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Recycling Materials for Wrought Aluminium Alloys

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Preface

This document was drafted in accordance with GB/T 1.1-2020 Directives for Standardization - Part 1: Rules for the structure and drafting of standardizing documents.

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The main drafters of this document: Wu Xinfeng, Ge Lixin, Pan Feng, Zhao Xiaoguang, Deng Xiaowei, Liu Jun, Chen Guanbiao, Ge Sujing, Li Wangcheng, Cao Qiuhua, Ma Yue, Ma Pengtao, Luo Ming, Yuan Weibing, Que Shisheng, Zhan Shifen, Li Zhigang, Gu Huafeng, Yu Fang.

Recycling Materials for Wrought Aluminium Alloys

1 Scope

This document specifies the classification, requirements, test methods, inspection rules, factory inspection and acceptance, packaging, transportation, storage, quality certificates and purchase orders (or contracts) of recycling materials for wrought aluminium alloys.

This document is applicable to the wrought aluminium alloys raw materials (hereinafter referred to as raw materials) used for melting and casting obtained from recycled aluminum after sorting and processing.

2 Normative references

The content of the following documents constitutes an indispensable clause of this document through normative references in the text. Among them, for dated reference documents, only the version corresponding to that date is applicable to this document; for undated reference documents, the latest version (including all amendments) is applicable to this document.

GB/T 7999 Optical emission spectrometric analysis method of aluminum and aluminum alloys

GB/T 8005.1 Aluminium and aluminium alloys. Terms and definitions. Part 1: product and method of processing and treatment

GB/T 8170 Rules of rounding off for numerical values & expression and judgement of limiting values

GB/T 17432 Methods for sampling for analyzing the chemical composition of wrought aluminum and aluminum alloys

GB/T 20975 Methods for chemical analysis of aluminium and aluminium alloys
YS/T 491 Flux for wrought aluminium and aluminium alloy

3 Terms and definitions

The following terms and definitions defined in GB/T8005.1 apply to this document.

3.1 Recycling materials for wrought aluminium alloys

Wrought aluminum alloy raw materials for melting and casting that are obtained after sorting and other processing treatments of recycled aluminum that meet the relevant requirements of this document.

3.2 Foreign material

Non-metallic substances doped or attached to raw materials.

Note: foreign materials include wood, textiles, plastics, glass, stone, paper, sand, rubber, sludge, powders (powder, oil, crystalline salt, fiber powder, etc.) With a particle size of not more than 2 mm, and materials covered with organic polymer coatings, etc. They do not include the packaging of this product and other substances that need to be used during transportation.

3.3 Volatile substance

At a temperature lower than the melting point of the metal, the volatile substance can be separated from the raw material after being properly heated.

3.4 Metal recovery rate

The proportion of the aluminum alloy produced after the raw materials are pretreated and smelted according to the methods specified in this document, expressed as mass fraction.

4 Categories

4.1 The category, description, source, composition type and packaging method of raw materials are shown in table 1.

Table 1 Category, description, source, composition type and packaging method of raw materials

Category of raw materials	Description of raw materials	Source of raw materials	Composition type of raw materials*	Packaging method of raw materials"	
				Bulk	Compacted scrap
Recycled aluminum ingot	It is an aluminum ingot for melting and casting that is made of recycled aluminum	Wrought aluminium and aluminum alloy machining residues and	Raw materials of the same brand, raw materials of the same series brand, and raw	Bundle	

<table>
<tr><td colspan="2"></td><td>and meets the requirements of this document.</td><td rowspan="4">geometric scraps, unqualified products produced in the process of wrought aluminium and aluminum alloy production, wrought aluminium and aluminum alloy products that have lost their original functions and recycled aluminum composed of broken materials. See Appendix B~ Appendix D for the source of typical raw materials</td><td rowspan="4">materials of multi series brand</td><td></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Material</td><td>Heavy material</td><td rowspan="3">It is obtained after dismantling, mechanical separation or manual sorting, classification and other pretreatment processes to remove the inclusions in the recycled aluminum (see Appendix A for a typical diagram), and it meets the aluminum materials specified in this document.</td><td rowspan="3">Bagging/boxing/bundle/ nude packing/wrapping</td><td rowspan="3">Easily disassembled package/block</td><td rowspan="3">Compaction packages/blocks</td></tr>
<tr><td>Light material</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="7">See Appendix E for the chemical composition of various types of raw materials.
See Appendix B for typical packaging of raw materials of the same brand; see Appendix C for typical packaging of raw</td></tr>
</table>

materials of same series brand; and see Appendix D for typical packaging of raw materials of multi series brand. When the buyer has special requirements for the packaging of raw materials, it shall be negotiated by the supplier and the buyer and indicated in the order form (or contract).

Compaction packages/blocks refer to compressed packages/blocks that cannot be dismantled manually.

4.2 The size and specification of the recycled aluminum ingot and the net weight of the ingot shall be negotiated between the supplier and the buyer. See table 2 for dimensions and net weights of other raw materials.

Table 2 Raw material size specifications and net weight

<table>
<tr><td colspan="2" rowspan="3">Raw material packaging method</td><td colspan="3">Size and net weight of raw materials</td></tr>
<tr><td colspan="2">Large material</td><td>Small material</td></tr>
<tr><td>Heavy material</td><td>Light material</td><td></td></tr>
<tr><td colspan="2">Bulk</td><td>The diameter of the aluminum rod or wire in the raw material shall not be less than 10 mm, and the thickness or wall thickness of other materials shall not be less than 2 mm. The net weight of the block shall not be less than 10 kg.</td><td>The diameter of the aluminum rod or aluminum wire in the raw material shall not be less than 0.8 mm, and the thickness or wall thickness of other materials shall not be less than 0.2 mm. The net weight of the block is less than 10 kg and not less than 5 kg.</td><td>The diameter or thickness (or wall thickness) of the material block shall not be less than 0.2 mm. The net weight of the block shall be less than 5 kg.</td></tr>
<tr><td rowspan="2">Compacted scrap</td><td>Easily disassembled package/block</td><td colspan="3">The size and the net weight of the material block shall meet the requirements of bulk materials. The maximum size of the easily disassembled block shall be no more than 500 mm. The length of the easily disassembled package shall be no more than 2,400 mm, the width shall be no more than 1,100 mm, the height shall be no more than 1,000 mm, and the net weight shall be no more than 1,500 Kg.</td></tr>
<tr><td>Compaction package/block</td><td colspan="3">The size of the material block and the net weight of the material block shall meet the requirements of bulk materials. The maximum size of the compacted block shall not be greater than 500 mm, and the height of the compaction package shall not be greater than 500 mm.</td></tr>
</table>

5 Requirements

5.1 Foreign material content

5.1.1 The raw materials shall not be mixed with explosives such as combustibles, discarded bombs, and artillery shells.

5.1.2 The raw materials shall not be mixed into airtight containers and pressure vessels.

5.1.3 The inside of the compaction package/block shall not be mixed with foreign material.

5.1.4 The mass fraction of the material block covered with organic polymer coating shall be less than 5%; mass fraction of other foreign materials such as wood, paper, plastic, rubber, glass, stone, textiles, powders with a particle size not greater than 2 mm, etc. shall not be greater than 0.5%, and the mass fraction of powders (dust, sludge, oil, crystalline salt, fiber powder, etc.) with a particle size of not more than 2 mm shall be less than 0.1%.

5.2 Fracture organization of recycled aluminum ingots

The fracture structure of recycled aluminum ingots shall be dense and shall not be mixed with slag or foreign material.

5.3 Radioactive contaminants

The control of radioactive contaminants shall meet the following requirements:

A) There shall be no radioactive substances mixed therein;

$$\mu Gy/h$$

C) The α and β radioactive contamination levels on the surface of the raw materials shall be: the average value α of the maximum detection level of 300 cm2 on any part of the surface shall not exceed 0.04 Bq/cm", and β shall not exceed 0.4 Bq/cm2.

6 Test method

6.1 Content of foreign material

6.1.1 General inspection

6.1.1.1Compaction package/block

Observe whether there is foreign material in the compaction package/block.

6.1.1.2 Other raw materials

Visually check whether the raw materials are mixed with explosives, airtight containers, pressure vessels, materials covered with organic polymer coatings and other foreign materials, and estimate the mass percentage of foreign material in blocks covered with organic polymer coatings and other foreign material samples (easily disassembled package/block need to be disassembled). When it is suspected that the sample does not meet the requirements, the arbitration inspection shall be carried out according to 6.1.2.

6.1.2 Arbitration inspection

6.1.2.1 Weigh the mass of the sample and record it as m.

6.1.2.2 Manually sort out the material blocks covered with organic polymer coating, weigh and record it as m1.

6.1.2.3 Calculate the mass fraction wt of the material block covered with organic polymer coating on the surface according to formula (1), the value is expressed in %, and the calculation result is expressed to one digit after the decimal point, and rounded according to the provisions of GB/T 8170.

$$w_T = \frac{m_1}{m} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

Where:

M——the mass of the sample, the unit is kilogram (kg);

M1——the mass of the block of organic polymer coating on the surface, the unit is kilogram (kg).

6.1.2.4 Use a vibrating screen (see Appendix F) to screen out powders (dust, sludge, crystalline salt, fiber powder, etc.) with a particle size of not more than 2 mm, and the vibration time is 5 min, then use an electronic balance with an accuracy of 0.01 g to weigh and record the separated powder mass m2.

6.1.2.5 Calculate the powder mass fraction wf according to formula (2), the value is expressed in %, and the calculation result is expressed to one decimal place, and rounded according to the provisions of GB/T 8170.

$$w_F = \frac{m_2}{m} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Where:

M2—the mass of the powder, in kilograms (kg).

6.1.2.6 Manually sort out foreign materials such as wood, paper, plastic, rubber, glass, stone, textile, etc.

Carefully. If the size of the sample is too large, or foreign material is suspected of being embedded in it, the sample shall be broken and the embedded foreign material shall be mechanically separated. Weigh and record the total mass m3 of the separated foreign material plus the powder (m2).

6.1.2.7 Calculate the foreign material mass score wj according to formula (3), the value is expressed in %, and the calculation result is expressed to one decimal place, and rounded according to the provisions of GB/T 8170.

$$w_j = \frac{m_3}{m} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$

Where:
M 3—the total mass of foreign material, in kilograms (kg).

6.2 Fracture organization of recycled aluminum ingots

At 1/4 of the length of the ingot opposite the gate of recycled aluminum ingots, saw from the bottom to no more than 1/3 of the thickness of the ingot, break the ingot, and visually inspect the fracture of the ingot.

6.3 Radioactive contaminants

For the inspection of radioactive contaminants, see Appendix G.

7 Inspection rules

7.1 Inspection and acceptance

The product shall be inspected by the supplier before leaving the factory to ensure that the quality of the product meets the requirements of this document and the purchase order (or contract), and a quality certificate shall be filled in.

7.2 Batch

Raw materials shall be submitted for inspection in batches, and each batch of raw materials shall be composed of blocks of the same category, the same composition type, the same source and the same packaging method. The batch weight and batch weight deviation are determined through negotiation between the supplier and the buyer.

7.3 Inspection items and sampling

7.3.1 Inspection items

Each batch of raw materials shall be inspected for foreign material content, recycled aluminum ingots fractured tissue and radioactive contaminants.

7.3.2 Sampling regulations

7.3.2.1 Inspection of foreign material content and fractured structure of recycled aluminum ingots

7.3.2.1.1 The unpacking inspection quantity of raw materials for container shipment shall be no less than 50% of the total number of containers in the batch, and the devanning inspection quantity shall not be less than 10% of the total number of containers in the batch. Samples are randomly selected based on more than 5% of the net weight of the goods in each container inspected.

7.3.2.1.2 The inspection quantity of bulk shipping raw materials shall not be less than 50% of the total number of cabins in the batch. The number of landing inspections shall not be less than 10% of the total number of cabins in the batch, and samples shall be randomly selected based on more than 1% of the net weight of the cargo in each cabin.

7.3.2.1.3 For the raw materials transported by land, 100% inspection shall be carried out, and samples shall be randomly selected based on more than 5% of the net weight of the batch of goods.

7.3.2.1.4 At least 2 samples shall be taken from each batch. The quality of each sample (shall be 1 bundle/bag/case/package) shall be no less than 1t. The samples selected shall be representative.

7.3.2.1.5 Inspect the corresponding items at any position where the samples are taken.

7.3.2.2 Inspection of radioactive contaminants

100% of the raw materials shall be sampled and inspected.

7.4 Judgment of inspection results

7.4.1 For the inspection of foreign material, double samples shall be determined in advance. When the first inspection does not meet the requirements, the second sample can be inspected, and the weighted average calculation with the first inspection result can be carried out. If the weighted average calculation result is qualified, the batch is judged to be qualified; otherwise, it is judged that the batch does not meet the requirements of this document.

7.4.2 For the inspection of the fractured structure of recycled aluminum ingots, double samples shall be

determined in advance. If the first inspection does not meet the requirements, the second sample can be inspected. If the result of the second inspection is qualified, the batch of raw materials is judged to be qualified, otherwise it is judged that the batch does not meet the requirements of this document.

7.4.3 If the inspection result of radioactive contaminants is unqualified, it is determined that the batch of raw materials does not meet the requirements of this document.

8 Incoming inspection and acceptance

The purchaser shall carry out incoming inspection and acceptance in accordance with Appendix H. If the inspection result does not conform to the provisions of this document and the purchase order (or contract), it shall be submitted to the supplier in writing. If arbitration is required, a unit recognized by both the supplier and the buyer can be entrusted to conduct arbitration and take samples together with the buyer.

9 Packaging, transportation, storage and quality certificate

9.1 Packaging

9.1.1 Packaging method of raw materials shall be negotiated and determined by the supplier and the buyer, and indicated in the order form (or contract).

9.1.2 The exterior of the package shall be accompanied by a label containing the following contents:

A) Type of raw material, source of raw material;

B) Raw material packaging form [large material/small material, heavy material/light material, bulk/easily disassembled or compacted (package or block)];

C) Total weight;

D) Net weight;

E) Type of raw material composition (brand/series/level);

F) The number of this document.

9.1.3 If the buyer has requirements for informatization signs such as QR codes or barcodes, the contents of the informatization signs shall be negotiated and determined by the supplier and the buyer, and shall be indicated in the order form (or contract).

9.2 Transportation and storage

Waterproof measures shall be taken during transportation, loading and unloading, and stacking.

9.3 Quality certificate

Each batch of raw materials shall be accompanied by a quality certificate, which shall indicate:

A) The name of the supplier;

B) Type of raw material, source of raw material;

C) Raw material packaging form [large material/small material, heavy material/light material, bulk/easily disassembled or compacted (package or block)];

D) Type of raw material composition (brand/series/level);

E) Net weight;

F) Index inspection results of volatile content, foreign material content, metal recovery rate, etc.;

G) Inspection and printing by the supplier's quality supervision department;

H) The number of this document.

10 Contents of the purchase order (or contract)

The purchase order (or contract) for the materials listed in this document shall include the following:

A) Type of raw material, source of raw material;

B) The packaging form of the raw materials;

C) Composition type;

D) Special requirements for the appearance and size specifications of the raw materials;

E) Foreign material content;

A) Volatile content;

B) Metal recovery rate;

C) Number of this document

Appendix A

(Informative)

Typical figures of foreign material

Figure A.1-Figure A.14 shows typical examples of foreign material.

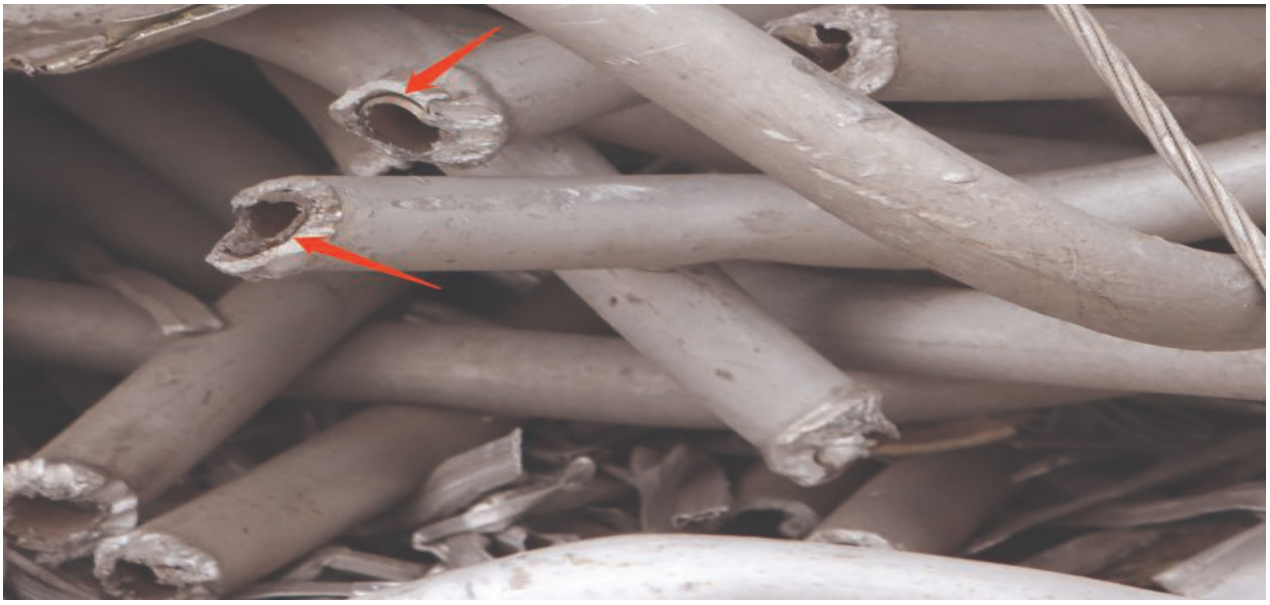

Figure A.1 Copper core parts inlaid inside aluminum tubes

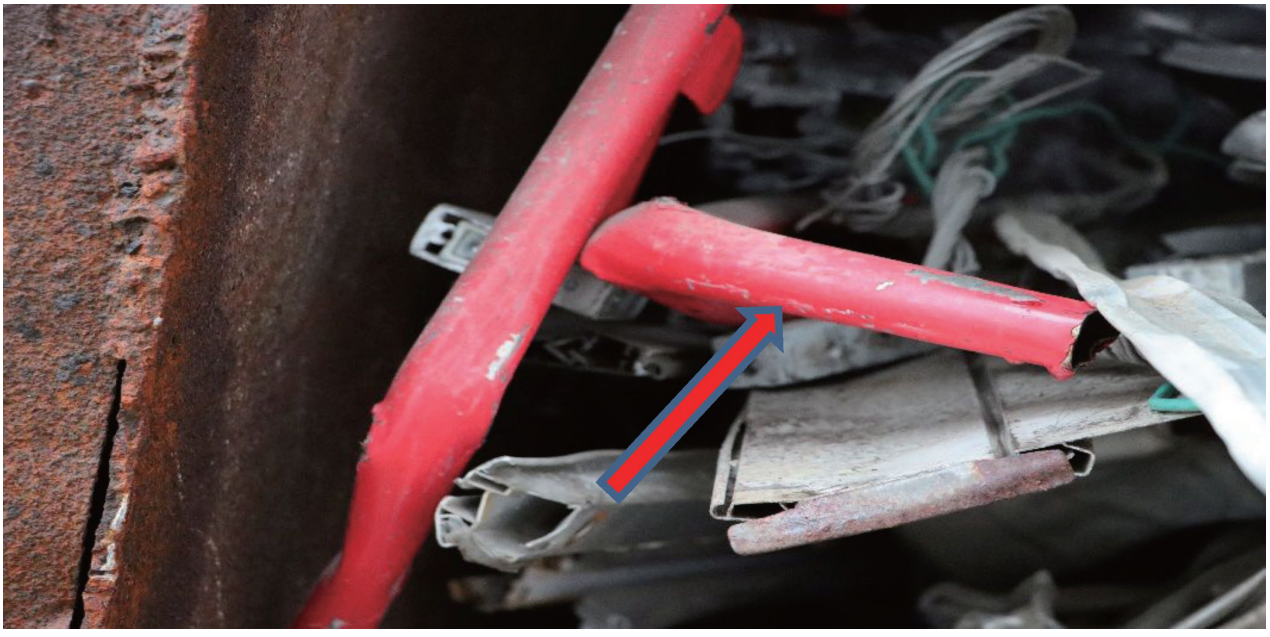

Figure A.2 Paint coating covering the surface of aluminum pipe

Figure A.3 Copper screws inlaid in aluminum plate

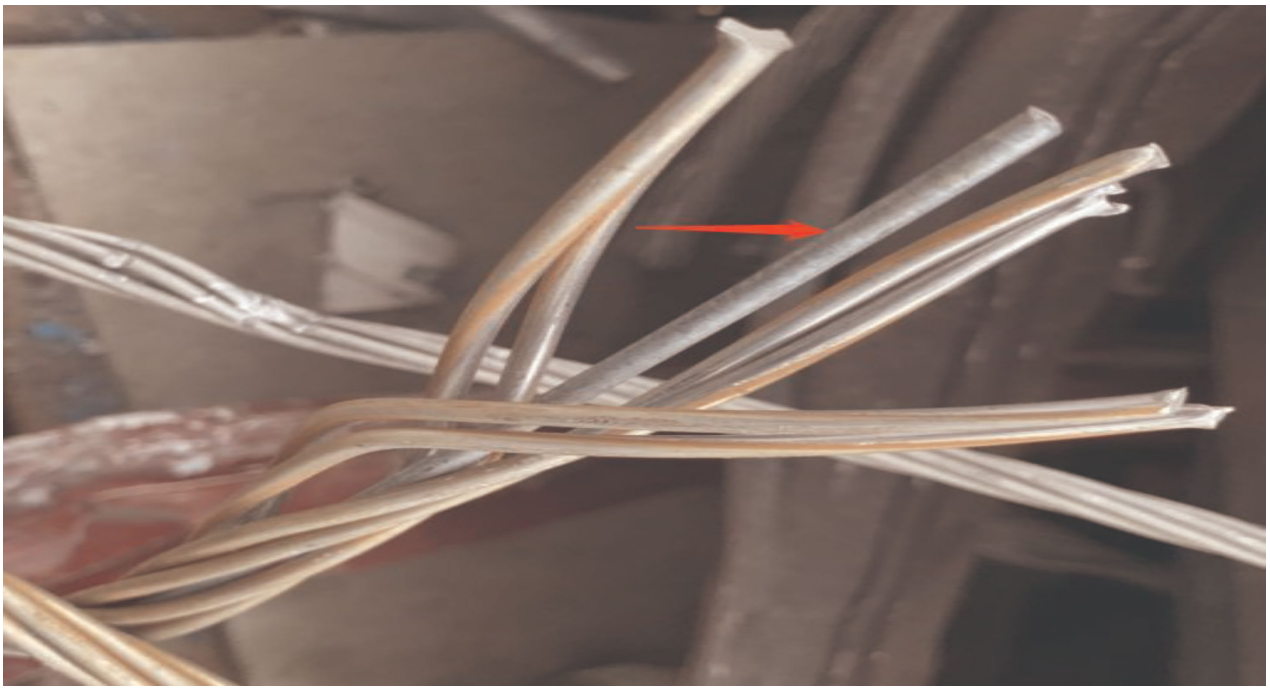

Figure A.4 Steel wire in aluminum wire

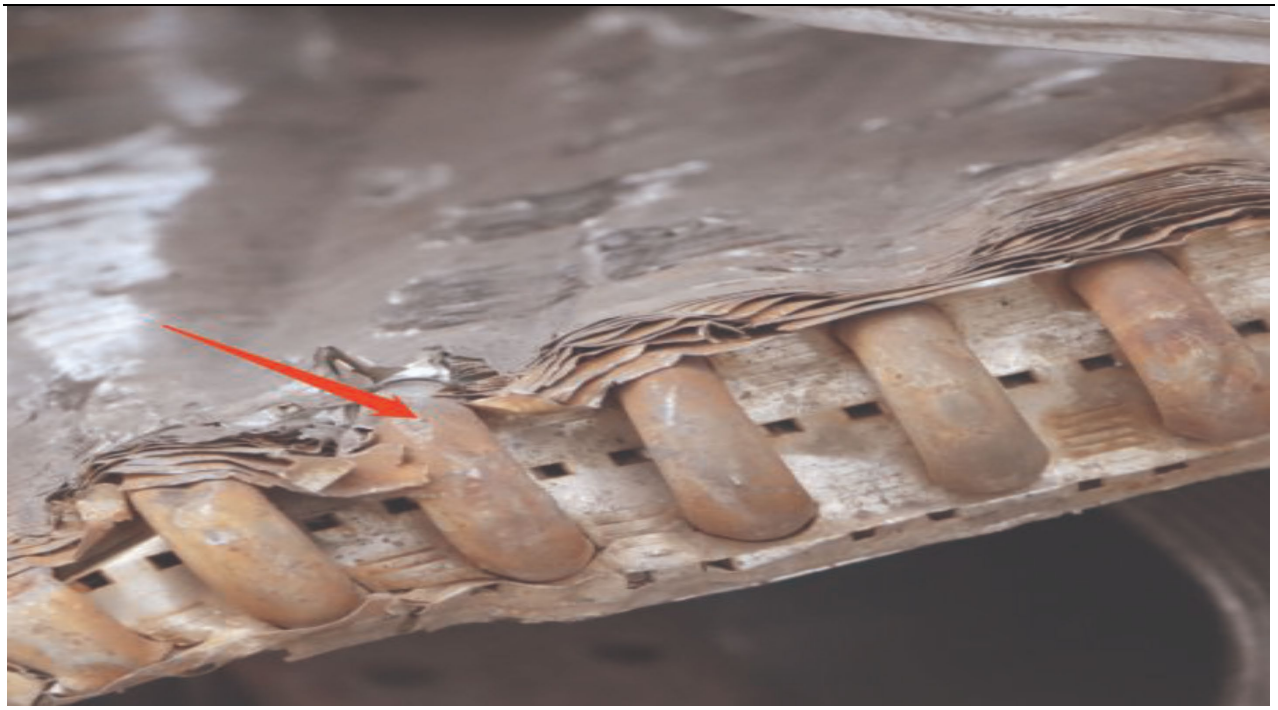

Figure A.5 Copper tube inlaid inside aluminum plate

Figure A.6 Circuit board aluminum plate

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Figure A.7 Felt inlaid in aluminum plate

Figure A.8 Plastic and glass in aluminum lamps

Figure A.9 Iron inlay in aluminum pot

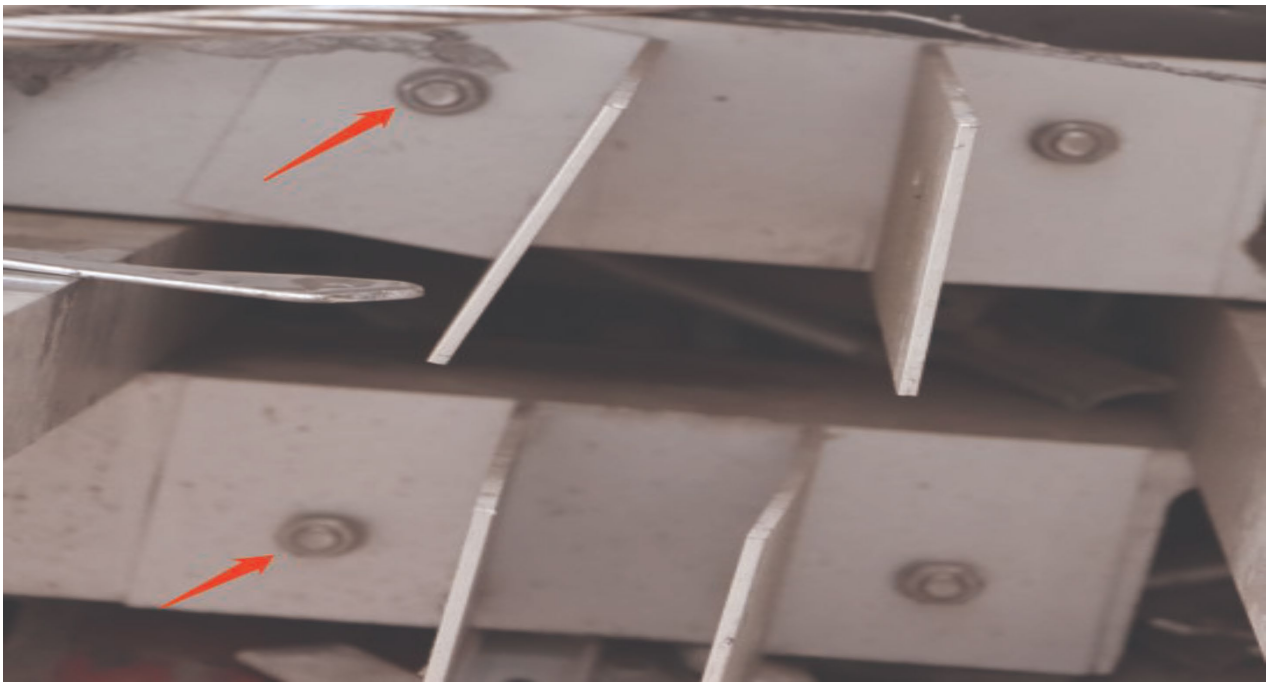


Figure A.10 Iron screws in aluminum plate

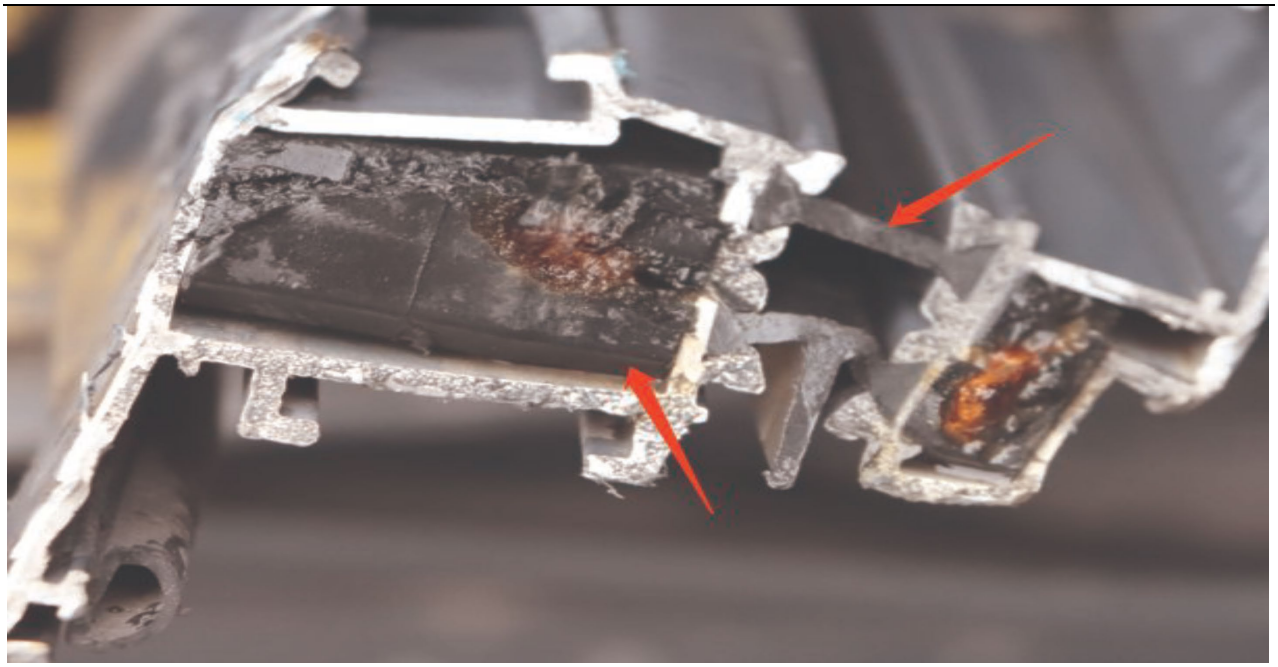


Figure A.11 Non-metallic insulation in aluminum profiles

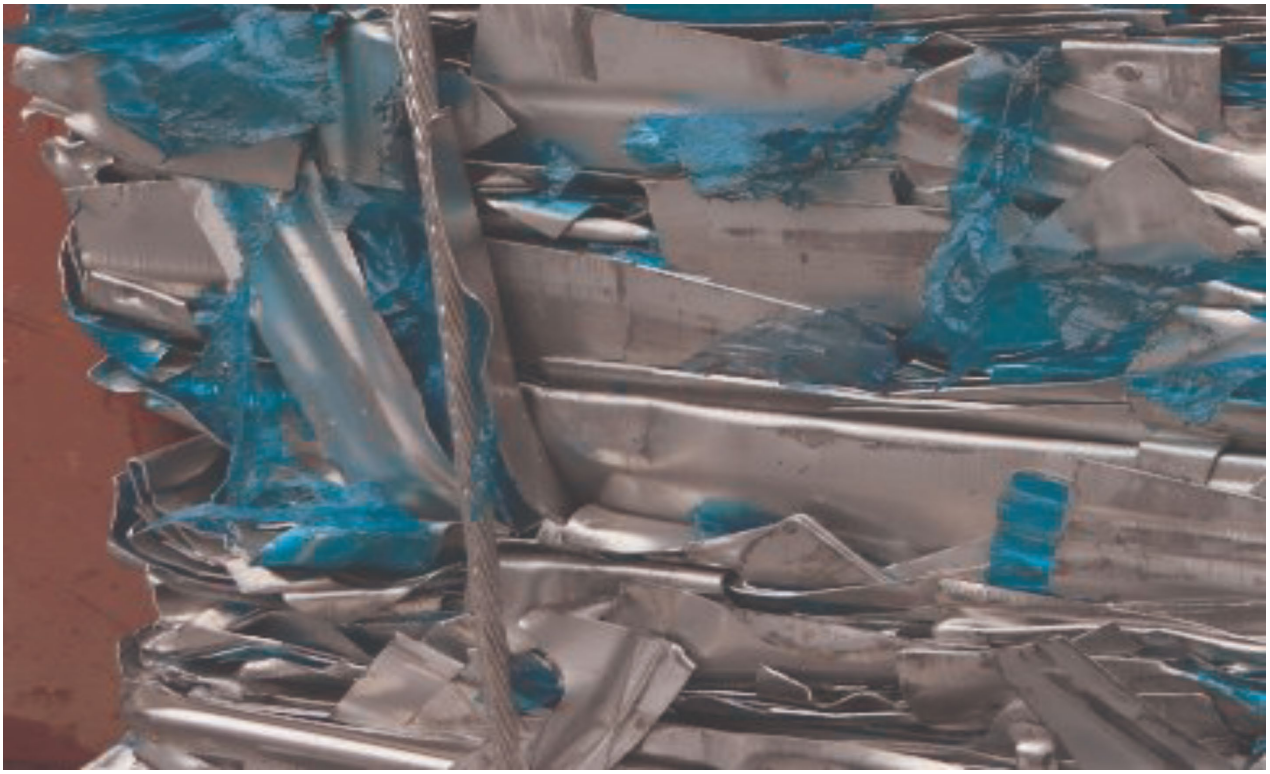


Figure A.12 Adhesive film on the surface of aluminum plate

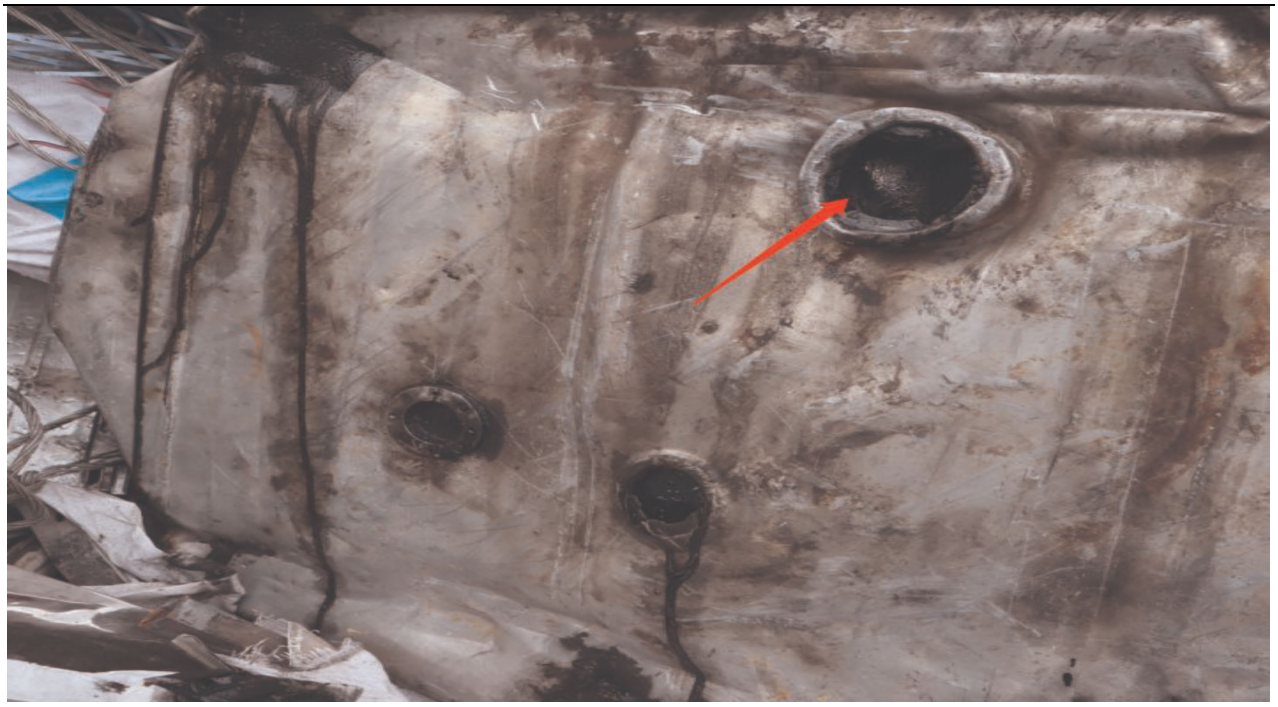


Figure A.13 Oil stains on aluminum appliances

Figure A.14 Mud, sand and pollution corrosion products on the surface of aluminum plate

Appendix B

(Informative)

Typical sources and packaging methods of raw materials of the same brand

Figure B.1 - Figure B.16 gives examples of typical sources and packaging methods of raw materials of the same brand.

Figure B.1 Bulk small material - from the old extruded material of the same brand.

A) Remnant of extruded material processing B) Remnant of plate processing

Figure B.2 Bulk small material - newly processed remnants and geometric waste of the same brand

Figure B.3 Bulk small material - from casting, forging, and extrusion new materials of the same brand

Figure B.5 Bulk small material - from the new clean printing plate base

Figure B.6 Bulk large material (heavy) - from the new processing remnant material and geometric waste of the same brand

Figure B.7 Bulk large material (heavy) - from the old extruded material of the same brand

Figure B.8 Bulk large material (heavy) - from forged aluminum wheels

Figure B.9 Bulk large material (heavy) - from aircraft aluminum plate

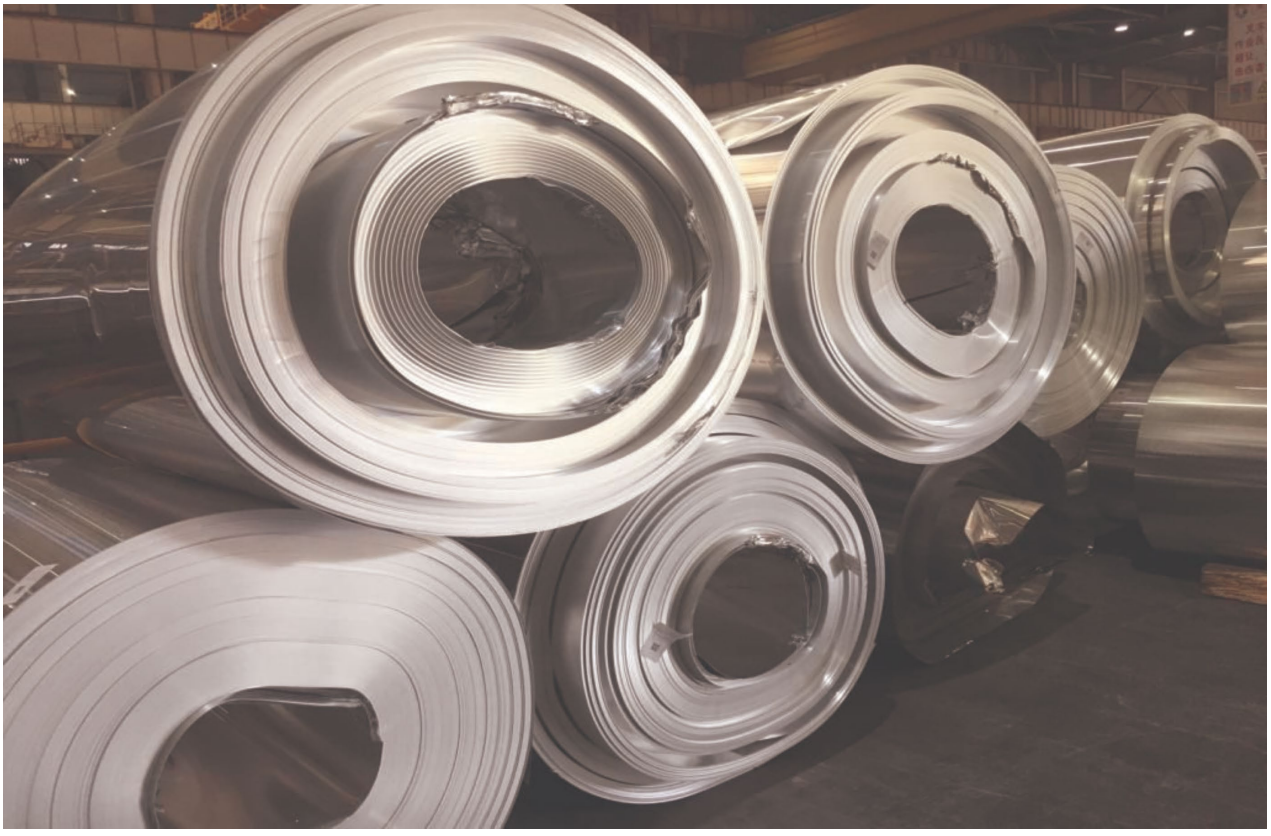
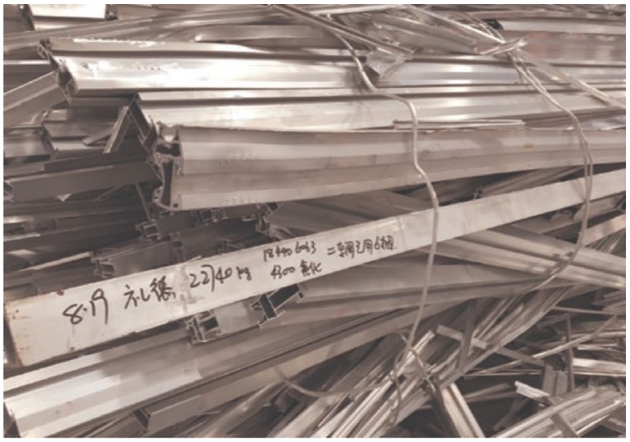


Figure B.10 Bulk large material (light) - from aluminum plate, aluminum strip of the same brand

Figure B.11 Bulk large material (light) - from the aluminum appliance

A) Discard



B) Extruded profiles with unqualified performance

Figure B.12 Bulk large material (light) - from the new extruded material of the same brand

A) Aluminum wire of the same brand

B) Aluminum cables of the same brand

Figure B.13 Bulk large material (light) - from aluminum wire (cable) of the same brand

Figure B.14 Easily disassembled package of large material (light) - from aluminum wire (cable) of the same brand

Figure B.15 Compaction block of small material - from new processing remnant material and geometric waste material of the same brand

Figure B.16 Compaction package of large material (heavy) - from the old extruded material of the same brand

Appendix C

(Informative)

Typical source and packaging of material of the same series brand

Figure C.1 ~ Figure C.6 give examples of typical sources and packaging of material of the same series brand.

Figure C.1 Bulk small material - from mixed new processing remnant materials and geometric waste materials

Figure C.2Bulk large material (light) - from extruded material "10/10"

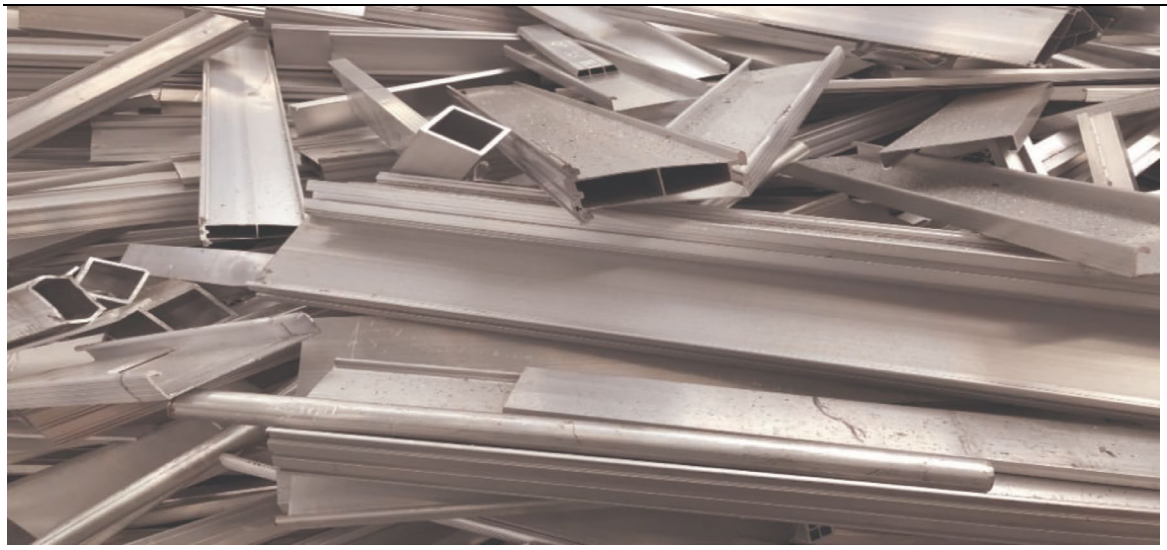


Figure C.3 Bulk large material (light) - from the mixed new processing remnant material and geometric waste

Figure C.4 Easily disassembled package of small material - from mixed new processing remnant materials and geometric waste materials

Figure C.5 Easily disassembled package of large material (light) - new aluminum wires and cables from the same series

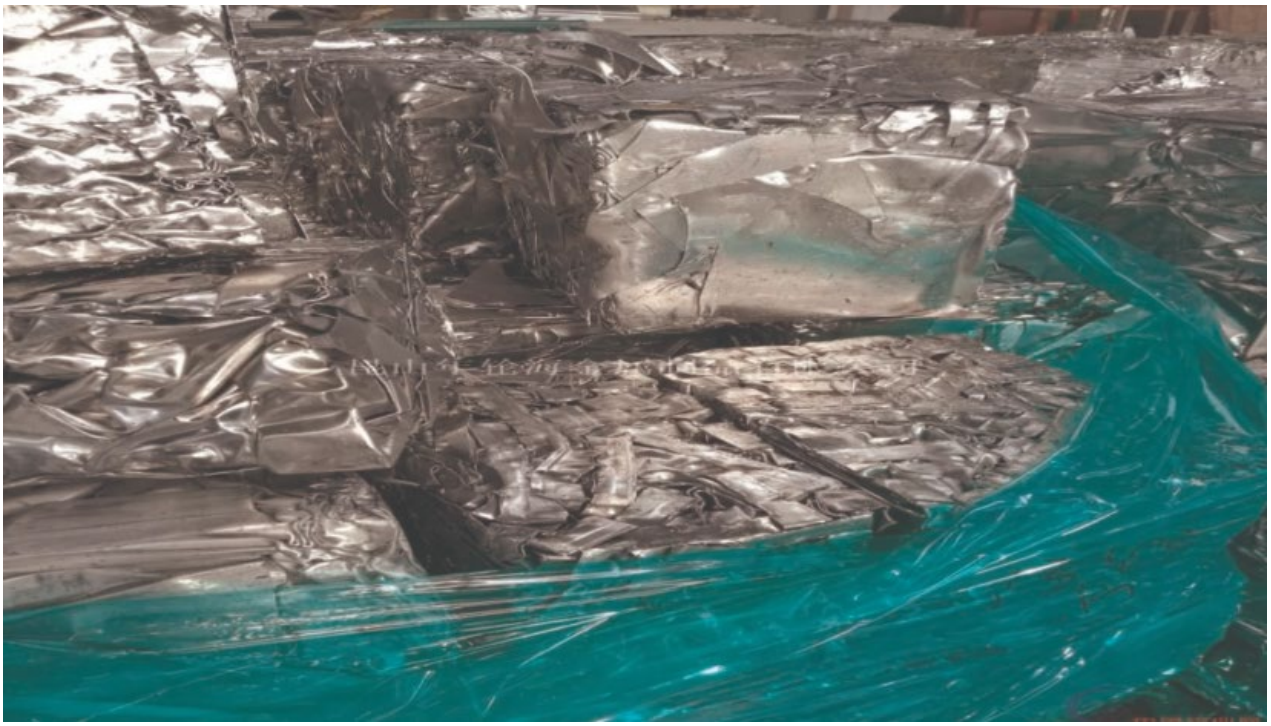


Figure C.6 Compaction block large material (light) - from mixed new processing remnant material and geometric waste

Appendix D

(Informative)

Typical source and packaging of material of multi series brand

Figure D.1 ~ Figure D.8 give examples of typical sources and packaging methods of material of multi series brand.

Figure D.1 Bulk small material - from mixed new processing remnant materials and geometric waste materials

Figure D.2 Bulk small material - from the clean printing plate base

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Figure D.5 Easily disassembled package of large material (heavy) - from mixed old extruded material

Figure D.6 Easily disassembled package of large material (heavy) - from mixed old aluminum

Figure D.7 Easily disassembled package large material (light) - from mixed new processing remnant materials and geometric waste materials

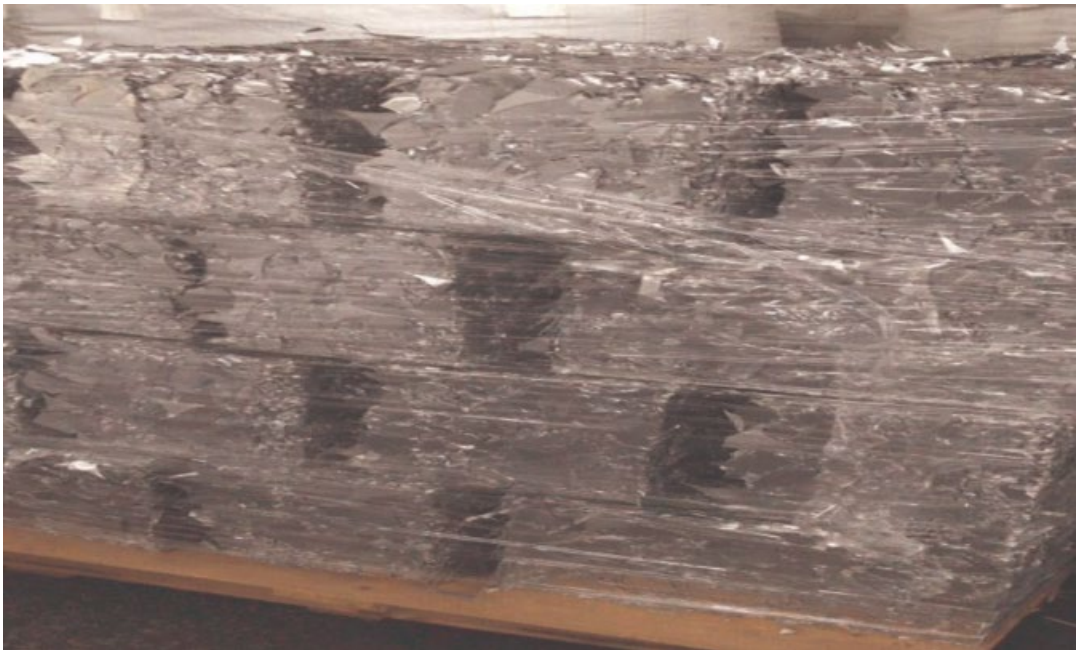

Figure D.8 Compaction package of small material - from mixed new processing remnant materials and geometric waste materials

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Appendix E

(Informative)

Chemical composition of raw materials

E.1 The chemical composition of material of the same brand

For the chemical composition of material of the same brand, see GB/T 3190.

E.2 The chemical composition of material of the same series brand

The chemical composition of material of the same series brand is shown in Table E.1~Table E.7.

Table E.1 the chemical composition of 2××× series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Other[b]		Ai
							Single	Total	
Mass fraction [a] %	0.50	0.50	3.5	0.7	2.0	0.25	0.05	-	Margin
a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit. b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.									

Table E.2 chemical composition of 3××× series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction[a] %	0.6	0.6	0.20	1.3	1.3	0.20	0.10	0.10	0.10	-	Margin
a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit. b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.											

Table E.3 chemical composition of 5××× low magnesium series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction[a] %	0.3	0.5	0.10	0.6	2.5	0.25	0.20	0.10	0.05	-	Margin

Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.

"Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.4 chemical composition of 5××× high magnesium series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction[a] %	0.3	0.5	0.10	0.6	2.5-6.0	0.25	0.20	0.10	0.05	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.

b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.5 chemical composition of 6××× series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction [a] %	1.1	0.5	0.20	0.15	1.0	0.25	0.20	0.10	0.05	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.

b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.6 chemical composition of 7××× cr-containing series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction [a] %	0.40	0.50	1.0	0.20	2.5	6.5	0.20	0.10	0.05	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.
b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.7 chemical composition of 7××× Zr-containing series

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Cr	Ti	Others[b]		Ai
									Single	Total	
Mass fraction[a] %	0.50	0.50	1.0	0.20	2.5	6.5	0.10	0.20	0.05	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.
b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

E.3 the chemical composition of material of multi series brand

The material of multi series brand is divided into three levels: A, B and C. The chemical composition of grade A raw materials is shown in Table E.8, the chemical composition of grade B raw materials is shown in Table E.9, and the chemical composition of c-grade raw materials is shown in Table E.10.

Table E.8 chemical composition of grade A raw materials

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Ti	Others[b]		Ai
								Single	Total	
Mass fraction[a] %	0.7	0.7	0.40	0.50	0.6	0.40	0.20	0.10	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.
b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.9 chemical composition of grade B raw materials

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Ti	Others[b]		Ai
								Single	Total	
Mass fraction[a] %	1.0	0.8	0.80	0.50	0.6	0.50	0.20	0.10	-	Margin

a. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.

b. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Table E.10 chemical composition of grade C raw materials

Chemical composition	Si	Fe	Cu	Mn	Mg	Zn	Ti	Others[b]		Ai
								Single	Total	
Mass fraction[a] %	1.5	1.2	1.0	1.0	2.0	0.7	0.20	0.15	-	Margin

A. Where the content in the table is a single value, aluminum is at the lowest limit, and other elements are at the highest limit.

c. "Other" refers to elements that are not listed or specified in the table for mass fraction values.

Appendix F

(Informative)

Vibrating screen

F.1 Working mechanism

The motor rotates to drive the eccentric block, which makes the screen frame with fixed-size holes vibrate regularly, so as to separate materials of different sizes like a sieve shaker.

F.2 Basic requirements

F.2.1 Main components

The vibrating screen is mainly composed of a vibration system, a screen frame, a receiving device, and a shock absorption device.

F.2.2 Vibration system

The vibration system includes a motor, a speed change device, a rotating shaft, and an eccentric block.

F.2.3 Screen frame

F.2.3.1 The mesh size of each screen frame is fixed.

F.2.3.2 The height of the side of the screen frame shall not be less than 140 mm, and the distance between adjacent screen frames shall be 10 mm~15 mm.

F.2.3.3 A discharge port shall be provided at the bottom of the screen frame.

F.2.3.4 The screen frame shall be easy to disassemble and install.

F.2.4 Receiving device

F.2.4.1 The discharge direction of two adjacent screen frames with different screen hole sizes shall be kept the same.

F.2.4.2 The discharging nozzle of the screen frame with the same discharging direction protrudes 400 mm

from the frame.

F.2.5 Damping device

The damping spring is installed at the lower end of the vibrating screen frame and shall be vertical to the ground plane.

F.3 Technical indicators

F.3.1 The working size of the screen surface: 2 000 mm × 1 000 mm.

F.3.2 Motor parameters: 1.5 kw, 1 400 r/min.

F.3.3 Amplitude: 5 mm~7 mm.

F.3.4 Screen inclination angle: 10°±1°.

F.3.5 Screening capacity: ≤2 t/h.

F.3.6 All discharge ports are discharged in a staggered manner.

F.3.7 Surface screen: the screen hole diameter is 70 mm.

F.3.8 Middle screen: the screen hole diameter is 28 mm.

F.3.9 Bottom screen; the diameter of the screen hole is 2 mm or 5 mm.

F.3.10 The bottom screen shall be freely drawn and replaced in time according to the measured size of the raw material and the size of the foreign material.

F.4 Structure of vibrating screen

The structure diagram of the vibrating screen is shown in Figure F .1.

Indexing serial number description:

1 - Feed inlet;

2 - The support of the screen frame;

3 – Shock absorption spring;

4 - Mounting bracket;

5 - Exit of surface screen throughs;

6 - The frame of material transfer;

7- The exit of the middle screen throughs;

8 - The exit of bottom screen through;

9 - The exit of bottom screen throughs;

10 - Vibration machine;

11 - Surface screen;

12- Middle screen;

13 - Bottom screen,

Figure F .1 Schematic diagram of vibrating screen

Appendix G

(Informative)

Inspection methods for radioactive contamination

G.1 Inspection instrument

The instrument used for inspection shall meet the requirements of GB 18871, GB/T 12162.3 and GB/T 5202.

G.2 Measurement of the penetration radiation dose rate of external exposure

G.2.1 Measurement of natural environmental radiation background value

G.2.1.1 Before measuring the external radiation penetrating radiation dose rate, the local natural environmental radiation background value shall be measured and determined first.

G.2.1.2 Select 3~5 points (which can be used as fixed survey points) that can represent the local normal natural radiation background state and flat open ground without radioactive pollution as the measurement points.

G.2.1.3 Place the probe of the measuring instrument at a height of 1 m from the ground above the measuring point, determine the external radiation penetration radiation dose rate, and read the measured value once every 10 s. Take the average of 10 readings as the measured value at this point, and take the arithmetic average of the measured values at each measurement point as the normal natural radiation average.

G.2.1.3 Place the probe of the measuring instrument at a height of 1 m from the ground above the measuring point, measure the external radiation penetrating radiation dose rate, and read the measured value once every 10 s. Take the average of 10 readings as the measured value of the measuring point, and take the arithmetic average of the measured values of each measuring point as the normal natural radiation average.

G.2 Measurement of penetration radiation dose rate of external exposure

G.2.1 Measurement of natural environmental radiation background value

G.2.1.1 Before the external radiation penetration radiation dose rate measurement, the local natural environmental radiation background value shall be measured and determined first.

G.2.1.2 Select 3 to 5 points (can be used as fixed survey points) that can represent the local normal natural radiation background state and flat open ground without radioactive pollution as the measurement points.

G.2.1.3 Place the probe of the measuring instrument at a height of 1 m from the ground above the measuring point, measure the external radiation penetration radiation dose rate, and read the measured value once every 10 s. Take the average of 10 readings as the measured value at this point, and take the arithmetic average of the measured values at each measurement point as the normal natural radiation average.

G.2.2 Patrol detection

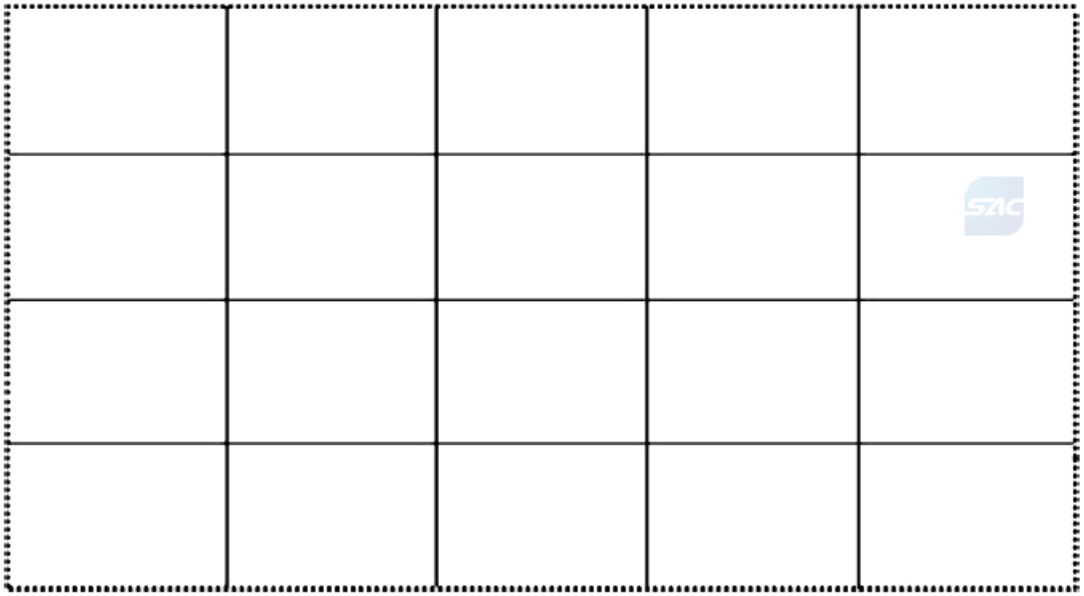
G.2.2.1 The raw materials shall undergo patrol detection of radioactive contamination before passing through the port channel. For patrol detection, place the measuring instrument as close as possible to the surface of the measured object or the surface of the container, car body, warehouse body, etc. Loaded with raw materials, so as to perform patrol detection on the peripheral surface of the measured object.

G.2.2.2 During patrol detection, if it is found that the radioactivity obviously exceeds the management limit of the three detection indicators, it will be judged as unqualified. If radioactive contamination has been found to exceed the management limit of the three detection indicators, no separate inspection or selection will be carried out.

G.2.3 Distribution of test points

G.2.3.1 For cars, trains, containers and ships that carry raw materials, or bulk materials spread in a pile, the points can be arranged according to the grid method (see figure g.1). Direct measurement methods are used to detect the external radiation penetrating radiation dose rate and surface contamination.

Figure g.1 Schematic diagram of radioactive contamination measurement points



G.2.3.2 For automobiles, the points are arranged and measured on the 6 intersections of the grid according to the longitudinal 2-line and horizontal 3-line grid method of the carriage.

G.2.3.3 For trains and containers, the layout and measurement shall be carried out according to the grid method of vertical and horizontal directions, and the number of points shall be no less than 10.

G.2.3.4 For ship cabins, grids shall be laid out based on the size of the deck and the front, middle and rear 3 lines and the left, middle and right 3 lines of the deck. The measurement points shall be arranged at the intersection of the grid, and the number of points shall be no less than 12.

G.2.4 Measurement

G.2.4.1 Standard operation shall be carried out in accordance with the requirements of the instruction manual of the measuring instrument.

G.2.4.2 Place the probe of the measuring instrument as close as possible to the surface of the measured object (the distance between the probe of the general measuring instrument and the measured object is no more than 300 mm).

G.2.4.3 Start measurement and reading after the display value of the measuring instrument is stable, and read once every 10 s. Take the average of 10 readings as the measured value of the external radiation penetrating radiation dose rate of the measuring point.

G.2.4 Measurement

G.2.4.1 Conduct standardized operations in accordance with the requirements of the instruction manual of

the measuring instrument.

G.2.4.2 Place the probe of the measuring instrument as close as possible to the surface of the measured object (the distance between the probe of a general measuring instrument and the measured object shall not be greater than 300 mm).

G.2.4.3 Start measurement and reading after the display value of the measuring instrument is stable, and read once every 10 s. Take the average of 10 readings as the measured value of the external radiation penetration radiation dose rate of the measuring point.

Note: when inspecting tubes, containers and other containment bodies, special attention shall be paid to the α and β possible surface contamination inside, which cannot be easily detected from the outside due to shielding.

G.2.5 Efficiency factor of the measuring instrument

G.2.5.1 For measuring instruments in service, the calibration source shall be used for tracking calibration (for example, once in the morning, noon, and evening respectively).

G.2.5.2 Place the measuring instrument probe above the non-polluting dry ground, and then after the probe is stabilized, read once every 10 s. Take the average value D1 of 10 readings as the background value of natural environmental radiation.

G.2.5.3 Adjust the gear of the instrument according to the net source value R of the calibration source, buckle the calibration source on the probe and stand it in place, and then read the value 10 times to obtain the average value D2 of the calibration source.

G.2.5.4 Calculate the efficiency factor k of the measuring instrument according to formula (G.1).

$$K_{\eta}=\frac{R}{\dot{D}_2-\dot{D}_1} \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (G.1)$$

Where:

R-the net source value of the verification source, the unit is microgray per hour (μGy/h);

D2-the average of 10 readings of the calibration source, the unit is microgray per hour (μGy/h);

D1——the background value of natural environmental radiation, the unit is microgray per hour (μGy/h).

G.2.6 Correction of measured values

Calculate the corrected external radiation penetrating radiation dose rate d according to formula (G.2), in microgray per hour (μGy/h).

Where:

K1-the scale factor of the measuring instrument (given by the instrument's calibration certificate);

K_η

D_c D—the reading of the measured value of the measuring instrument, in microgray per hour (μGy/h).

G.3 Inspection of α and β surface contamination

G.3.1 Testing requirements

In general, the patrol inspection and spot measurement of the level of α, β surface contamination shall be carried out at the same time as the measurement of the external radiation penetrating radiation dose rate. If necessary, the patrol inspection and spot measurement of the project can also be carried out separately.

G.3.2 Layout of test points

For α and β surface contamination level detection, the test points shall be arranged in accordance with the provisions of G.2.3, and the measurement area shall be greater than 300 square centimeters.

G.3.3 Measurement of efficiency of α surface contamination measuring instrument

G.3.3.1 Use the α surface pollution measuring instrument to measure the natural environmental radiation background count $N_{0,a}$ for 10 minutes.

G.3.3.2 Determine the calibration source for 5 minutes and obtain the count $N_{1.a}$.

G.3.3.3 Reverse the probe of the measuring instrument by 180°, and then measure for 5 minutes to obtain the count $N_{2,a}$ of the calibration source (considering the unevenness of the plane source).

$\eta_{4\pi(\alpha)}$

$$\eta_{4\pi(\alpha)} = \frac{(N_{1,\alpha} + N_{2,\alpha}) - N_{0,\alpha}}{10A_\alpha} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (G.3)$$

Where:

$N_{1,\alpha}$

$N_{2,\alpha}$

$N_{0,\alpha}$

A_α - Activity value of α correction source (plane source).

G.3.4 Efficiency measurement of surface contamination measuring instrument

$N_{0,\beta}$

$N_{1,\beta}$

$N_{2,\beta}$

$\eta_{4\pi(\beta)}$

$$\eta_{4\pi(\beta)} = \frac{(N_{1,\beta} + N_{2,\beta}) - N_{0,\beta}}{4A_{\beta}} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (G.4)$$

Where:

$N_{1,\beta}$

$N_{2,\beta}$

$N_{0,\beta}$

A_{β} - activity value of β correction source (plane source).

G.3.5 Level measurement of α and β surface contamination

G.3.5.1 The probe of α, β surface contamination measuring instrument shall be as close as possible to the surface of the measured object (the distance between the measuring instrument and the measured object surface shall not be greater than 20 mm and 50 mm respectively), and the measurement area shall be greater than 300 c m^2.

G.3.5.2 Move the measuring instrument at a speed of no more than 100 mm/s to detect the level of contamination on the surface of α and β.

G.3.5.3 Each test point shall be read 2 to 3 times, with an interval of 1 min each time, and the cumulative count value n shall be read.

G.3.5.4 Calculate the α and β surface pollution levels $C_{(a \text{ or } \beta)}$ according to formula (G.5), the unit is beques per square centimeter (Bq/c m^2).

$$C_{(a或\beta)} = \frac{N}{\eta_{4\pi(a或\beta)} \cdot S \cdot t} \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (G.5)$$

Where:

N - counting of measuring instruments;

$\eta_{4\pi(a \text{ or } \beta)}$ - the efficiency factor of the α or β surface contamination measuring instrument;

S - the area of the detection window of the measuring instrument, in square centimeters (c m^2);

t measurement time, in seconds (s).

Appendix H

(Normative)

Incoming inspection and acceptance

H.1 inspection items and requirements

H.1.1 inspection items

Each batch of raw materials shall be inspected for appearance quality, volatile content, metal recovery rate, and chemical composition.

H.1.2 Project requirements

H.1.2.1Aappearance quality

H.1.2.1.1Tthe surface of recycled aluminum ingots shall be kept clean and free of serious flashes or pores.

H.1.2.1.2 The appearance of other raw materials shall be clean, free of obvious oil, sand, and corrosion. There shall be no obvious paper, plastic, rubber, foam, fiber, iron, copper, tin and other non-aluminum metals.

H.1.2.2 Volatile content

The raw material moisture shall not be more than 0.5%, and other volatile matter shall not be more than 1%.

H.1.2.3 metal recovery rate

The metal recovery rate of raw materials shall meet the requirements of Table H.1.

Table H.1 metal recovery rate

Raw material category	Recycled aluminum ingots	Large material		Small material
		Heavy material	Light material	
Metal recovery rate	≥97	≥97	≥96	≥94

H.1.2.4chemical composition

The chemical composition shall meet the requirements of Appendix E.

H.2 Sample preparation

The preparation of the sample shall meet the requirements of Table H.2.

Table H.2 requirements for sample preparation

Test items	Requirements for sample preparation
	Take a single sample as 1 sample
Appearance quality	Take at least 5 kg of material blocks [using a shredder (see Appendix (1) to take blocks after the samples are broken) from each sample and mix them together as a sample.
	Take at least 100 kg of material blocks [using a shredder (see Appendix D) to crush the sample and extract the material block] from each sample, mix the material pieces taken from all samples together, and use them as a sample
Chemical composition	When using a portable fast spectrometer to detect chemical composition, randomly sample blocks from each sample. When testing the chemical composition of a sample according to the provisions of GB/T 20975 (all parts) or GB/T 7999, extract at least 100 kg of material [using a shredder (see Appendix D) to crush the sample and extract the material block] from each sample.

H.3 Inspection method

H.3.1 Appearance and quality

Visually inspect the appearance of the sample. It is advisable to spread the sample (easily disassembled package/block need to be disassembled) on a clean surface for inspection.

H.3.2 Volatile content

The volatile matter of the sample shall be tested in accordance with the provisions of Appendix J.

H.3.3 Metal recovery rate

The metal recovery rate shall be tested in accordance with the provisions of Appendix K.

H.3.4 Chemical composition

H.3.4.1 Prepare the samples for chemical composition analysis according to Appendix K.

H.3.4.2 Use a portable fast spectrometer (see Appendix l) to randomly spot test the chemical composition of the block, or test the chemical composition of each sample according to GB/T 20975 (all parts) or GB/T 7999.

H.3.4.3 Compare the detection result of the chemical composition with the composition type (brand/series/level) of the raw material identification.

H.4 Judgment of inspection results

H.4.1 If the test result of the appearance quality of any sample is unqualified, the batch shall be judged as unqualified.

H.4.2 If the test result of the volatile content of any sample is unqualified, one shall take another double number of samples from the batch of samples (one can also take another double sample from the batch, and then re-take the sample), and then repeat the test on the unqualified items. If the repeated test results are qualified, the batch of raw materials is judged to be qualified, otherwise the batch is judged to be unqualified.

H.4.3 If the test result of the metal recovery content of any sample is unqualified, one shall take another double number of samples from the batch of samples (one can also take another double number of samples from the batch and re-take the sample), repeat the test on unqualified items. If the repeated test results are qualified, the batch of raw materials shall be judged to be qualified, otherwise, the batch shall be judged to be unqualified.

H.4.4 If the test result of the portable fast spectrometer of any material is unqualified, the chemical composition of each sample shall be tested according to the provisions of GB/T 20975 (all parts) or GB/T 7999. If the chemical composition analysis test result of any sample is unqualified, another double number of samples shall be taken from the batch of samples and repeat the test. If the repeated test results are all qualified, the batch shall be judged to be qualified, otherwise the batch shall be judged to be unqualified.

Appendix I

(Informative)

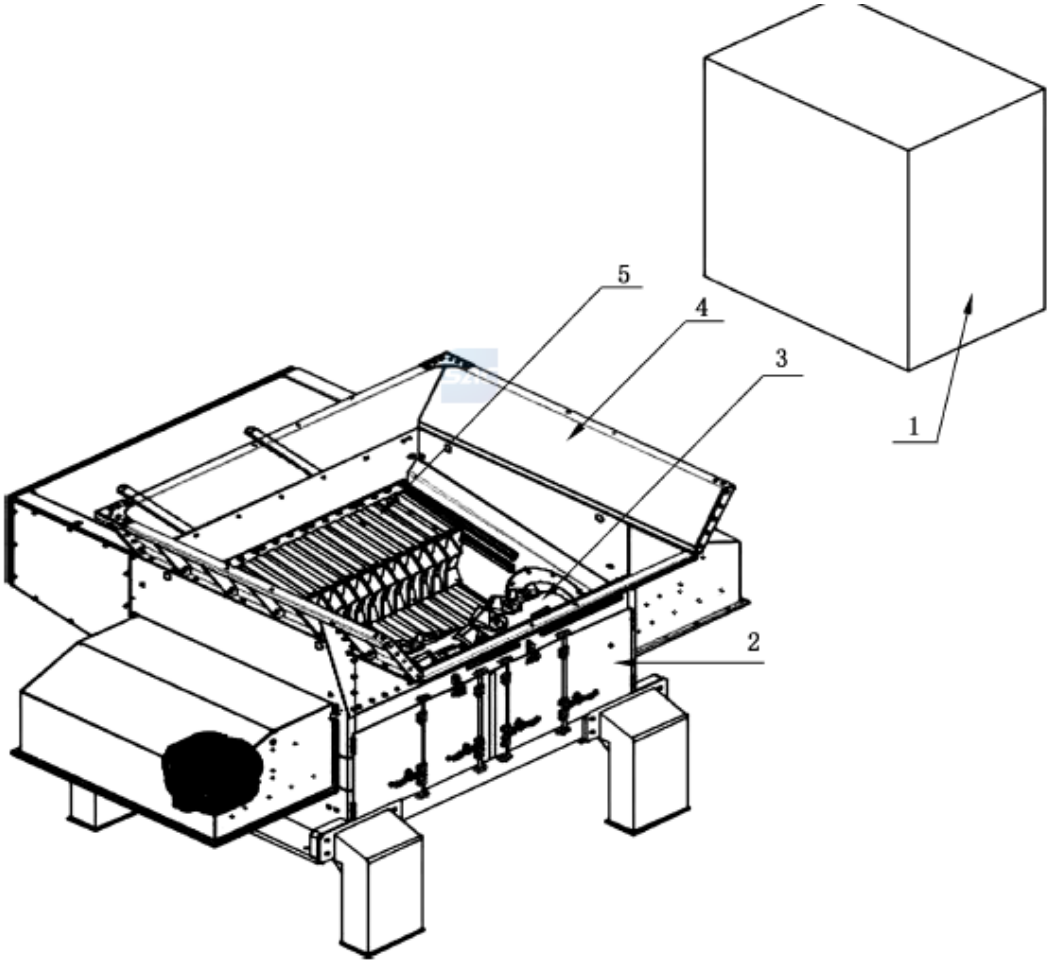
Hydraulic single shaft shredder

I.1 Working principle

The hydraulic drive system drives the main shaft equipped with blades to rotate, forming a tearing effect with the static knife, thereby shredding the material.

I.2 The composition of the shredder

The single shaft shredder is mainly composed of a frame, a transmission system, and a shredding system, as shown in Figure I.1.



Indexing serial number description

1 - Transmission system;

2 - Frame;

3 - Main shaft;

4 - Feed hopper;

5 - Scraping plate.

Figure I.1 Schematic diagram of the single shaft shredder

I.3 Framework

The frame includes a frame, a supporting leg, a rear cover assembly, and a motor cover assembly.

I.4 Transmission system

I.4.1 The transmission system includes a motor, a hydraulic pump, a hydraulic control valve, a hydraulic motor, and a material pushing cylinder.

I.4.2 the motor drives the hydraulic pump, which drives the hydraulic motor through the hydraulic valve to rotate the main shaft, then the material pushing cylinder feeds the material into the shredding system.

I.5 Shredding system

I.5.1 The shredding system includes a main shaft, static knife, scraping plate, and feed hopper.

I.5.2 Blades are installed on the outer cylindrical surface of the main shaft, and the center distance between adjacent blades shall be 100 mm~200 mm.

I.5.3 The center distance between adjacent blades of the static knife shall be 100 mm~200 mm.

I.5.4 The gap between the shaft blade and the static knife blade shall be 3 mm~5 mm.

I.5.5 The scraping plate reciprocates to push the material to the main shaft.

I.5.6 The feed hopper shall be installed above the main shaft.

I.6 Technical specifications

I.6.1 Material size: ⩽2,500 mm.

I.6.2 Shredded size: 50 mm~200 mm.

1.6.3 The amount of shredded materials: 4 t/h~6 t/h.

Appendix J

(Normative)

Detection method of volatile matter

J.1 Overview of the method

Heat the sample to a fixed temperature and keep it to a constant weight, and calculate the volatiles by measuring the mass loss.

J.2 Testing equipment or devices

J.2.1 Electronic scale: the maximum weighing is no less than 2 kg, and the accuracy is 0.01 g.

J.2.2 High-temperature furnace: the working temperature of the high-temperature furnace can reach 500 ℃, and the accuracy is ±5 ℃.

J.2.3 Sample tray.

J.2.4 Glass desiccator.

J.3 Sample

J.3.1 Weigh the sample with an electronic scale and record the quality of the sample.

J.3.2 When the capacity of the high-temperature furnace is insufficient, the sample can be divided into several parts and tested independently. The mass of each sample shall be weighed and recorded.

J.4 Detection steps

J.4.1 During the test, clamps or corresponding tools shall be used to avoid direct contact with hands when the sample plate and sample are turned around.

J.4.2 After keeping the sample plate at 360°c for 8 hours, put it in a glass desiccator to cool to room temperature, weigh the mass and record it as m1, and put it in the glass desiccator for later use.

m_2

J.4.4 If the sample is divided into several parts, test independently, weigh and record the mass of each part,

m_2

J.4.5 Put the sample pan containing the sample in a high-temperature furnace, heat it up to 105 ℃, keep it for 4h, and put it into a glass desiccator. After cooling to room temperature, weigh and record the mass.

J.4.6 Put the sample plate containing the sample in the high-temperature furnace again, heat it up to 105 ℃

m_3

m_3

J.4.8 Put the sample pan with the sample back into the high-temperature furnace, heat it up to 360 ℃

m_4

m_4

J.5 Result calculation

Calculate the mass fraction w_r of other volatiles in the sample according to formula (J.1), the value is expressed in %, and the calculation result is expressed to one decimal place, and rounded according to the provisions of GB/T 8170.

$$w_r = \frac{m_3 - m_4}{m_2 - m_1} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (J.1)$$

Where:

M 3 - the total mass of the sample and the sample plate treated at 105°c and constant weight, in kilograms (kg);

M 4 - the total mass of the sample and the sample plate treated at 360 ℃ and constant weight, in kilograms (kg);

M2 - the mass of the sample plate containing the sample, in kilograms (kg);

M 1 - the mass of the sample plate, in kilograms (kg).

Appendix K

(Normative)

Preparation of chemical composition sample and inspection method of metal recovery rate

K.1 Method overview

The inspection of the chemical composition requires the material block (or the metal recovery test sample) to be melted in the melting furnace and then refined to prepare the chemical composition analysis sample. The mass of the ingot obtained after the melt is cooled and solidified and the aluminum content of the aluminum slag are added to obtain a sum. The ratio of the sum to the mass of the sample is the metal recovery rate.

K.2 Reagent

K.2.1 Covering agent: meet the requirements of YS/T 491, the brand shall be NK5048F2A.

K.2.2 Refining agent: meet the requirements of YS/T 491, the brand shall be NK4847F5A.

K.3 Main tools and equipment

K.3.1 Electronic scale: the accuracy is 0.05 kg.

K.3.2 Electric melting furnace: the temperature of the melting electric furnace is not less than 1,000 ℃, the accuracy is ±15 ℃, and the furnace capacity is no less than 200 kg. Graphite crucible shall be used for smelting.

K.3.3 Sampling spoon: meet the requirements of GB/T 17432.

K.3.4 Sampling mold: meet the requirements of GB/T 17432.

K.4 Test procedure

K.4.1 Weigh the sample

Use an electronic balance (k.3.1) to weigh the mass of the material block (or the sample used for the metal recovery test) for the chemical composition inspection, and record it as m.

K.4.2 Pretreatment

Manual sorting shall be used to remove foreign material in the block (or sample) (except for the aluminum block covered with organic polymer coating). If the size of the material block (or sample) is too large, or it is suspected that it contains foreign material (except for the aluminum block covered with organic polymer coating), the material block shall be broken, and the foreign material embedded in the material block (or sample) shall be mechanically separated.

K.4.3 Melting and heat preservation

K.4.3.1 Put the pretreated material block (or sample) into the electric melting furnace (K.3.2).(if the material blocks cannot be added all at once, they can be added again during the melting process) the temperature of the melting electric furnace shall be set to 1,000 ℃~1，200 ℃.

K.4.3.2 When the material block (or sample) is melted until a layer of molten aluminum appears on the surface, a layer of covering agent (K.2.1) shall be sprinkled with 0.2%~0.4% of the flux to reduce the oxidation of the melt.

K.4.3.3 When the melt is heated to a temperature of 710 ℃ ± 10 ℃, the refining agent (k.2.2) shall be used for refining, and the amount of flux is 0.2%~0.4%. Stir thoroughly and use a slag skimmer tool to pick up the aluminum slag in the melt.

K.4.4 Preparation of samples for chemical composition analysis

m_v

K.4.4.2 Use a sampling spoon (K.3.3) to scoop an appropriate amount of melt, and pour it into the heated sampling mold (K.3.4) in accordance with the provisions of GB/T17432. After the melt is cooled, the sampling mold is opened, and the mass of the ingot condensed from the melt is weighed with an electronic balance and marked as m_y. The ingot is the sample for chemical composition analysis.

m_z

K.5 Result calculation

Calculate the metal recovery rate w_H according to formula (K.1), the value is expressed in %, and the calculation result is expressed as a single digit, and rounded according to the provisions of GB/T 8170.

$$w_H = \frac{m_z + m_y + m_v \times 50\%}{m_x} \times 100\% \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (K.1)$$

Where:

m_z - the mass of the ingot condensed from the melt in the melting electric furnace (not including the melt used to make the chemical composition analysis sample), in kilograms (kg);

m_y - the mass of the chemical composition analysis sample, in kilograms (kg);

m_v - the mass of aluminum slag, in kilograms (kg);

m_x - the mass of the block (or sample), in kilograms (kg).

Appendix L (Informative)

General requirements and testing methods for portable spectrometer equipment

Warning - personnel using this document shall have practical experience working in a regular laboratory. This document does not point out all possible security issues. The user of this document is responsible for taking appropriate safety and health measures and ensuring compliance with the conditions stipulated by relevant national laws and regulations.

L.1 Technical indicators of testing equipment

L.1.1 General requirements

L.1.1.1 Users of laser products need to wear a Class 1M eye-safe laser with a wavelength range of 1,500 nm to 1,700 nm.

L.1.1.2 It shall be easy to use, and its weight shall ensure portable operation.

L.1.1.3 It has the functions of displaying, viewing historical test data and exporting.

L.1.1.4 It has a self-calibration function.

L.1.1.5 The relative standard deviation of the repeatability of the instrument test is RSD≤10%.

L.1.2 Technical parameters

L.1.2.1 The wavelength range of the spectrometer shall be 200 nm to 700 nm, with high resolution and high sensitivity.

L.1.2.2 This equipment can measure AI, Si, Fe, Cu, Mn, Mg, Cr, Ni, Zn, Ti, Ag, Bi, Li, Pb, Sn, V, Zr and other elements.

L.1.2.3 The determination range and relative error of element content are shown in table l.1.

Table l.1 Determination range and relative error of element content

Element content (mass fraction)	Determination of relative error
>10	≤10
>1~10	≤15
>0.1~1	≤20
0.01~0.1	≤25

L.2 Sample

μm

L.3 Measurement procedure

Carry out the test on any test point of the sample according to the instrument operation instruction.

L.4 Test result processing

L.4.1 Calculate the average of 3 test results as the measurement result of the sample.

L.4.2 Export the measurement result or upload it directly to the user's computer.

Reference

[1] GB/T 3190 chemical composition of wrought aluminium and aluminium alloys

[2] GB/T 5202 radiation protection instrumentation α, β and α/β (β energy greater than 60keV) contamination meters and monitors

[3] GB/T 12162.3 for calibrating dosemeters and dose rate meters and for determining their response parameters χ and γ Part 3: calibration of area and personal dosemeters and the determination of their response as a function of beta radiation energy and angle of incidence

[4] GB 18871 basic standards for protection against ionizing radiation and for the safety of radiation

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sources