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Second Edition

## **DRAFT EAST AFRICAN STANDARD**

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**Packaging ancillary materials — Code of practice — Desiccants**

**EAST AFRICAN COMMUNITY**

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## Contents

Page

Foreword .....	iv
1 Scope .....	1
2 Normative references .....	1
3 Terms and definitions .....	1
4 Packaging environment .....	2
4.1 Dampness .....	2
4.2 Humidity .....	2
4.2.1 General .....	2
4.2.2 Relative humidity .....	2
5 Desiccated packages .....	3
5.1 General .....	3
5.2 Sources of moisture .....	3
6 Factors determining choice of desiccant .....	3
6.1 General management of the desiccant .....	3
6.2 Important factors .....	4
6.2.1 Moisture absorbing capacity of desiccant in relation to bulk and mass .....	4
6.2.2 Stability and physical form of the desiccant .....	4
6.2.3 Means of containing the desiccant .....	4
6.3 Commonly used desiccants for packaging .....	4
7 Quantity of desiccant .....	5
7.1 General .....	5
7.2 Calculation of quantity of desiccant required .....	6
7.2.1 Basic desiccant .....	6
7.2.2 Formulae .....	6
8 Conditions in use for desiccants .....	7
Annex A (informative) Methods of meeting desired conditions .....	8
Bibliography .....	9

## Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in the East African Community. It is envisaged that through harmonized standardization, trade barriers that are encountered when goods and services are exchanged within the Community will be removed.

The Community has established an East African Standards Committee (EASC) mandated to develop and issue East African Standards (EAS). The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the public and private sector organizations in the community.

East African Standards are developed through Technical Committees that are representative of key stakeholders including government, academia, consumer groups, private sector and other interested parties. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the Principles and procedures for development of East African Standards.

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

The committee responsible for this document is Technical Committee EASC/TC 066, *Packaging*.

Attention is drawn to the possibility that some of the elements of this document may be subject of patent rights. EAC shall not be held responsible for identifying any or all such patent rights.

With regard to the first edition (EAS 931: 2019), the following changes have been made in this Second edition:

- Deletion of the second sentence after the full stop in clause 3.4
- Updates on the bibliography.

# Packaging ancillary materials — Code of practice — Desiccants

## 1 Scope

This Draft East Africa Standard gives the guidelines on the selection and use of desiccants in packaging.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 15106-3, *Plastics — Film and sheeting — Determination of water vapour transmission rate — Part 3: Electrolytic detection sensor method*

## 3 Terms and definitions

For the purposes of this document, the following definitions shall apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1

#### **barrier**

any material providing physical shield against ingress of water vapour which causes deterioration to the packaged article. This may be used in the form of a liner or as-a coating

### 3.2

#### **desiccant**

material used to take up water vapour from the air-space within a container or from air passed through it

### 3.3

#### **dunnage**

any materials within the barrier other than the packaged item, for example, packing or blocking materials, instrument cases, etc.

### 3.4

#### **hygroscopic**

substance capable of absorbing water vapour from the surrounding atmosphere.

### 3.5

#### **basic desiccant**

product capable of absorbing 27 % of moisture on its dry weight at 50 % relative humidity and 25 °C

### 3.6

### **ancilliary materials**

materials associated with packaging operations but are not intended to be part of the final product. They includes but not limited to desiccants, staple pins, adhesives, packaging tapes, Straps, packaging machinery.

## **4 Packaging environment**

### **4.1 Dampness**

**4.1.1** Dampness not only encourages corrosion but can also cause growth of molds and bacteria even when water is not present. Various steps can be taken to reduce the adverse effect of moisture on a packed article such as application of temporary protective treatment against corrosion to metallic surfaces or the proofing of textiles. Such direct protection is not practicable for all articles, especially for certain electrical components of scientific and optical instruments.

**4.1.2** An ideal method of providing protection in such instances is by using a completely sealed package. There may still be dampness inside the container, and the moisture may be given off by cushioning material used to hold the articles in position. Furthermore, few materials used in making sealed packages are completely resistant to penetration of water vapour and a certain amount of moisture may reach the articles through the walls of the package. Desiccants are, therefore, essentially used to take-up moisture that may be in package from any of these sources.

### **4.2 Humidity**

#### **4.2.1 General**

**4.2.1.1** Air naturally contains moisture in the form of vapour. The quantity of moisture present in a unit volume is known as absolute humidity. At any particular temperature, the air can hold only a limited amount of water vapour; the higher its temperature, the more water vapour the air can hold. Air containing as much water vapour as it can hold is said to be saturated. If saturated air is cooled, it will give up by condensation just enough of its moisture as liquid water to leave it saturated at the lower temperature.

**4.2.1.2** The maximum quantity of moisture which can be held in vapour form by the atmospheric air is determined by the temperature. The hygrometric tables and charts provide this data for a whole range of temperature.

#### **4.2.2 Relative humidity**

**4.2.2.1** Normally air is not saturated with water vapour unless it is in close contact with liquid water. The actual amount of water vapour present in air (that is, the absolute humidity) expressed as a percentage of amount the air contains when saturated at the same temperature is called the relative humidity or RH. For example, suppose a cubic metre of air contains 5 g of water vapour and that air if saturated at the same temperature would contain 20 g of water vapour per cubic metre, then the air has a relative humidity of:

$$\frac{5}{20} \times 100 = 25\%$$

Saturated air has relative humidity of 100 %

**4.2.2.2** The relative humidity of atmosphere is the dominating factor in determining whether the corrosion of metals, mould growth, rotting etc., will take place. It is known, for example, that at ordinary temperatures, corrosion of iron is extremely slow at relative humidity below 60 % but becomes rapid at higher humidities. Mould growth does not in general take place or is extremely slow unless the relative humidity is above 70 %. Generally, for engineering products a 50 % relative humidity level has been found to be the critical level and provides a tolerance against a sudden fall in temperature but for other products, other critical levels may apply.

## 5 Desiccated packages

### 5.1 General

**5.1.1** The deterioration of many articles can be minimized by applying suitable treatment to the article itself either during or after manufacture. Sometimes such treatment is not practicable or desirable and it is still necessary to protect the contents. One method of doing this is to ensure that the relative humidity of the atmosphere in contact with the item never exceeds a safe limit which is generally taken in practice to be 50 %.

**5.1.2** A package that contains a sufficient quantity of suitable desiccant to ensure that the RH within it will not exceed this figure when stored in any part of the world for a specified period is called desiccated package. An essential requirement of such a pack is that it should contain sufficient quantity of a suitable desiccant to reduce the relative humidity within the pack to 50 % or less and maintain this for the desired period. To assist in maintaining this reduced level of humidity, the entry of water vapour is retarded.

**5.1.3** There are various ways of achieving this. Hermetically sealed metal containers may be used, or the container may incorporate or be made from a water vapour barrier, that is a material with a high resistance to the passage of water vapour. It is rarely possible to exclude air from such packages or to avoid the use of interior packaging materials that contain some moisture.

### 5.2 Sources of moisture

**5.2.1** The air inside the barrier contains some water vapour.

**5.2.2** The air outside the barrier is the most important source of moisture even in a sealed container except a perfectly sealed metal or glass container which may be completely water vapour proof.

Air-tightness is an even less reliable criterion than waterproofness. The implication of this is that if the relative humidity outside the package is higher than inside, there is a tendency for moisture to pass into the package. Often in many countries, the relative humidity is 80 % to 100 % and since that of the atmosphere inside the package is to be kept below 50 %; the transmission of water vapour may be considerable.

**5.2.3** Hygroscopic material inside the barrier is a considerable source of moisture. For example, wood and paperboard are both hygroscopic and will give up moisture if temperature rises. The packaged item itself may create a problem if it's made from hygroscopic materials.

**5.2.4** Trapped water, there is always a possibility of water being trapped within the article, for example, in pumps after testing, or water being entrained in any oil remaining in an oil bath. Certain non-hygroscopic materials used for packaging contain water as a result of their manufacturing process. Expert guidance should be sought to deal with this problem.

## 6 Factors determining choice of desiccant

### 6.1 General management of the desiccant

**6.1.1** A desiccant maintains a safe relative humidity within the package by absorbing moisture from the air and any moisture arising from the goods internal hygroscopic materials. It will further absorb any moisture which enters the package through the barrier but only for a calculated period.

The desiccant should be in a dust proof container that will prevent its spreading throughout the pack and at the same time allow the desiccant to absorb the moisture from the atmosphere within the pack.

**6.1.2** There are many dehydrating agents that can be used but certain properties such as moisture absorbing capacity, chemical inertness, etc. makes some materials more suitable than others for use as desiccants in packaging.



## 6.2 Important factors

### 6.2.1 Moisture absorbing capacity of desiccant in relation to bulk and mass

To maintain a safe relative humidity inside a desiccated package, it is essential to have sufficient amount of desiccant to cater for all possible sources of moisture. In order to minimize the space required in the package for desiccant, it is desirable to use materials of high moisture absorbing capacity.

### 6.2.2 Stability and physical form of the desiccant

**6.2.2.1** The physical form of the desiccant should be such that it exposes maximum surface of the desiccant and allow diffusion of package atmosphere through its mass. The packaging for the desiccant should be designed to minimize hindrance to such diffusion. These conditions are best satisfied if the desiccant is available in the form of coarse granules, or tablets.

**6.2.2.2** The desiccant should retain its form throughout the performance of its function, i.e. should remain solid and dry to the touch and suffer little or no disintegration. The material should be such that the absorption of moisture is not by chemical changes that will cause it to corrode or otherwise damage its container or the article packed. It should not produce a liquid or gas or a significant rise in temperature.

**6.2.2.3** Desiccants remove moisture from the atmosphere in one of the following two ways:

- a) Physically - Moisture taken up physically is held less firmly and an increase in temperature can cause the desiccant to give up moisture to the atmosphere. It is important, therefore, that those desiccants which take up moisture physically should not give it up again in sufficient quantities to affect materially the relative humidity if the temperature rises.
- b) Chemically - Moisture taken up by chemical combination is firmly held and is not liberated by temperature increase normally encountered in the environment

### 6.2.3 Means of containing the desiccant

It is essential that the moisture in the package should be able to reach the desiccant and that the desiccant or dust from it should not be allowed to spread throughout the package. For this reason, importance is attached to the package in which the unit quantities of desiccant are held. The considerations discussed in clause 5 should, therefore, be taken into account in selecting a unit package for the desiccant. The unit package should be firmly anchored and properly distributed inside the package.

The desiccants may be indicative or non-indicative type. Indicative type changes colour as it absorbs moisture while non-indicative do not.

## 6.3 Commonly used desiccants for packaging

The following are commonly used desiccants for packaging:

- a) silica gel,
- b) activated alumina, and
- c) activated clays.

## 7 Quantity of desiccant

### 7.1 General

**7.1.1** Type of water vapour barrier. The layer or layers of the package that are intended to exclude water vapour constitute the water vapour barrier. Some barriers will allow the passage of water vapour only at an extremely slow rate but even at this rate, the relative humidity may become dangerously high in the absence of a desiccant after a few days under humid conditions.

**7.1.2** The important factor is the Water Vapour Transmission Rate (WVTR) of the barrier material. This rate is determined experimentally under standard conditions and is expressed in grams per m<sup>2</sup> per 24 h. Typical figures for WVTR for some of the materials are given in Table 1.

**Table 1 — WVTR of various materials at 38 °C and 90 % RH**

S/N	Material	Thickness (µm)	Typical WVTR (g/m <sup>2</sup> /24 h)	Test method
i.	Low density polyethylene	65	10.00	ISO 15106-3
		150	3.40	
		250	2.00	
ii.	High density polyethylene	25	25.00	
iii.	Cross linked orientated polyethylene	75	3.50	
		150	2.60	
iv.	Polypropylene	50	2.30	
v.	Polyvinyl chloride (PVC)	100	31.00	
		225	9.00	
vi.	Polyester	60	11.00	
		120	4.00	
vii.	Polyvinylidene chloride (PVDC)	25	5.00	
viii.	Fluorocarbon co-polymer	250	0.15	
ix.	Aluminium foil laminate	75	0.05	

**7.1.3** From the transmission rate, it is possible to calculate the quantity of desiccant necessary to keep the relative humidity inside a package below the critical level for any specified period under the climatic conditions it is expected to encounter. The better the barrier, the less the desiccant required; if no moisture can enter, no desiccant is required to deal with it though it would still be necessary to absorb moisture derived from interior packaging material and enclosed air. Any seals employed should at least be as adequate as the barrier material.

**7.1.4** In service packaging, water-vapour barriers are classified as follows:

- Water vapour resistant:** offers a high resistance to the passage of water vapour. Water Vapour Transmission Rate (WVTR) shall not exceed 8 g/m<sup>2</sup> per 24 h when measured at a temperature of 38 °C and a relative humidity of 90 %;
- Water vapour proof:** Offers a high resistance to the passage of water vapour; the Water Vapour Transmission Rate (WVTR) shall not exceed 1 g/m<sup>2</sup> per 24 h when measured at a temperature of 38 °C and a relative humidity of 90 %.

**7.1.5** Area of the barrier - The surface area should be kept as small as possible.

**7.1.6** Weight of hygroscopic material inside the barrier - Sufficient desiccant should be used to absorb moisture given off by hygroscopic materials such as wood and paperboard present inside the water vapour barrier and thus reduce the relative humidity to a safe value. All hygroscopic materials tend to reach equilibrium with the surrounding atmosphere at a relatively slow rate. If a desiccant is used, equilibrium is reached between the moisture in the package atmosphere and that in the hygroscopic material and the desiccant. It is necessary, therefore, to include enough desiccants to absorb the moisture that may be given off by the hygroscopic material at elevated temperatures and to ensure that the relative humidity can in no circumstances be above 50 %.

**7.1.7** Required period of storage - It is the total time elapsing between sealing the package by the packer and its first opening.

**7.1.8** Volume of air inside the barrier - The volume of air inside the package contains water vapour and allowance for this is made in the calculations given under 7.2.

**7.1.9** For extremely sensitive articles, the outer packing is preferably done in a partially dehumidified room particularly during the wet season.

## **7.2 Calculation of quantity of desiccant required**

### **7.2.1 Basic desiccant**

There are several different types of desiccants which may be used for several applications, all of which have a differing moisture absorption capability. As it is not practical to redefine the formulae for each type of desiccant, the calculations are based on the concept of basic desiccant.

### **7.2.2 Formulae**

- a) Where goods are shipped through, or stored in tropical conditions commercial distribution and warehousing practice;

$$W = 40ARM + DF$$

- b) Where goods are shipped and stored in temperate climates subject to normal commercial practice

$$W = 11ARM + DF$$

- c) Where goods are packed to military specifications for extended storage periods of not less than two years

$$\text{Unheated covered storage worldwide } W = 24ARM + DF$$

$$\text{Heated covered storage worldwide } W = 6ARM + DF$$

- d) Where goods are packed in a container manufactured from a water-vapour impervious material, such as, glass or metal fitted with a removable closure and when the sealing gasket is known to be capable of water-vapour transmission, the formulae in (d) become;

$$\text{Non-thermally insulated } W = 170 V + 90R_s LM + DF$$

$$\text{Thermally insulated } W = 70 V + 90 R_s LM + DF$$

where

$W$  is the mass of basic desiccant in g;

$A$  is the area of water vapour barrier in  $m^2$ ;

$M$  is the maximum storage time in months;

$R$  is the water vapour transmission rate of the barrier measured at 90 % RH and 38 °C in g/m<sup>2</sup> per 24 h;

$V$  is the volume of free air inside the barrier in m<sup>3</sup>;

$L$  is the length of seal (gasket) in m;

$R_s$  is the water vapour transmission rate of the seal in g/m length 24 h;

$D$  is the mass of dunnage inside the barrier in g; and

$F$  is the factor dependent upon the type of dunnage used as follows:

1/5 for timber of moisture content greater than 14 %;

1/8 for felt, carton board and similar packaging materials;

1/10 for plywood and timber with less 14 % moisture content; and

0 for expanded polyethylene or expanded polystyrene.

## 8 Conditions in use for desiccants

In order that the desiccant shall be fully effective in use, it is imperative that:

- a) the desiccant is in a fully activated condition;
- b) it can be reached by the air within the water vapour barrier but is prevented from spreading; over the items in the package;
- c) it is in perfect condition as regards its moisture-absorbing capacity when it is placed within the barrier; and
- d) as much as possible of the dunnage material is placed outside the barrier.

NOTE Annex A describes method of test for desired conditions of the packaging.

## **Annex A** **(informative)**

### **Methods of meeting desired conditions**

**A.1** The desiccant should be in unit containers such as bags or sachets which should be fastened securely within the water vapour barrier so that they will not wander or chafe.

**A.2.** Bags of desiccant are available in various sizes providing quantities of any particular desiccant equivalent in moisture-absorbing capacity to weight units of basic desiccant. Commercial desiccants can be obtained in unit containers equivalent to 25 g, 50 g, 100 g, 250 g, 500 g, 1 kg, 2.5 kg and 5 kg of basic desiccant.

**A.3** In order to achieve the requirement mentioned in 8), the units should be packed, transported and stored in sealed metal containers. The latter should be kept closed until the packer is ready to transfer and seal the required amount of desiccant into a space within the water vapour barrier, the metal container being closed immediately after transfer. It is not usually a good policy to obtain a bulk container of such a size that it has to be continually opened and shut in order to withdraw small numbers of units. It is preferable to have a larger number of small bulk containers. Indicator papers enclosed in the container should be checked as a guide whether the desiccant is still in good condition.

**A.4** The quantity of desiccant required for a particular package can be pre-determined by calculation. The distribution of the desiccant requires careful thought so that, wherever possible, the size of the barrier is not increased to accommodate the desiccant. Where dimensions are critical, the use of an alternative or thicker barrier material should be considered. It is often possible to utilize the empty spaces within the barrier by breaking down the total quantity of desiccant required into convenient units.

**A.5** Desiccant should not be removed from its unit container in order to add small quantities to a package. Unit containers of the desiccant should be used as supplied. It is sometimes advisable to make separate compartments for the necessary unit containers, both for convenience in packing and unpacking, and ease of securing, but if this method is adopted then adequate provision must be made to ensure a free circulation of air within the barrier. Material is used for these compartments, due allowance must be made if hygroscopic.

In the packaging of certain items, such as precision instruments, it is essential to prevent desiccant dust from escaping from its container. Special containers are available for this purpose. To safeguard against accidental sifting of desiccant from the unit containers, it is advisable that the packaged item be suitably protected so that the dust cannot filter into small orifices, oil holes, etc.

**A.6** Desiccants which for accidental or other reasons have been exposed to the atmosphere should never be introduced or re-introduced into the barrier. Where goods are sent for export shipment, there is a danger of the water vapour-proof barrier being damaged by customs examination and steps should be taken to avoid this, otherwise it may be necessary to re-desiccate and reseal the package. When calculating the amount of desiccant required, it is desirable to allow for unforeseen delays in transit. The expiry date should always be stamped on the package.

## **Bibliography**

EAS 931:2019 Packaging ancillary materials — Code of practice — Desiccants.



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