KINGDOM OF SAUDI ARABIA

SAUDI STANDARDS, METROLOGY AND QUALITY ORGANIZATION

SASO

SAUDI STANDARD

DEGRADABLE PLASTIC PRODUCTS

STANDARDS, METROLOGY AND QUALITY ORGANIZATION

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Foreword

Saudi Standards, Metrology and Quality Organization (SASO) has prepared the Saudi Standard "Degradable Plastic Products" based on relevant ADMO, International and National foreign Standards and references.
Degradable Plastic Products

1. SCOPE AND FIELD OF APPLICATION

1.1 This Standard specifies the specifications and test methods applicable to oxo-biodegradable disposable articles made from plastic films (polyolefin) based on polyethylene and polypropylene with film thickness ≤ 250 microns.

1.2 This standard covers essentially, but not limited to, flexible shopping bags and semi-rigid plastic packaging for food, magazines garbage bags, bin-liners for household use, cling film, soil remediation, agricultural/horticultural applications (e.g. banana bags, mulch film,) etc. and other articles normally used over short periods and subsequently discarded.

2. COMPLEMENTARY REFERENCES

2.1 –SASO ISO 472/2006 “Plastics- vocabulary”

2.2 -SASO-GSO-1863/2013 Food packages - part 2 plastic packages - general requirements


2.4 - SASO ASTM D5208/2014 Standard Practice for Fluorescent Ultraviolet (UV) Exposure of Photodegradable Plastics

2.5 - SASO ASTM D3826/98(2013) Standard Practice for Determining Degradation End Point in Degradable Polyethylene and Polypropylene Using a Tensile Test

2.6 - SASO ASTM D4001/2013 - Standard Test Method for Determination of Weight-Average Molecular Weight of Polymers By Light Scattering

2.7- SASO ASTM D2765/2011 Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics


2.9 - SASO ISO 17556/2012 Plastics -Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved
3. **DEFINITIONS**

3.1 For the purposes of this standard, the following terms and definitions and those given in SASO/ISO 472 “Plastics - Vocabulary” apply.

3.2 **Degradable plastic**

plastic designed to undergo a significant change in its chemical structure under specific environmental conditions, resulting in a loss in some properties that may vary as measured by standard test methods appropriate to the plastic and the application in a period of time that determines its classification.

3.3 **Biodegradable plastic**

degradable plastic in which the degradation process results in lower- molecular-weight fragments produced by the action of naturally occurring microorganisms.

3.4 **Abiotic degradation**

Degradation without influence from microorganisms, e.g. hydrolysis or oxidation by heat and/or light through the actions of living organisms.

3.5 **Oxidatively-degradable plastic**

degradable plastic in which the degradation results from oxidation.

3.6 **Shelf life**

storage time under specified conditions during which a material may be expected to retain its essential properties for example working properties and specified strength.

4. **materials and Use**

4.1. Materials made with oxo-biodegradable plastics are intended to show relatively rapid deterioration (as compared with normal plastics of the same type) of chemical, physical and mechanical properties when exposed to light, heat, and air after fulfilling their intended purpose. The purpose of the addition of pro-degradant additives to plastic polymers is to induce property changes associated with conditions that might be experienced when the material is discarded as litter, including the effects of sunlight, moisture, and heat.

4.2. for environment it is necessary to ensure that the particle size of the degraded plastic object is such that not only are they not visible, to mitigate unsightly litter, but also to ensure that the final residue does not add to soil toxicity. for this case, where are the eco-toxicity methods to be employed in assessing (soil impact)Phase 3.
5. Requirements

5.1-General

5.1.1 Food package Plastics

when the product use for food package All components, polymers and additives shall be conform with SASO-GSO-1863 standard.

5.1.2 Chemicals composition of degradable Plastic

All included components such as polymers, additives, fillers, pigments, stabilizers, pro-oxidants, etc. shall be declared to SASO with chemical/trade name and, where possible, the percentage of each component shall also be given. None of the included components constituting \( \geq 0.1\% \) not used if officially classified as environmentally hazardous according to the Globally Harmonized System (GHS)”.

5.1.3 Comply Products to Purpose

the products must be suitable for their purpose, meet its standard requirements and the fulfill functional demands.

5.1.4 Residual Material (Heavy metals)

The residual material from the abiotic tests shall not create harmful or persistent residues as measured. the heavy metals must be determined directly on test material before degradation in order to verify that their concentration is within acceptable limits as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>mg/kg of dry substance</th>
<th>Element</th>
<th>mg/kg of dry substance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn</td>
<td>150</td>
<td>Cr</td>
<td>50</td>
</tr>
<tr>
<td>Cu</td>
<td>50</td>
<td>Mo</td>
<td>1</td>
</tr>
<tr>
<td>Ni</td>
<td>25</td>
<td>Se</td>
<td>0.75</td>
</tr>
<tr>
<td>Cd</td>
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<td>As</td>
<td>5</td>
</tr>
<tr>
<td>Pb</td>
<td>50</td>
<td>F</td>
<td>100</td>
</tr>
<tr>
<td>Hg</td>
<td>0.5</td>
<td>Co</td>
<td>38</td>
</tr>
</tbody>
</table>
5.1.5 Shelf Life.
- All articles meant for use by consumers, and certified to be oxo-biodegradable, shall carry a “use by …” marking so as to forewarn the consumer about the useful life after which the article is liable to start degrading.

Figure (1)- Guide For Tests
5.2 Abiotic degradation (Phase 1)

5.2.1 To predict the behavior of polymer materials in the form of films when subjected to light and temperature stresses likely to occur in the K.S.A. The extent of degradation shall be evaluated by measuring the loss in mechanical properties, decrease in molecular weight, and determination of gel content after Samples will be exposed to ultraviolet radiation in a QUV Panel apparatus shall be give the following requirements.

5.2.1.1- Elongation at break $\leq 5\%$ of the original value ($\geq 95\%$ reduction).

5.2.1.2 decrease in molecular weight $< 5,000 *$Daltons (Da).

*Note: Dalton (Da) or, sometimes, universal mass unit (u), is a unit of mass used to express atomic and molecular masses. It is the approximate mass of hydrogen

\[ Values \ of \ u = 1.660538782(83) \times 10^{-24} \text{ g} \]

5.2.1.3 content of Gel Fraction $< 5\%$.

5.2.2 Test Procedures

5.2.2.1 - exposed to ultraviolet radiation in a QUV Panel /se test apparatus fitted with (UVA 340) lamps, in general accordance with ASTM D 5208.

5.2.2.2 - black panel temperature of 50ºC should be used in conjunction with a humid environment.

5.2.2.3 - The abiotic degradation test must proceed so that at the end of four weeks maximum in the QUV apparatus (equivalent to a calculated time of 24 months in the intended use & disposal conditions above), the oxo-biodegradable film should be fully embrittled, showing signs of breakdown.

5.2.2.4 - The irradiance of the lamps should be set at 0.78 W/m2/nm. Samples of the additive and control materials must be withdrawn every 48 hours, tested for percent Elongation at Break using ASTM D882 and their Carbonyl Indices determined by FTIR spectroscopy - Attenuated Total Reflectance (ATR) surface scan method.

5.2.2.5 - The surfaces of the samples analyzed are to be in contact with a Zn Se crystal with a 45º angle of incidence.

5.2.2.6 - The peaks are then analyzed without smoothing the data. Following equation is to be applied.
Carbonyl index (optical density) = $I_{1715}/I_{2912}$

Note: Carbonyl species (aldehydes, ketones, carboxylic acids, etc.) are reaction by-products of the oxidative degradation process and as such their accumulation are indicative of the rate of degradation.

5.2.3 Polyolefins should generally be reduced to the embrittled state of 5% elongation when the carbonyl index is greater than approximately 0.1 to 0.6 depending on the type, grade, pigmentation and thickness of the product under consideration. Thicker sections, stabilizer packages and heavier pigmentation can give critical carbonyl indices far greater than the range given, but the actual critical carbonyl index should be readily determined empirically during the testing procedure (by relating it to the embrittled state).

5.3 Gel formation (Non-degradable fraction)

A sample of the residual material from the abiotic degradation test shall be dissolved in an appropriate nonreactive solvent, such as toluene, and the gel phase, if any, separated by filtration, dried, and the weight ratio of gel to the total sample established. This is regarded as the non-degradable fraction of the polymer, and should be $\leq 5\%$ according to ASTM D2765.

5.4 Biotic degradation (Phase 2)

A portion of the residual material from the abiotic degradation test shall be tested for ultimate aerobic biodegradability under controlled conditions in a laboratory environment by analysis of evolved carbon dioxide.

5.5 Mineralization (Organic carbon convert) (Phase 2)

5.5.1 For products consisting of a single polymer (homopolymers 60 %) of the organic carbon must be converted to carbon dioxide before ending the test, and

5.5.2 For products consisting of more than one polymer (block copolymers, segmented copolymers, blends, or addition of low molecular weight additives), 90 % of the organic carbon must be converted to carbon dioxide, before ending the test according to ISO 17556:2012.
Films shall be require no more than 24 months to oxidize and biodegrade in the intended use and disposal options for the test to be viable. In this case, the film must present a controlled in-house shelf life of approximately 18 months at 20 °C; a further dwell time, normally around 2 months after photo-initiation takes place in an open outdoor field under an oxidative environment; and then a rapid breakdown of film properties resulting in acute embrittlement, normally after around another 4 months.

5.6 **Plant -toxicity test (plant germination) (Phase 3)**

For the toxicity tests and the determination of further biodegradation of the plastic materials in the soil by study its impact in Plant Germination as the following method:

5.6.1 After completion of Phase 2 as defined in 5.4 and 5.5 testing to preparing residual solids for toxicity following biodegradation the test method ASTM D5951 provides a guide summary of preparation follows:

5.6.2 After biodegradation in the chosen environment, remove residual solids and mix the contents of each replicate vessel carefully. Continue mixing until the contents are mixed thoroughly. The resulting homogeneous mixture should have uniform moisture content and appearance. Repeat the same procedure for positive reference and blank replicates.

5.6.3 The rest of the mixture is dried at a temperature of 20 to 45°C until a dry solids content of 65 ±2 % is reached. The dry solids content is determined after drying.

5.6.4 The dried mixtures can be stored for a maximum of four weeks at 4°C. The mixtures should be opened on a weekly basis to prevent slow accumulation of acids in the mixtures as a result of anaerobic conditions.

5.6.5 For the terrestrial toxicity tests and the determination of further biodegradation of the plastic materials in the soil, the final dried mixture at 65 % dry solids is used as is. for assess
5.6.6 Plant Germination—The potential effect of materials on plant germination may be assessed with the cress seed test. This step especially valuable for screening processing additives used at 1 % or less in the plastic. Soils from the above soil biodegradation testing may be evaluated at the beginning and end of the test to establish the potential effect of microbial degradation products. In the cress test, soil is extracted with water and filtered. The supernatant is used for the germination test. Various dilutions of the supernatant are prepared, and aliquots are added to petri dishes lined with filter paper. Cress seeds are placed on the wet paper and left to germinate in the dark over four days at room temperature.

5.6.7 The percentage of germinated seeds is determined after four days and compared to a water control. Soils containing test materials should not be significantly different from the blank soil at 95 %.

- See Figure (1) for test plan which carry out on the sample

NOTE 1: Film blends containing as much as 90% of recycled material have shown to pass the Oxo biodegradation testing, not dramatically speeding up the biodegradation process.

NOTE 2 It is a requirement that at least three replicates of each material evaluated be exposed to allow for statistical evaluation of results.
6 - Requirement Tests

Tests shall be carried out on the sample.

6.1 – Thickness of sample
6.2 – Mass of sample before and after.
6.3 – Heavy metals concentration.
6.4 – Abiotic degradation.
6.5 – Molecular weight.
6.6 – Gel content.
6.7 – Tensile strength monitoring.
6.8 – Non-Degradable Fraction.
6.9 – Carbon dioxide evolved.
6.10 – Plant toxicity test.

7 – Reporting.
The reporting section must clearly and objectively include the proposed real world applications and disposal environments for which the plastic end product is being developed, with indicated exposure and lifetime expectations. The report must identify the following:

Note: there is a form for test report in annex b

7.1 Product use must be clearly stated, target of application.
7.2 Product specifications must be noted including the thickness.
7.3 Polymer grade plus the commercial name of the pro-degradant additive formulation and percentage of additive inclusion, as well as the blend used in addition to the layer distribution (in the case of multilayer structures).
7.4 The required storage conditions for the plastic to maintain properties and not begin biodegradation earlier than stated shelf-life must be clearly indicated.

7.5 There should be shipment tracking information noting the shipping and transportation conditions, including required humidity level and temperature.

7.6 The proposed disposal medium for the plastic must be indicated, with anticipated service-life and storage-life noted.

7.7 The exposure conditions such as temperature, time, moisture and oxygen concentrations shall be reported.

7.8 The exposure conditions and time of exposure (kJ/m²·nm at 340 nm) to radiation, if used, must be recorded.

7.9 Molecular weight, tensile elongation and percentage of gels of the samples before and after the indicated time for abiotic test exposure shall be reported.

7.10 Mass before and after the test shall be reported.

7.11 Extent of biodegradation, expressed as a percentage of theoretical carbon dioxide, to be reported.

7.12 Percentage of gel or other non-degradable fractions, to be reported.

7.13 Volatiles (carbon dioxide) produced by the oxidation process, to be reported.

7.14 Additions of inoculants and moisture and their timing and any additional mixing procedures to be reported.

7.15 Regulated metal concentrations are to be reported.

7.16 Type of recycled materials used in the final product (if any), amount and source, and proportion oxo-biodegradable recycled material

**Note:** Additives can have a very significant effect on the performance of the oxo-biodegradable additive system. Stabilizers, such as antioxidants or UV absorbers in the base film, can slow down the degradation response while certain types of pigments can accelerate breakdown.
8- MARKING AND LABELING REQUIREMENT

Each pieces shall be legibly and indelibly marked with the following information in Arabic or in both Arabic and English and on package for small pieces which difficult to print on it.

8.1 Type of plastic material
8.2 Name of the manufacturer and / or the trademark
8.3 Country of origin and whether manufactured under license to a named brand / manufacturer.
8.4 Date of production in day , month and year and bar code.
8.5 Purpose and type of application.
8.6 The shelf life period and storage conditions
8.7 the oxobiodegradable Sign or Logo on each piece of product.
REFERENCE


3. SPCR 141 Polymeric waste compostable in small scale (home) composts – Requirements and test methods


5. OECD GUIDELINE 208 Terrestrial Plant Test:208: Seedling Emergence and Seedling Growth Test.

### ANNEX A (informative)

Examples for degradable plastic products

<table>
<thead>
<tr>
<th>Ser</th>
<th>Item</th>
<th>Ser</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carrier Bags</td>
<td>8</td>
<td>Cling Film</td>
</tr>
<tr>
<td>2</td>
<td>Courier and Security bags</td>
<td>9</td>
<td>Plastic Liners for Cartons</td>
</tr>
<tr>
<td>3</td>
<td>Mail Order Bags (Magazine and Newspaper Bags)</td>
<td>10</td>
<td>Polyethylene Sheets on Rolls such as table covers</td>
</tr>
<tr>
<td>4</td>
<td>soil remediation, agricultural/horticultural applications (e.g. banana bags, mulch film,)</td>
<td>11</td>
<td>Personal Care products such as gloves, shoe covers, aprons and any disposable personal care products</td>
</tr>
<tr>
<td>5</td>
<td>Bubble Wrap and Cushioning Packaging</td>
<td>12</td>
<td>Bags for packaging Bread, nuts, sweets and all bakery items</td>
</tr>
<tr>
<td>6</td>
<td>Flower Wrap</td>
<td>13</td>
<td>Plastic bags for seedlings</td>
</tr>
<tr>
<td>7</td>
<td>Overwrap Packaging</td>
<td>14</td>
<td>Shrink Film</td>
</tr>
<tr>
<td>8</td>
<td>Stretch Film</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex B (informative)

Test report form

<table>
<thead>
<tr>
<th>Report on materials test to KSA standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of report:</td>
</tr>
<tr>
<td>Name of the manufacturer and / or the trademark</td>
</tr>
<tr>
<td>Sample submitting entity</td>
</tr>
<tr>
<td>1- Target application</td>
</tr>
<tr>
<td>2- Plastic type</td>
</tr>
<tr>
<td>3- Production date</td>
</tr>
<tr>
<td>4- The shelf life period and storage conditions</td>
</tr>
<tr>
<td>Sample masses (mg)</td>
</tr>
<tr>
<td>Sample sizes (largest dimension, mm)</td>
</tr>
<tr>
<td>Tested: Yes/No</td>
</tr>
<tr>
<td>Test used</td>
</tr>
<tr>
<td>Exposure cycle A) and total exposure time Lamp UV used, humidity/Thermal oxidation/Temperature</td>
</tr>
<tr>
<td>1- M.wt</td>
</tr>
<tr>
<td>4- Elongation %</td>
</tr>
<tr>
<td>5- Gel content</td>
</tr>
<tr>
<td>and total exposure time</td>
</tr>
<tr>
<td>Biotic test</td>
</tr>
<tr>
<td>Plant-toxicity</td>
</tr>
<tr>
<td>Heavy metals concentration</td>
</tr>
<tr>
<td>Product fit to its standard</td>
</tr>
</tbody>
</table>