g	0,5 g	$\pm 1\text{ g}$	-
Masses in the range up to 100 g	g	0,05 g	$\pm 0,1\text{ g}$	-
Ambient temperature	$^{\circ}\text{C}$	0,1 $^{\circ}\text{C}$	$\pm 0,5\text{ K}$	-
Water temperature	$^{\circ}\text{C}$	0,1 $^{\circ}\text{C}$	$\pm 0,5\text{ K}$	-
Ambient humidity	% (RH)	1% (RH)	$\pm 3\text{ \% (RH)}$	The specifications shall be met over a temperature range of 15 $^{\circ}\text{C}$ to 25 $^{\circ}\text{C}$
Water volume (water inlet)	l	0,1 l	$\pm 2\text{ \%}$	-
Water pressure	kPa	10 kPa	$\pm 5\text{ \%}$	-
Time	s	5 s	$\pm 10\text{ s}$	-
Electrical energy consumption	kWh	- As specified in IEC 62053-21 (class 1, instrument definition)	$\pm 1\text{ \%}$	Due to distortion of the voltage and current wave forms caused by inductive devices such as motor controls, specific requirements for energy meters are necessary
Hardness of water	mmol/l	As specified in IEC 60734		
Conductivity of water	$\mu\text{S/cm}$	As specified in IEC 60734		
Off mode and left on mode power	W	Measurement instrumentation for off mode and left on mode power are described in IEC 62301:2011		

6 Preparation for testing

6.1 General

This section sets out the requirements for the preparation of a **tumble dryer**. It also specifies the requirements for the preparation of **test loads**.

6.2 Installation of the tumble dryer

The measurements shall generally be carried out on a new **tumble dryer** which is installed and used in accordance with the manufacturer's instructions, except as required by this International Standard. Where there is more than one option for installation, the option chosen for testing shall be documented in the test report.

Where the **tumble dryer** is intended for use without a duct (i.e. the **tumble dryer** is intended to be vented into the room), the **tumble dryer** shall be tested as supplied without a duct.

Where the **tumble dryer** is intended for use with a duct and the duct is supplied with the **tumble dryer** (i.e. not as a separate accessory), the **tumble dryer** shall be tested with this duct, placed in a configuration consisting of three right angle bends as in Figure B.2.

Where the **tumble dryer** is intended for use with a duct and the duct is supplied with the **tumble dryer** (i.e. not as a separate accessory), but the supplied duct is too short to be placed in a configuration consisting of three right angle bends as in Figure B.2, it shall be tested with a duct as specified in B.3.

Where the **tumble dryer** is intended for use with a duct and the duct is not supplied with the **tumble dryer**, the **tumble dryer** shall be tested with a duct as specified in B.3.

Where a manufacturer gives the option to use the **tumble dryer** both with and without a duct, the **tumble dryer** shall be tested with a duct.

The test report shall clearly state which duct configuration, if any, is used in each test.

Where a water inlet is supplied, it shall be connected to an appropriate laboratory water supply system for testing (refer to 5.2.2).

If the manufacturer gives the option to use a **condenser tumble dryer** both with and without condensation box, the dryer shall be tested in accordance with the manufacturer's instructions. If no instructions are provided, then the dryer shall be tested with the condensation box.

6.3 Preparation of the tumble dryer for a test series

Before a **test series** is commenced the **tumble dryer** shall be checked to confirm that it has no operating defects that may affect the **operation** of the unit.

6.4 Preparation of the tumble dryer for a test run

Before each **test run** the filters, heat exchangers and ducts intended to be serviced by the consumer shall be cleaned according to the manufacturer's instructions.

The **tumble dryer** shall be at laboratory ambient temperature (refer to 5.2.3.1) at the beginning of each **test run**. This requirement has been met if the temperature of the hottest internal surface of the **tumble dryer** drum remains within 2 °C of the ambient air temperature for a period of 15 minutes whilst the drum door remains closed. Alternatively the **tumble dryer** shall be left for 18 hours at ambient temperature between **test runs**.

NOTE The latter is the preferred method when testing **tumble dryers** with a high thermal mass (such as heat pump dryers).

6.5 Preparation of test loads

6.5.1 General

This section sets out requirements for the preparation of the **test loads** used in the **tumble dryer** which is to be tested in accordance with this International Standard. Refer to Clause 7 regarding the selection of the required **test load mass** and requirements for tests at **rated capacity**. This section sets out:

- **Pre-treatment** of new **test load** items prior to use in testing;
- Average age requirements for **test load** items used in a **test series**;

- **Normalization** of the **test load** items;
- **Conditioning** of **test load** items to determine the **test load mass** at a known remaining **moisture content**;
- **Test load** composition;
- Wetting of the **test load**.

6.5.2 Pre-treatment of new test load items prior to use

New cotton and synthetics/blend **test load** items shall be treated before their first use by undergoing a **normalization** wash process five times, as defined in 6.5.4 but without intermediate drying. 15 g of the reference detergent A* base powder per kg of **test load** is added to the first five washes. After the final **pre-treatment** wash, the **test load** shall be dried.

6.5.3 Requirements regarding the age of test load items

6.5.3.1 General

No individual cotton or synthetic/blend **test load** item shall be used for more than 80 **test runs** excluding **pre-treatment** runs prior to initial use and the **normalization** runs (refer to 6.5.4).

Test loads intended for **tumble dryer** tests following this standard shall not be used for any other purpose. Loads that have been used for any other purpose are not suitable for **tumble dryer** tests following this standard.

NOTE It may be advisable to use the same test load for a test series.

To meet the age requirements specified in this standard, a system for tracking the number of **test runs** for each load item is required.

6.5.3.2 Average age requirements for cotton test load items

To minimise the influence of changes in the characteristics of the textiles with increasing age, the cotton **test load** for each **test run** shall consist of load items that are well distributed in age for each different item type to give a weighted average age of the **test load** between 30 and 50 **test runs**, using the nominal mass for each item given in A.2. An example of how this can be achieved is provided in A.2. The weighted average age of the **test load** shall be calculated according to A.4. The weighted average age shall be reported.

6.5.3.3 Average age requirements for synthetics/blends test load items

To minimise the influence of changes in the characteristics of the textiles with increasing age, half of the synthetics/blends **test load** shall consist of items used up to 40 **test runs** and the other half more than 40 **test runs**. The synthetics/blends **test load** shall consist of shirts and pillowcases that are well distributed in age to give a weighted average age of the **test load** between 20 and 60 **test runs** using the nominal mass for each item given in A.2. The weighted average age of the **test load** shall be calculated according to A.2.

6.5.4 Normalization of test load items

6.5.4.1 General

After they have been used for a minimum of 10 **test runs** and a maximum of 12 **test runs**, all **test load** items shall undergo **normalization**. **Normalization** is the process of washing the **test load** in a reference washing machine (or suitable alternative as described in 5.4.1) using a specified **programme** in order to bring the **test load** back into a standardized state.

6.5.4.2 Normalization of cotton test load items

Normalization of cotton **test load** items is achieved by processing them once in a reference washing machine using 15 g / kg of the reference detergent A* base powder and using the 60 °C cotton reference **programme** described in A.10. On completion of the **programme**, the **test load** items shall then be dried in a **tumble dryer**.

For **normalization** purposes, up to 6,5 kg can be washed in a reference washing machine. Where the **test load** to be normalized is more than 6,5 kg, the **test load** shall be split into two even parts (as far as is possible, with a mix of items in each part) for the **normalization** process.

6.5.4.3 Normalization of synthetics/blend test load items

Normalization of synthetics/blend **test load** items by processing them once in a reference washing machine using 15 g / kg of the reference detergent A* base powder and using the 60 °C synthetics/blends textile reference **programme** described in A.10. On completion of the **programme** the **test load** items shall then be dried in a **tumble dryer**.

For **normalization** purposes up to 4 kg can be washed in a reference washing machine. Where the **test load** to be normalized is more than 4 kg, the **test load** shall be split into two even parts (as far as is possible, with a mix of items in each part) for the **normalization** process.

6.5.5 Conditioning of test load items

6.5.5.1 General

Conditioning is the process of bringing the **test load** to a known **moisture content** after **normalization** and drying at the completion of a **test series** in order to check the standardized mass of each load item prior to commencing the next **test series**.

Conditioning may be done in an ambient controlled room/chamber or using the bone dry method. The method used shall be reported.

6.5.5.2 Conditioning of test load items in an ambient controlled room/chamber

In this method, the **test load** textiles are dried in a **tumble dryer** to a **final moisture content** of each single item of about -3 % in the case of cotton textiles or about -1 % in the case of synthetics/blend textiles and they are then stretched or flattened by hand. They are then allowed to reach an equilibrium **moisture content** when placed in a room/chamber with an ambient temperature and humidity which is maintained in accordance with 5.2.3.2. Under this method, two options are available as follows:

- The textiles shall be hung singly and separately so that air can freely circulate between individual load items. The load is left for a period of not less than 15 h.
- Textiles shall be left until their mass has changed by less than 0,5 % for two successive measurements which are taken at intervals of 2 h or more.

NOTE The **final moisture content** is defined at -3 % and -1 % in order to ensure that all items of the load are conditioned coming from a more dry state.

The mass of the complete test load in its conditioned state shall be recorded. If the test load is to be used for evenness measurements then the mass of each and every test load item in its conditioned state shall be recorded.

6.5.5.3 Conditioning of test load items using the bone dry method

In this method, the **test load** textiles are dried continually in a **tumble dryer** of known performance until the remaining **moisture content** has been reduced to a level that is known

as the “bone dry” condition, where very little free moisture is present. The conditioned mass of the **test load** is then determined by taking the bone dry mass and multiplying it by factor which is determined by the dryer performance characteristics.

If the load is to be used for evenness of drying measurements, the bone dry mass and the conditioned mass of each item in the load shall be determined individually.

The specification for the **tumble dryer** used and the method to prepare the **test load** to the bone dry condition prior to a **test series** and the calculation of conditioned mass is specified in A.3.

6.5.6 Test load composition

6.5.6.1 Cotton test load composition

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the **tumble dryer** to be tested. The numbers of sheets, pillowcases and towels in the cotton **test load** for various required **test load masses** are specified in Table 3. Final adjustment of the **test load mass**, is made by adding or removing towels so that the total mass is as close as possible (± 60 g) to the required **nominal test load mass**.

Table 3 – Number of items in the cotton test load for various test load masses

Required test load mass kg ^a	Number of sheets	Number of pillowcases	Number of towels ^b
1	0	2	5
1,5	0	3	7
2	0	4	9
2,5	0	5	12
3	2	4	5
3,5	2	4	10
4	2	4	14
4,5	2	6	15
5	2	6	19
5,5	2	8	19
6	2	8	24
6,5	2	10	24
7	2	12	24
7,5	3	12	22
8	3	12	27
8,5	3	14	27
9	4	14	25
9,5	4	14	29
10	4	16	30
10,5	5	15	30
11	5	15	34
11,5	5	16	37
12	6	17	32
12,5	6	17	37
13	6	18	39
13,5	6	19	42

Required test load mass kg ^a	Number of sheets	Number of pillowcases	Number of towels ^b
14	6	19	46
14,5	7	20	42
15	7	21	44
^a For test load masses to the whole or half kg rating which are greater than those specified in the table, the number of sheets is the nominal test load mass divided by (3 × 0,725) (rounded to the nearest whole sheet) and the number of pillowcases is the nominal test load mass divided by (3 × 0,24) (rounded to the nearest whole pillowcase). The balance of the required nominal test load mass is made up of towels as required. The mass of all test load items can be expected to decline slightly with increasing age. ^b The actual number of towels may differ from the number indicated above (which is intended to be indicative).			

Care is required to ensure that no **test load** items are lost or gained between **test runs**, so a system of accounting for all **test load** items should be used.

6.5.6.2 Synthetics/blends test load composition

The **test load mass** is adjusted so that it corresponds to the required **test load mass** for the specified **programme** of the **tumble dryer** to be tested. The numbers of pillowcases and shirts in the synthetics/blends **test load** for various required **test load masses** are specified in Table 4. The synthetic/blends **test load** is set up first with an equal number of shirts and pillowcases. Final adjustment of the **test load mass** is made by adding or subtracting one shirt or one pillowcase, whichever brings the **test load mass** to be closest to the required **nominal test load mass**.

Table 4 – Number of items in the synthetic/blends test load for various test load masses

Required test load mass kg	Number of shirts	Number of pillowcases
1	3	3
1,5	4	4
2	5	6
2,5	7	6
3	8	8
3,5	9	9
4	11	11
4,5	12	12
5	14	13
NOTE The actual number of items above is only indicative. The mass of all test load items can be expected to decline slightly with increasing age.		

Care is required to ensure that no **test load** items are lost or gained between **test runs**, so a system of accounting for all **test load** items should be used.

6.5.7 Wetting

The **initial moisture content** is established by wetting and spinning the load.

The load shall be homogeneously wetted. This shall be carried out in a washing machine according to the specification given in 5.4.3. The load shall be spun for as long as necessary to reach **initial moisture content** in the range:

$$\mu_{i0} + 1 \% \text{ to } \mu_{i0} - 3 \%$$

where μ_{i0} is the nominal **initial moisture content**.

The **moisture content** of the wet **test load** μ_{ij} is calculated as

$$\frac{W_i - W_0}{W_0} \text{ expressed as a percentage,}$$

where

W_i is the mass of the **test load** after wetting; and

W_0 is the mass of the conditioned **test load**.

Water is then added evenly by means of a fine spray as necessary, so that the **initial moisture content** of the **test load** when starting the test lies within the allowable range specified in Table 5. This initial wet mass is recorded as W_i .

Initial moisture contents other than specified in Table 5 may be used if clearly stated with the results. Annex F shows how the results of tests using two different **initial moisture contents** may be used to calculate the drying time and energy consumption that relate to other **initial moisture contents**.

NOTE 1 The preferred method is the one given in Annex F. The values given in Table 5 are only recommended where a single result is required for a single market and load.

NOTE 2 Results measured directly have priority over results calculated using the method shown in Annex F, for the purposes of resolving disputes.

Table 5 – Specifications for initial moisture content in the test load

Textile	Nominal initial moisture content μ_{i0}		Allowable range for initial moisture content μ_{ij}	
	A	B	A	B
Cotton	70 %	60 %	69 % to 71 %	59 % to 61 %
Synthetics/blend	50 %	40 %	49 % to 51 %	39 % to 41 %

7 Performance measurements – General requirements

This clause sets out the overall strategy for carrying out performance tests using this International Standard.

Prior to performing a **test series**, the following parameters need to be selected:

- Load type (i.e. cotton or synthetics/blends);
- Performance tests required (energy and water consumption, condensation efficiency, evenness of drying, etc);

- **Programme** to be tested on the **tumble dryer**;
- **Initial moisture content** of the **test load**;
- Target **final moisture content** of the **test load**;
- **Test load mass** (**rated capacity** or part load).

The primary requirement of this International Standard is for determination of performance at **rated capacity** for each relevant load type and set of test conditions. Any claim of performance to this International Standard without a statement of load size shall be determined on the basis of tests at **rated capacity**. However, additional tests may be conducted at other capacities. Any claims of performance for such test results shall be qualified with the **test load** capacity used.

When two or more of the following performance parameters are required for a single **tumble dryer**, they shall be measured as far as possible using a single common **test series** as set out in Clause 8:

- Electric energy consumption;
- Water consumption;
- **Programme time**;
- Condensation efficiency;
- Evenness of drying;
- Exhaust air volume.

8 Tests for performance

8.1 General

This clause sets out the test procedure for the determination of performance with a cotton load or a synthetic/blend load.

8.2 Test procedure for performance tests

8.2.1 Test conditions, materials and preparation for testing

For each **test run the tumble dryer** shall be prepared according to Clause 6.

8.2.2 Programme

The **programme** selected on the **tumble dryer** and any associated settings shall initially be in accordance with the manufacturer's instructions. In the absence of any instructions from the manufacturer, or if the recommended **programmes** do not achieve valid results (see 8.2.5) then a suitable **programme** is established by trial and error before a full **test series** is carried out.

For **automatic tumble dryers** those **programmes** are selected which aim to achieve target **final moisture content** values that are close as possible to but no greater than the values given in Table 6.

For **non-automatic tumble dryers** the dryer is operated for as long as required to achieve the target **final moisture content** values given in Table 6. The period of time required for this is determined by monitoring the drying process.

Table 6 – Specification for final moisture content of the test load after drying

Programme or user requirements	Target final moisture content value μ_{f0}	Range for final moisture content for a test run μ_{fj}	Allowable range for average final moisture content μ of a test series
Dry cotton	0 %	–3 % to +3 %	Less than +1,5 %
Iron dry cotton	+12 %	+8 % to +16 %	Less than +14 %
Synthetic/blends textile	+2 %	–1 % to +5 %	Less than +3,5 %

The selected **programme** shall be used for all **test runs** in a **test series**. If it is decided part way through a **test series** that the **programme** must be changed in order to achieve the required target **final moisture content** value then the **test series** shall be aborted and another **test series** started using the alternate **programme**.

The **programme** selected on the **tumble dryer** (with any associated settings) shall be reported.

8.2.3 Test load

Prior to a **test run**, a separate conditioned **test load** of the required type and mass as specified in Clause 6 shall be prepared for each **tumble dryer** being tested.

8.2.4 Test procedure

Immediately before each **test run**, the **test load** shall be wetted according to 6.5.7.

The **test load** shall be loaded into the **tumble dryer** within 5 minutes of having been wetted and the selected **programme** shall be started without delay.

No control on the **tumble dryer** (for example the timer control) shall be adjusted by the operator while the **programme** is running.

At the **end of the programme**, the **test load** shall be removed within 5 minutes and immediately weighed. The final **test load mass** for **test run j** is recorded as W_{fj} .

When the **programme** has terminated and the **tumble dryer** has stopped, this means that the **test run** has finished. The **test load** shall not be subjected to any further drying as part of the same **test run**.

The **final moisture content** for **test run j** is calculated as:

$$\mu_{fj} = (W_{fj} - W_0) / W_0 \text{ (expressed as a percentage)}$$

where W_0 is the mass of the conditioned **test load**.

The **final moisture content** shall be reported.

8.2.5 Validity of a test run

For an **automatic tumble dryer**, if the **final moisture content** for a **test run** is below the upper limit of the range given in Table 6, then the **test run** shall be declared valid. Otherwise the **test run** shall be declared invalid.

For a **non-automatic tumble dryer**, if the **final moisture content** for a **test run** is within the range given in Table 6, then the **test run** shall be declared valid. Otherwise the **test run** shall be declared invalid.

If the dryer has stopped automatically during a **test run** because the condensate container is full of water, the fact shall be reported and the **test run** shall be declared invalid.

Any adverse warning indicators (e.g. warnings or faults) shall be recorded and considered when assessing **test run** validity. However, if the run is not invalid for any of the reasons given above, it shall be declared valid.

8.2.6 Validity of a test series

A **test series** of five tests shall be carried out on the **tumble dryer**. In circumstances where one of the five **test runs** is invalid, a sixth **test run** may be carried out on the **tumble dryer** using the same **programme** setting, and the same nominal **initial moisture content** as all the previous **test runs** in the **test series**. The invalid **test run** shall be eliminated completely from any subsequent evaluation.

If more than one **test run** is invalid in a **test series**, then the whole **test series** shall be declared invalid.

If the average **final moisture content** for a **test series** of five valid runs is below the upper limit of the allowable range given in Table 6, then the **test series** shall be declared valid and the results evaluated according to Clause 9. Otherwise the **test series** shall be invalid.

If a **test series** of 5 valid **test runs** is invalid, it shall not be made valid by substituting one of the **test runs** with a sixth **test run**.

Data from an invalid **test series** shall not be used for evaluation according to Clause 9.

If a **tumble dryer** cannot complete a valid **test series** using the **programme** recommended by the manufacturer to dry a particular load type then this fact shall be reported. A new **test series** shall then be carried out using the **programme** with the next lower **final moisture content**. If no such **programme** is available then the **test series** shall be stopped.

If a **tumble dryer** cannot complete a valid **test series** with a particular load type using any of its **programmes** then this fact shall be reported.

A schematic representation of a **test series** is set out in Annex C.

8.3 Measurements to determine water and energy consumption and programme time

8.3.1 General

This clause contains specific requirements for the measurement of energy consumption, **programme time** and water consumption. The purpose is to obtain reproducible data for the calculation of environmental impacts and cost of **operation** based on energy and water consumption.

Evaluation of the measurements performed in this clause is set out in 9.2, 9.3, 9.4 and 9.5.

Determination of power consumption in **off mode** and **left on mode** is specified in A.5.

8.3.2 Procedure

The **test load** shall be subjected to the performance test procedure specified in 8.2. During these tests, instrumentation for the measurement of electrical energy and water volume shall record the required parameters (refer to Clause 5). It is recommended that data for all parameters be recorded at regular intervals throughout the test using a data logger or computer. Data collection should commence well before the **programme** is initiated and continue until after the **end of the programme**.

Measurements shall commence when the **programme** is initiated (without any user programmed delay). They shall be stopped at the **end of the programme**.

Measurements shall be made on all five valid **test runs** of a valid **test series** for the selected **programme**.

8.4 Measurements to determine condensation efficiency

8.4.1 General

This clause contains specific requirements for the measurement of condensation efficiency of **condenser tumble dryers**. Evaluation of the measurements performed in this clause is set out in 9.6.

8.4.2 Procedure

The **tumble dryer** shall be conditioned no more than 36 hours before the first **test run** by drying a **rated capacity** load that has been wetted to no less than the minimum relevant value given in Table 5. It shall then be allowed to cool to ambient temperature as described in 6.4.

The **tumble dryer** door shall remain closed during the period before starting the test.

The **test load** shall be subjected to the performance test procedure specified in 8.2.

The mass of the **test load** is measured immediately before and after the **test run**. The mass of moisture condensed during the **test run** and collected in the container is determined.

If more than 36 hours elapses between one **test run** and the next then the **tumble dryer** shall be conditioned as described above prior to the next **test run**.

Measurements shall be made on all five valid **test runs** of a valid **test series** for the selected **programme**.

8.5 Measurements to determine evenness of drying

8.5.1 General

This clause contains specific requirements for the measurement of evenness of drying. Evaluation of the measurements performed in this clause is set out in 9.7. Limitations to this method and procedures for overcoming them are given in Annex G.

8.5.2 Procedure

Before testing, each individual piece of the **test load** is marked. The individual weight of each piece is measured and recorded after **conditioning** as described in 6.5.5 and after each **test run**.

The **test load** shall be subjected to the performance test procedure specified in 8.2.

Measurements shall be made on all five valid **test runs** of a valid **test series** for the selected **programme**.

8.6 Measurements to determine exhaust air volume

This clause contains specific requirements for the measurement of exhaust air volume. Evaluation of the measurements performed in this clause is set out in 9.8.

This measurement is applicable for externally **vented tumble dryers** only.

Under certain climatic conditions an **air vented tumble dryer** which is externally vented may consume additional thermal energy where the indoor temperature is lower or higher than the outdoor air temperature. In this case it is assumed that the exhaust air is vented outside and replaced through the intake of outdoor air into the building.

A possible measurement procedure is specified in Annex H.

9 Assessment of performance

9.1 General

This clause sets out the primary evaluation methods for the assessment of **tumble dryer** performance under this International Standard. These methods are applicable to both load types described in Clause 5.

This clause includes the evaluation of all the performance parameters listed in Clause 7.

Rounding shall only be applied to reported values in Annex D. If numbers have to be rounded they shall be rounded to the nearest number according to ISO 80000-1:2009 (B.3, Rule B). If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros.

9.2 Final moisture content of the load

The **final moisture content** of the load shall be evaluated as shown in 8.2.4.

The average **final moisture content** μ_f of the valid **test runs** of a **test series** is calculated as:

$$\mu_f = \frac{1}{n} \sum_{j=1}^n \mu_{fj}$$

where

n is the number of **test runs**;

j is the **test run** number;

μ_{fj} is the measured **final moisture content** after **test run** j .

The standard deviation of the measured **final moisture content** S_b , which is a measure of the variability between **test runs** in one **test series** on a selected **programme** or timer setting, is calculated for a **test series**:

$$S_b = \sqrt{\frac{1}{n-1} \sum_{j=1}^n (\mu_{fj} - \mu)^2}$$

where

n is the number of **test runs**;

j is the **test run** number;

μ_{fj} is the measured **final moisture content** after **test run** j ;

μ is the average measured **final moisture content** for the **test series**.

9.3 Corrected electrical energy consumption

The corrected electrical energy consumption shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.3.

The corrected electrical energy consumption E_j is calculated for each **test run** j in a **test series**:

$$E_j = E_{mj} \times \frac{(\mu_{i0} - \mu_{f0}) \times W}{(W_i - W_f)}$$

where

E_{mj} is the measured electric energy for **test run** j ;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected electric energy consumption E is calculated from the corrected electric energy consumption of all valid **test runs**:

$$E = \frac{1}{n} \sum_{j=1}^n E_j$$

where

n is the number of **test runs**;

j is the **test run** number;

E_j is the corrected electrical energy consumption of the **test run** j .

9.4 Corrected water consumption

The corrected water consumption shall be evaluated as shown below using the measurements from valid **test runs** determined in Clause 8.3.

The corrected water consumption L_j is calculated for each **test run** j in a **test series**

$$L_j = L_{mj} \times \frac{(\mu_{i0} - \mu_{f0}) \times W}{(W_i - W_f)}$$

where

L_{mj} is the measured water consumption for **test run** j ;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**;

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected water consumption L is calculated from the corrected water consumption of all valid **test runs**:

$$L = \frac{1}{n} \sum_{j=1}^n L_j$$

where

n is the number of **test runs**;

j is the **test run** number;

L_j is the corrected water consumption of **test run** j .

9.5 Corrected programme time

The corrected **programme time** shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.3.

The corrected **programme time** t_j is calculated for each **test run** j in a **test series**:

$$t_j = t_{mj} \times \frac{(\mu_{i0} - \mu_{f0}) \times W}{(W_i - W_f)}$$

where

t_{mj} is the measured **programme time** for **test run** j ;

μ_{i0} is the nominal **initial moisture content**;

μ_{f0} is the target **final moisture content**;

W is the **rated capacity** of the **tumble dryer** for the type of load tested;

W_i is the mass of the **test load** after wetting;

W_f is the mass of the **test load** after drying.

The average corrected **programme time** t is calculated from the corrected **programme times** of all valid **test runs**:

$$t = \frac{1}{n} \sum_{j=1}^n t_j$$

where

n is the number of **test runs**;

j is the **test run** number;

t_j is the corrected **programme time** of **test run** j .

9.6 Condensation efficiency

The **condensation efficiency** shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.4.

Condensation efficiency C_j is calculated for all valid **test runs** and expressed as a percentage:

$$C_j = \frac{W_{wj}}{W_i - W_f} \times 100$$

where

W_{wj} is the mass of water collected in the condenser reservoir during **test run** j ;

W_i is the mass of the **test load** used after wetting but before drying;

W_f is the mass of the **test load** after drying.

The average condensation efficiency C is calculated from the condensation efficiencies of at least five valid **test runs** and expressed as a percentage:

$$C = \frac{1}{n} \sum_{j=1}^n C_j$$

where

n is the number of **test runs**;

j is the **test run** number;

C_j is the condensation efficiency of **test run** j .

9.7 Evenness of drying

The evenness of drying shall be evaluated as shown below using the measurements from valid **test runs** determined in 8.5.

For each valid **test run** j , the **final moisture content** μ_{fjk} is calculated for each individual item k in the **test load**, expressed as a percentage:

$$\mu_{fjk} = (W_{fk} / W_{0k}) - 1$$

where

W_{fk} is the final mass of item k ;

W_{0k} is the mass of the conditioned **test load** item k .

For each valid **test run** j the average **final moisture content** of all the individual items in the **test load** μ_{fjav} is calculated:

$$\mu_{fjav} = \frac{1}{N} \sum_{k=1}^N \mu_{fjk}$$

where

k is the item number;