# INTERNATIONAL STANDARD

# IEC 61121

Third edition
2002-07

## 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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## Tumble dryers for household use – Methods for measuring the performance

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# CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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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 electrical appliances.

This third edition cancels and replaces the second edition published in 1997, of which it constitutes a technical revision.

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

| FDIS | Report on voting |
|---|---|
| 59D/219/FDIS | 59D/222/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 3.

Annexes A, B, C and D form an integral part of this standard.

In this standard, the following print types are used:

– *test specifications: in italic type;*
– notes: in small roman type;
– other text: in roman type.

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

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

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- withdrawn;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

The contents of the corrigendum of April 2003 and September 2003 have been included in this copy.

# INTRODUCTION

This third edition has been developed in light of experience with use of the second edition of IEC 61121. Other changes include some minor revisions to the test conditions and alterations to the test load to ensure that this remains harmonised with the IEC 60456 load for clothes washers.

In summary, the main changes are as follows.

1) 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;
   - the content has been organised into a more logical and simple structure, and repetitive sections have been removed.
2) The conditions of measurement:
   - the wording of various sections has been revised to reduce ambiguity;
   - limits have been defined for water conductivity for auto-sensing dryers that are sensitive to conductivity, as well as methods to adjust conductivity where necessary;
   - specifications of a nominal exhaust duct were included.
3) 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 **normalisation.**
4) 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.

# 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.

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

This standard is concerned neither with safety nor with performance requirements.

## 2 Normative references

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

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

IEC 60734, *Hard water to be used for testing the performance of some household electrical appliance*

IEC 61036, *Alternating current static watt-hour meters for active energy (Classes 1 and 2)*

IEC 61591:1997, *Household range hoods – Methods for measuring performance*

ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices – Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full*

## 3 Definitions and symbols

For the purposes of this standard, the following definitions apply.

**3.1**
**tumble dryer**
appliance in which textile material is dried by tumbling in a rotating drum, through which heated air is passed

**3.2**
**air vented tumble dryer**
**tumble dryer** with a fresh-air intake which is heated and passed over the textile material and where the resulting moist air is exhausted into the room or vented outside

**3.3**
**condenser tumble dryer**
**tumble dryer** in which the air used for the drying process is dehumidified by cooling

NOTE Combinations of the above-mentioned types are possible.

**3.4**
**automatic tumble dryer**
**tumble dryer** which switches off the drying process when a certain moisture content of the load is reached

NOTE This may include conductivity or temperature sensing

**3.5**
**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 manually controlled

**3.6**
**pre-treatment**
successive washing, rinsing, spinning and drying of a new test load prior to its first use to avoid rapid changes of characteristics during the tests

**3.7**
**normalisation**
successive washing, rinsing, spinning and drying of a test load after a pre-determined number of cycles to bring the test load to a normal state

**3.8**
**conditioning**
treatment of test load to assure homogenous condition

**3.9**
**programme**
series of operations which are pre-defined and which are declared as suitable for drying certain types of textiles

**3.10**
**cycle**
complete drying process, as defined by the **programme** selected, consisting of a series of different operations (heat, cool down etc.)

**3.11**
**rated capacity**
mass in kg of dry textiles of a particular defined type, which the manufacturer declares can be treated in a specific **programme**

### 3.12 List of symbols

| | |
|---|---|
| $\mu_f$ | actual final moisture content of the test load (%) |
| $\mu_{f0}$ | nominal final moisture content (%) given in table 3, without tolerances |
| $\mu_{fi}$ | actual final moisture content of the test load after the i:th **cycle** (%) |
| $\mu_{fj}$ | actual final moisture content of the j:th individual piece of textile in a **cycle** (%) |
| $\mu_i$ | actual initial moisture content (%) |
| $\mu_j$ | arithmetic average of $\mu_{(f, j)}$ for all individual load items |
| $\mu_{i0}$ | nominal initial moisture content (%) given in table 2, without tolerances |
| $\mu$ | arithmetical average of $\mu_f$ for all i **cycles** |
| $C$ | condensation efficiency (%) |
| $E_m$ | measured energy consumption kWh |
| $E$ | corrected energy consumption kWh |
| $L_m$ | measured water consumption (l) |
| $L$ | corrected water consumption (l) |
| n | number of **cycles** |
| $s_b$ | standard deviation as a measure of the variability between **cycles** in one test series |
| $S_w$ | average drying evenness |
| $s_{wr}$ | standard deviation for the evenness of drying within a load |
| $W$ | **rated capacity** for the **programme** (g) |
| $W_0$ | conditioned mass of the test load (g) |
| $W_f$ | mass of the test load after drying, "the final mass" |
| $W_i$ | mass of the test load after wetting (but before drying), "the initial mass" |
| $W_w$ | mass of the condensed water |
| $t_m$ | measured **programme** time |
| $t$ | corrected **programme** time |

## 4 Dimensions

Height $a_1$ = vertical dimension measured from the lower edge (on the floor) to the upper edge of the top, with the door closed. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.

Height $a_2$ = 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 open. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.

Width b = horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the tumble dryer, including all projections.

Depth $c_1$ = 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 closed.

Depth $c_2$ = 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 open.

Drum volume = the volume of the drum in which textiles are placed, determined as the inside volume of the drum, in litres, after subtraction of ribs or other inward protrusions, etc.

## 5 Rated capacity

If the **rated capacity** is not declared by the manufacturer, the **rated capacity** shall be deduced from the volume of the drum according to the following ratios:

– for cotton textiles: 1 kg / 24 l;

– for easy-care textiles: 1 kg / 60 l.

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.

## 6 General conditions for measurements

### 6.1 General

The measurements shall be carried out on a **tumble dryer** installed and used in accordance with the manufacturer's instructions, except as required by this standard.

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** is tested with this duct, placed in a configuration consisting of three right angle bends as in figure A.2, as far as possible.

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 annex A.

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

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

### 6.2 Resources and ambient conditions

#### 6.2.1 Electricity supply

The supply voltage 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 **tumble dryer** is intended to be used.

The supply frequency 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 **tumble dryer** is intended to be used.

#### 6.2.2 Water supply

For all processes on the test load a water hardness of not higher than (2,5 ± 0,2) mmol/l shall be used. Water hardness shall be reported. If water hardness needs to be adjusted, IEC 60734 shall be followed.

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

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

For testing conductivity controlled automatic **tumble dryers**, water with a conductivity of (75 ± 15) mS/m at 20 °C shall be used. If the water conductivity is not within the range of this requirement, it can be adjusted as described in annex D. The conductivity shall be reported.

#### 6.2.3 Ambient temperature

The ambient temperature of the room in the vicinity of the dryer shall be maintained at (20 ± 2) °C throughout the test. The measured ambient temperature shall be recorded.

#### 6.2.4 Ambient humidity

The ambient humidity of the room in the vicinity of the dryer shall be maintained at (65 ± 5) % throughout the test. The measured ambient humidity shall be recorded.

## 7 Test loads

### 7.1 Composition

#### 7.1.1 Cotton test load

The cotton test load shall consist of sheets, pillowcases and hand-towels as defined in annex B.

The test load shall be made up of conditioned items whose total mass is as close as possible to $W$. This mass is recorded as conditioned mass, $W_0$.

The number of sheets, pillowcases and hand towels in the cotton test load for various **rated capacities** is given in the table 1.

**Table 1 – Number of items of cotton test load for various rated capacities, *W***

| **Rated capacity** kg | **Number of sheets** | **Number of pillowcases** | **Number of hand-towels** |
|---|---|---|---|
| 2 | 1 | 2 | |
| 2,5 | 1 | 3 | |
| 3 | 1 | 4 | |
| 3,5 | 2 | 3 | |
| 4 | 2 | 4 | |
| 4,5 | 2 | 6 | |
| 5 | 2 | 6 | |
| 5,5 | 2 | 8 | Number required to make up **rated capacity** |
| 6 | 2 | 8 | |
| 6,5 | 2 | 10 | |
| 7 | 2 | 12 | |
| 7,5 | 3 | 12 | |
| 8 | 3 | 14 | |
| 8,5 | 3 | 16 | |
| 9 | 3 | 18 | |
| 9,5 | 3 | 20 | |
| 10 | 3 | 22 | |

NOTE For **rated capacities** other then those specified in table 1, the number of sheets and pillowcases in the test load shall be equal to that specified for the next lower capacity listed in table 1, with the balance of the **rated capacity** made up with hand-towels.

The test load shall be used only for testing **tumble dryers** according to this standard.

### 7.1.2 Easy-care textile test load

The easy-care textile test load shall consist of men's shirts and pillowcases as defined in annex B.

The easy-care textile test load is made up of an equal number of shirts and pillowcases. Final adjustment of the test load is made by adding one shirt or one pillowcase whichever adjusts closest to the **rated capacity** *W*.

## 7.2 Usage

An item shall not be used more than 80 **cycles** after **pre-treatment**. To minimize the influence of ageing of the textiles, half the test load shall consist of items used less than 40 times and the remainder used more than 40 times.

After every 10 **cycles,** the test load shall be normalized once according to 7.3.2 followed by **conditioning** according to 7.3.3.

NOTE The 80 **cycles** does not include **conditioning** and **normalization.**

### 7.3 Preparation

#### 7.3.1 Pre-treatment

New textile items shall undergo a **pre-treatment** before their first use by undergoing **normalisation** five times, as defined in 7.3.2, followed by **conditioning** according to 7.3.3.

#### 7.3.2 Normalisation

For **normalisation** wash the test load in a Wascator reference machine as defined in IEC 60456 with 15 g/kg of the reference detergent A* in IEC 60456.

All items of the load shall be dried to a moisture content of below 0 %.

This can be reached by the following procedures.

For cotton textiles, use the 60 °C cotton reference **programme** as defined in IEC 60456 without pre-wash but including rinsing and spinning and then dry to a final moisture content of about –3 %.

For easy-care textiles, use a 60 °C easy care textile reference **programme** as defined in IEC 60456 and then dry to a final moisture content of about –1 %.

NOTE Other machines may be used provided that they have at least the same washing and rinsing performance according to IEC 60456 in the relevant **programme**.

#### 7.3.3 Conditioning

**Conditioning** is carried out to define the nominal mass of the textiles.

The textiles are left at least for 15 h in an ambient temperature and humidity as specified in 6.2.3 and 6.2.4 unless the weight of the load has changed by less than 0,5 % for two successive measurements carried out at two hour intervals.

As an alternative the bone-dry method of annex C may be used.

The **conditioning** method used shall be reported.

NOTE If the bone-dry method is used, the results may be different from the results using ambient **conditioning**.

#### 7.3.4 Wetting

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

The load shall be homogeneously wet. This can be done in a washing machine able to take the total load. The load shall be rinsed three times using a minimum of 3 l/kg rinse water (including carry-over) and for at least 2 min each. The spinning is carried out for as long as necessary to reach initial moisture content in the range $\mu_{io}$ + 1 % to $\mu_{io}$ – 3 %.

The moisture content of the wet test load $\mu_i$ is calculated as $100 \times (W_i - W_0) / W_0$.

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 2. This initial wet mass is recorded as $W_i$.

Initial moisture contents other than specified in table 2 may be used if clearly stated with the results.

**Table 2 – Specifications for initial moisture content of the test load**

| Textile | Nominal initial moisture content $\mu_{i0}$ | | Allowable range for initial moisture content $\mu_i$ | |
|---|---|---|---|---|
| | A | B | A | B |
| Cotton textile | 70 % | 60 % | 69 % to 71 % | 59 % to 61 % |
| Easy-care textile | 50 % | 40 % | 49 % to 51 % | 39 % to 41 % |

## 8 Instrumentation and accuracy

Instruments having the following accuracy shall be used for tests.

### 8.1 Mass

Measurements shall be accurate to ±0,1 %.

### 8.2 Water and air temperature

Measurements shall be accurate to ±1 K.

### 8.3 Water volume

Measurements shall be accurate to ±1 %.

NOTE Devices using viscosity should be calibrated at the actual nominal water temperature ±5 K, and the nominal flow rate.

### 8.4 Water pressure

Measurements shall be accurate to ±5 %.

### 8.5 Water hardness

Measurements shall be accurate to ±0,1 mmol/l.

### 8.6 Water conductivity

Measurements shall be accurate to ±5 % at 20 °C.

### 8.7 Electrical energy

Measurements shall fulfil IEC 61036 Class1 specification.

### 8.8 Time

Measurements shall be accurate to ±5 s.

### 8.9 Ambient humidity

Measurements shall be accurate to within ±3 %, over the temperature range 18 – 22 ºC.

# 9 Performance tests

## 9.1 General

This clause contains specifications for the test procedure and defines performance test methods for the main **tumble dryer** functions. Tests are performed with the loads, specified in clause 7.

**Tumble dryers** shall be configured with or without a duct as specified in 6.1.

All tests shall be started with the **tumble dryer** at ambient temperature according to 6.2.3.

NOTE This can be done by leaving the machine at ambient conditions for at least 12 hours.

## 9.2 Procedure for drying performance

### 9.2.1 Drying tests general

For **automatic tumble dryers** those **programmes** are selected which aim to achieve the final moisture values given in Table 3.

For **non-automatic tumble dryers** the dryer is operated for as long as required to achieve the final moisture values given in Table 3. The periods of time required for this are determined by monitoring the drying process, see 9.2.1.2. The series of operations with these settings are regarded as **programmes** in case of **non-automatic dryers.**

**Table 3 – Specification for final moisture content of the test load after drying**

| Programme or user requirements | Nominal final moisture content $\mu_{f0}$ | Allowable range for final moisture content $\mu_f$ |
|---|---|---|
| Dry cotton | 0 % | –3 % to +3 % |
| Iron dry cotton | +12 % | +8 % to +16 % |
| Easy-care textile | +2 % | –1 % to +5 % |

The nominal amount of water to evaporate for the **programmes** or time settings tested is derived from the **rated capacity** and the nominal initial moisture content ($\mu_{i0}$) and final nominal moisture content ($\mu_{f0}$) according to tables 2 and 3.

The corresponding test load according to 7.1 with a mass of the **rated capacity** is put into the **tumble dryer**, after following the wetting procedure of 7.3.4.

NOTE The standing time between wetting and the start of drying should not exceed 5 min.

Depending on the dryer type the dryer is operated according to 9.2.1.1 or 9.2.1.2 respectively.

When the **programme** has terminated and the **tumble dryer** has stopped, the test load is removed within 5 min and immediately weighed. The test load weight is recorded as $W_f$. The amount of evaporated water in the test is $W_i - W_f$.

The actual final moisture content is calculated as $\mu_f = \dfrac{W_f - W_0}{W_0}$ (expressed as percentage).

The **programme** time, which is the actual time of operation, shall be reported, including the cool down period. If the **tumble dryer** has no cool down period, this shall be reported.

Water and energy consumption for the **cycle** shall be reported.

The minimum number of valid **cycles** shall be five. The reported results of the valid **cycles** are used for further evaluations according to Clause 10. If the dryer is automatically stopped during a **cycle** and the reason is that the condensation box is full of water, the fact is reported and the test is stopped.

NOTE If the manufacturer gives the option to use a condenser **tumble dryer** both with or without condensation box, the dryer should be tested with the condensation box.

#### 9.2.1.1 Procedure for automatic dryer

The **programme** under test is selected and the **tumble dryer** is started.

If the final moisture content $\mu_{fi}$ of a single run is below the upper limit of the allowable values given in table 3, the **cycle** is valid and the data can be used for further evaluation.

If the final moisture content $\mu_{fi}$ is above the upper limit of the allowable values given for the program specified in table 3 the **cycle** has to be repeated using a **programme** which has the next lower final moisture content (e.g. use ”extra dry” instead of ”dry cotton”).

The **programme** used is reported.

If there is no **programme** available which gives a final moisture content lower than the upper limit for a dry cotton program shown in table 3, the fact is reported and the test is stopped. If the measured value of the final moisture content for an **automatic dryer** is below the lower limit of the allowable values defined in table 3, no correction is made.

#### 9.2.1.2 Procedure for non-automatic dryer

The **tumble dryer** is operated for a period of time required. The time required is determined by monitoring the drying process. This can be done by either having the **tumble dryer** placed on a platform scale or by pre-testing.

If $\mu_f$ is within the allowable range specified in table 3, the **cycle** is valid and the data can be used for further evaluations.

If $\mu_f$ is not within the limits, the data shall not be used for evaluation.

NOTE Such a **cycle** can be considered to be a trial or pre-testing **cycle**.

If the dryer does not reach the required moisture content after its maximum **programme** time, this fact is reported and the test is stopped.

### 9.2.2 Condensation efficiency

The condensation efficiency for a **condenser tumble dryer**, shall be measured using the dry cotton **programme** and setting selected to achieve the "dry cotton" result (this means the equivalent timer setting for a timer dryer) in the drying test.

*The mass of the test load is measured immediately before and after the **cycle**. The mass of moisture condensed during the **cycle** and collected in the container is determined. The first **cycle** after a period of non-operation longer than 36 h shall not be used for evaluation.*

*During the time between two **cycles** the door of the **tumble dryer** shall be closed except for loading.*

NOTE It is also possible to weigh the total **tumble dryer** if it is placed on a scale platform. The mass of the **tumble dryer** without test load is measured immediately before and after the **cycle**. This method is not applicable if any condensed water accumulates within other parts of the dryer during the operation.

### 9.2.3 Evenness of drying

The drying evenness shall be tested using the iron-dry cotton **programme**.

Before testing, each individual piece of the test load is marked. The individual weight of each piece is measured and recorded after **conditioning** and after each cycle.

### 9.2.4 Air volume of exhaust air

Applicable for **air vented tumble dryers**.

Under certain climatic conditions an **air vented tumble dryer** which is externally vented may consume additional 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.

In a separate measurement, the flow rate of exhaust air is measured during empty operation of the **tumble dryer** without heating according to ISO 5167-1.

Under the circumstances described above the energy losses are proportional to the flow rate and the time.

## 10 Evaluation and calculation

### 10.1 Final moisture content of the load

The final moisture content of the valid **cycles** shall be averaged.

The standard deviation $s_b$, which is a measure of the variability between **cycles** in one test series on a selected **programme** or timer setting, shall be determined by the following formula:

$$s_b = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\mu_{fi} - \mu)^2}$$

where

$n$ is the number of cycles

$$\mu = \frac{1}{n}\sum_{i=1}^{n}\mu_{fi}$$

### 10.2 Electric energy consumption

The energy consumption measured in 9.2.1 is corrected by the following formula to give the corrected energy consumption corresponding to the nominal final moisture content, $\mu_{f0}$.

$$E = E_m \frac{(\mu_{i0} - \mu_{f0})\ W}{(\mu_i - \mu_f)\ W_0}$$

The electric energy consumption of the valid cycles shall be averaged.

If there is no **programme** available which gives a final moisture content lower than the upper limit for a dry cotton program shown in table 3, the fact is reported and the test is stopped.

### 10.3 Water consumption

The water consumption measured in 9.2.1 is corrected by the following formula to give the corrected water consumption corresponding to the nominal final moisture content, $\mu_{f0}$.

$$L = L_m \frac{(\mu_{i0} - \mu_{f0})\ W}{(\mu_i - \mu_f)\ W_0}$$

The water consumption of the valid cycles shall be averaged.

### 10.4 Time

The **programme** time measured in 9.2.1 is corrected by the following formula to give the corrected **programme** time corresponding to the nominal final moisture content, $\mu_{f0}$.

$$t = t_m \frac{(\mu_{i0} - \mu_{f0})\ W}{(\mu_i - \mu_f)\ W_0}$$

The **programme** time of the valid cycles shall be averaged.

### 10.5 Condensation efficiency

Efficiency of condensation, $C$, is determined according to 9.2.2 as the ratio between the water produced during the cycle $W_w$, relative to the total mass of water evaporated from the load.

$C = \frac{W_w}{W_i - W_f}$ is calculated for each cycle and expressed as percentage

*Efficiency of condensation is the mean value of a minimum of four valid* ***cycles****.*

NOTE Due this requirement the first run of a condensation efficiency test has normally to be discarded.

### 10.6 Evenness of drying

For each individual item j the weights corresponding to $W_f$ and $W_0$ are used to calculate individual values of $\mu_f$ for each individual item. The standard deviation $s_{wr}$ between these values is calculated as a measure for the evenness of drying of the test load.

$$s_{wr} = \sqrt{\frac{1}{k} \sum_{j=1}^{k} (\mu_{fj} - \mu_j)^2}$$

where

$$\mu_j = \frac{1}{k} \sum_{j=1}^{k} \mu_{fj}$$

$k$ = total number of load items in the test load.

NOTE The value $\mu$ is the average final moisture content of the whole base load, not the average final moisture content reading for each type of load item.

The evenness of drying $S_w$ is defined as the mean of the values of $s_{wr}$ for each of the valid cycles.

## 11 Reporting of test results

The following data shall be reported.

– **tumble dryer** identification;

for each **programme** tested:

– measured water pressure;
– measured water conductivity (if relevant);
– measured ambient conditions;
– **programme** setting used;
– **rated capacity** according to Clause 5 as used for the measurements to the nearest 0,1 kg;
– conditioned weight and initial humidity;
– actual final moisture content and standard deviation according to 10.1 to the nearest 0,1%;
– where required, condensation efficiency according to 10.5 to the nearest 1 %;
– where required, drying evenness according to 10.6 to the nearest 0.1 %;
– measured (and corrected) **programme** time according to 10.4 to the nearest 1 min;
– measured (and corrected) electric energy consumption according to 10.2 in kWh, to two decimal places;
– measured (and corrected) water consumption according to 10.3 to the nearest litre;

  time, water and energy consumption can also be expressed per kg of **rated capacity** or per nominal litre of evaporated water (calculation carried out before rounding);

– the method used for **conditioning**;
– details of duct configuration.

# Annex A
(normative)

# Nominal and standard exhaust duct for tumble dryer testing

## A.1 Nominal exhaust duct for tumble dryer testing

The pressure/air flow curve for the nominal exhaust duct shall comply, with an accuracy of ±5 %, to the following formula

$$p = k \times \dot{V}^2$$

where

$p$ is the pressure in Pa, measured at the point where the duct is connected to the **tumble dryer**;

$\dot{V}$ is the volumetric air flow in m³/h

$k = 1{,}9 \times 10^{-3}$

For example at an airflow of 200 m³/h the pressure is 76 Pa.

Figure A.1 shows the theoretical pressure/airflow curve for the duct (refer to IEC 61591:1997).

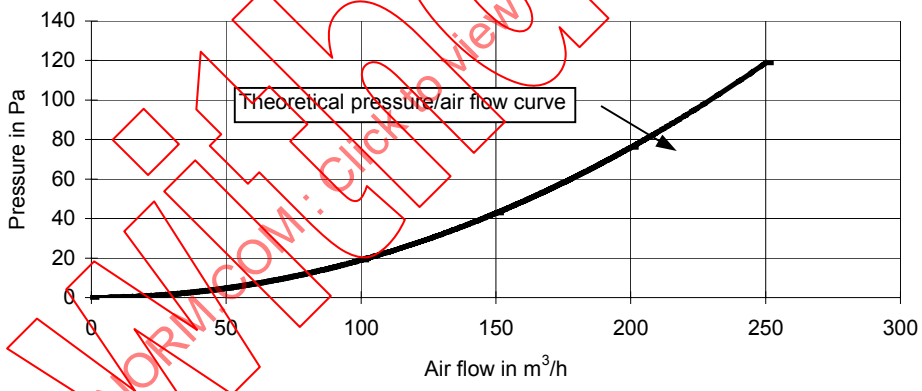


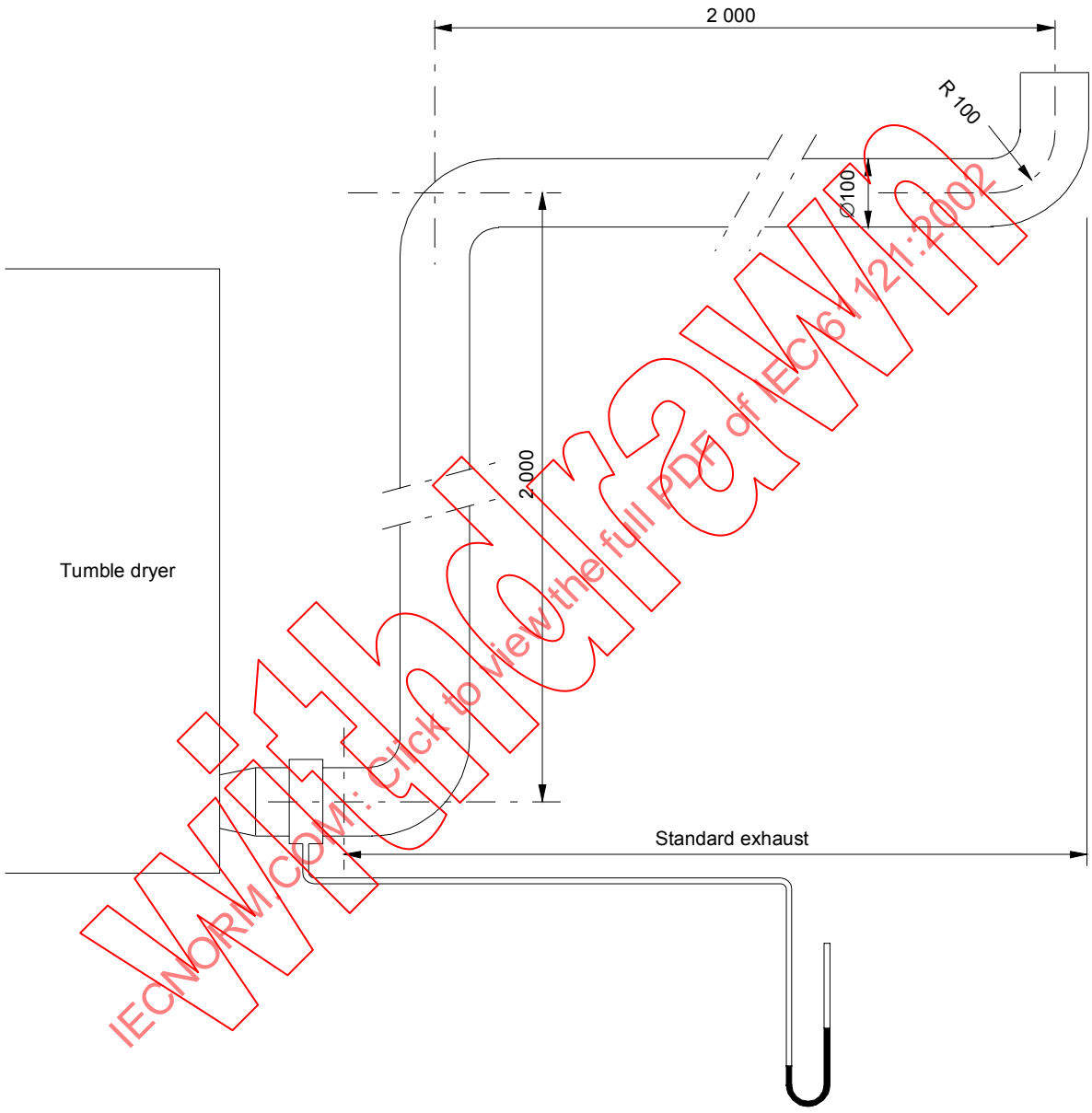

**Figure A.1 – Pressure/air flow curve**

This can be achieved by using a standard IEC exhaust duct as defined in the following section.

## A.2 Standard IEC exhaust duct for tumble dryer testing

The standard IEC exhaust duct shall be formed according to figure A.2. It consists of two straight pipe pieces and three bends. The pipe is of steel, so-called "spiro-pipe". Where the **tumble dryer** is placed on a balance, it may be more practical to replace the standard exhaust with the standard exhaust simulator which consists of a bend and a flexible pipe made of a plastic strip tube according to figure A.3.

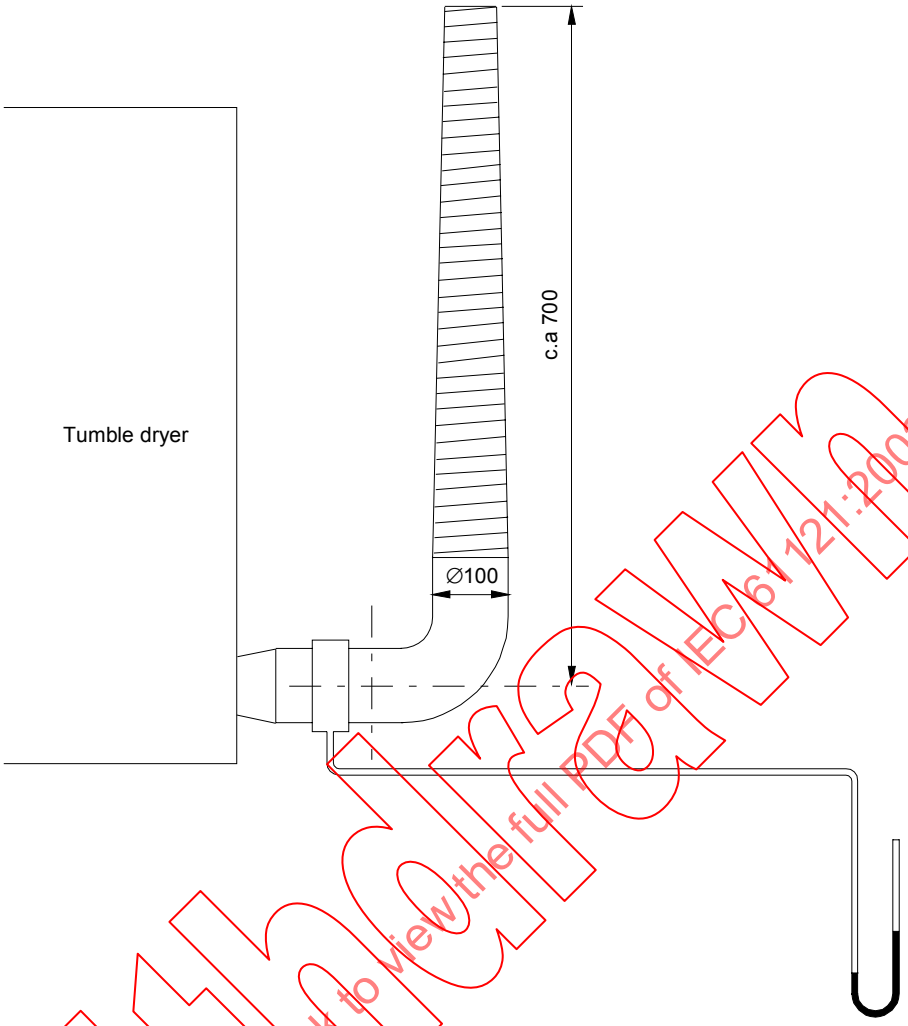
In this case, a standard exhaust shall be installed first. Then the **tumble dryer** is operated and the pressure in the duct at the **tumble dryer** outlet measured according to figure A.2. The flexible pipe is then formed so as to give the same pressure as in Figure A.1. When this pressure is obtained, the flexible pipe shall be fixed.






*Dimensions in millimetres*

**Figure A.2 – Standard exhaust**




*Dimensions in millimetres*

**Figure A.3 – Standard exhaust simulator**

# Annex B
(normative)

# Cotton test load

## B.1 Cotton test load

The cotton test load shall consist of bed sheets, pillowcases and huckaback towels conforming as new items with the specifications given in the table below (measured at 20 °C ± 2 °C, 65 % ± 5 % RH and certified by the supplier)

| Criterion | Bed sheets | Pillow cases | Huckaback towels |
|---|---|---|---|
| Substrate | Long staple pure cotton | | |
| Yarn | Ring spun | | |
| **Yarn twist (T/m)** | | | |
| Warp | 600 ± 20 | | 610 ± 20 |
| Weft | 500 ± 15 | | 490 ± 15 |
| **Yarn count (tex)** | | | |
| Warp | 33 ± 1 | | 36 ± 1 |
| Weft | 33 ± 1 | | 97 ± 1 |
| Weave | Plain weave linen 1/1 | | Huckaback |
| **Pick count (pick/cm)** | | | |
| Warp | 24 ± 1 | | 20 ± 1 |
| Weft | 24 ± 1 | | 12 ± 1 |
| Shrinkage warp/weft (%) after 5/25 Cycles and water uptake | Under consideration | | |
| Mass per unit area ($g/m^2$) | 185 ± 10 | | 220 ± 10 |
| **Dimensions (mm)** | | | |
| Length | 2400 ± 150 | 800 ± 50 | 1000 ± 50 |
| Width | 1600 ± 40 | 800 ± 20 | 500 ± 30 |
| Weight per piece (g) | 725 ± 15 | 240 ± 5 | 110 ± 3 |
| Finish | Desizing, boiling off, singeing, bleaching, no filling or stiffening size | | |