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W-16

SACRIFICIAL ANODES

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Foreword

China Classification Society (hereinafter referred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at <http://www.ccs.org.cn>. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

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Main changes:

The chemical composition and electrochemical performance requirements of two type of zinc anodes are added. The format and some text expression are adjusted.

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SACRIFICIAL ANODES

1 Application

- 1.1 This Chapter is applicable to product inspection of marine sacrificial anodes.
- 1.2 With the consent of CCS, the sacrificial anodes can also be inspected individually/in batches according to the technical requirements of the standards accepted by CCS.

2 Normative references

- (1) CCS Rules for Classification of Sea-going Steel Ships (hereinafter referred to as the Rules);
- (2) GB/T4948 Sacrificial Anode of Al-Zn-In Series Alloy;
- (3) GB/T4950 Sacrificial Anode of Zn Alloy;

3 Terms and definitions

- 3.1 Sacrificial anode means the metal or alloy with negative electrode potential in electrolyte attached to metal structure with positive electrode potential. The metal or alloy protects the metal structure by the current from its continuous decomposition.
- 3.2 Theoretical current capacity means the electric quantity (A h/kg) generated by sacrificial anodes of per unit mass calculated according to Coulomb Law.
- 3.3 Practical current capacity means the measured electric quantity (A h/kg) generated by sacrificial anodes of per unit mass.
- 3.4 Current efficiency means percentage of actual capacitance to theoretical capacitance.
- 3.5 Reference electrode means the electrode with stable potential used to other potentials.
- 3.6 Open circuit potential means the natural corrosion unit of sacrificial anode (V) in electrolyte.
- 3.7 Working potential means the potential of sacrificial anode (V) short-circuit connected with cathode in electrolyte.

4 Drawings and documents

- 4.1 According to the requirements of the current Rules of CCS, the sacrificial anodes on board

are not required to be approved by the Society, but are subject to be unit/batch inspected satisfactorily with the product certificate. The type test program (For approval) and the relevant drawings and documents are to be submitted when the factory voluntarily applies for approval.

5 Technical requirements

5.1 Chemical composition: the chemical composition of sacrificial anodes is to comply with Table 5.1

Zinc anode

Table 5.1 (1)

Type	Al	Cd	Impurities				Zn
			Fe	Cu	Pb	Others	
Type I Zn-Al-Cd ALLOY Anode	0.3~0.6	0.05~0.12	≤0.005	≤0.005	≤0.006	Si ≤0.125	Residual
Type II Zn-Al-Cd ALLOY Anode	0.1~0.5	0.025~0.07	≤0.005	≤0.005	≤0.006	≤0.1	Residual
Type III High-purity Zn Anode	≤0.005	≤0.003	≤0.0014	≤0.002	≤0.003	≤0.005	Residual

Aluminum anode

Table 5.1 (2)

Varieties	Chemical composition %										
	Zn	In	Cd	Sn	Mg	Si	Ti	Impurities, not greater than			Al
								Si	Fe	Cu	
Al-Zn-In-Cd Al1	2.5 ~ 4.5	0.018 ~ 0.050	0.005 ~ 0.020	-	-	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Sn Al2	2.2 ~ 5.2	0.020 ~ 0.045	-	0.018 ~ 0.035	-	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Si Al3	5.5 ~ 7.0	0.025 ~ 0.035	-	-	-	0.10 ~ 0.15	-	-	0.15	0.01	Residual
Al-Zn-In-Sn-Mg Al4	2.5 ~ 4.0	0.020 ~ 0.050	-	0.025 ~ 0.075	0.50 ~ 1.00	-	-	0.10	0.15	0.01	Residual
Al-Zn-In-Mg-Ti A21	4.0 ~ 7.0	0.020 ~ 0.050	-	-	0.50 ~ 1.50	-	0.01 ~ 0.08	0.10	0.15	0.01	Residual

Note: The chemical composition of sacrificial anodes may be adjusted as required by the user, however, the properties and quality are to comply with the requirements in the Guidelines.

5. 2 The electrochemical properties of sacrificial anodes are to comply with Table 5. 2

Electrochemical properties of sacrificial anode

Table 5.2

Anode material	Open circuit potential V	Working potential V	Actual capacitance Ah/kg	Current efficiency %	Consumption rate Kg/(A×a)	Dissolution
Zn Anode of Type I & Type II	≤-1.05	≤-1.00	≥780	≥95	≤11.23	Corrosion products are apt to shed; surface dissolution is even
Zn Anode of Type III	≤-1.05	≤-1.00	≥760	≥92	≤11.53	Corrosion products are apt to shed; surface dissolution is even
Aluminium anode of type 1	-1.18~ -1.10	-1.12~ -1.05	≥2400	≥85	≤3.65	Corrosion products are apt to shed; surface dissolution is even
Aluminium anode of type 2	-1.18~ -1.10	-1.12~ -1.05	≥2600	≥90	≤3.37	Corrosion products are apt to shed; surface dissolution is even

Note: The medium is to be artificial seawater. The reference electrode is to be saturated calomel electrode. A11, A12, A13 and A14 are of type 1, while A21 is of type 2.

5.3 Anodes are to be fitted with iron core. In case of steel cores, they are to be so designed as to retain the anode even when the anode is wasted. Anodes are to be of typical design and sufficiently rigid to avoid resonance in the anode support.

5.4 The contact resistance between base and core of sacrificial anodes is not to be greater than 0.001Ω.

5.5 The working surface of the sacrificial anode is to be free from oxide skins, burrs, flashes .

Cracks and shrinkage holes should be complied with the requirements of the standards accepted by CCS. The working surface of the sacrificial anode is to be clean and free from paints or stains. The non-working surface should be smooth, and it is appropriate to evenly paint organic paint or install other insulating layers on the non-working surface.

5.6 Weight tolerance of every sacrificial anode is $\pm 3\%$, but the total weight should not be negative tolerance; The weight deviation of strip zinc anode should meet the requirements of accepted standards.

5.7 length tolerance, width tolerance, thickness tolerance of every sacrificial anode is $\pm 2\%$, $\pm 3\%$, $\pm 5\%$ respectively and straightness is not greater than 2%. The dimension deviation of strip zinc anode should meet the requirements of accepted standards.

6 Materials and components

Materials and components should comply with the requirements of the standards accepted by the Society

7 Type test

7.1 The prototype test of sacrificial anode should be carried out when one of the following situations occurs:

- (1) When the product is first applied for inspection by CCS
- (2) Production process changed
- (3) Requested by Orderer
- (4) Voluntary application for Works approval

7.2 The test items for sacrificial anodes are given in Table 7.2.

Items of the prototype test

Table 7.2

Serial number	Test items	Basis for inspection
1	Visual examination、 weight and dimension check	5.5、 5.6 and 5.7 of this Guideline
2	Chemical analysis of finished products	5.1 of this Guideline
3	Electrochemical properties	5.2 of this Guideline
4	Contact resistance	5.4 of this Guideline

7.3 Rule of sampling

For each type of product, sample of typical specification should be used for type test..

7.4 Sample quantity

7.4.1 When the chemical composition analysis is performed, the sacrificial anode of each batch of smelting production should be taken respectively three samples before furnace and on product. When sampling before furnace, from upper and lower smelting furnace from casting liquid; sampling on product ; random sampling three anode products, respectively, in each of the anode products take a sample analysis, sampling site should avoid iron feet. each sample is more than 20 g.

7.4.2 When the weight and dimension are inspected, in the same batch, the same size model of the product, ten samples to be taken randomly to determine its weight and dimension.

7.4.3 The surface quality of sacrificial anode should be checked one by one.

7.4.4 When the electrochemical properties test is carried out, three samples should be used in each test, and the samples should be taken from the three anode.

7.4.5 When the contact resistance test is carried out, each of the five batches of sacrificial anode was randomly taken three samples, and the contact resistance was measured between the anode and the iron feet.

7.5 Criterion rule

If there is a sample does not meet the requirements in the test, double sampling will be inspected. If the re-examination still does not meet the requirements, the type test fails.

8 Unit/batch inspection

8.1 Rule of group batch

Using the same batch of raw materials, the same process production line, it is a batch that the same workers of team produce the sacrificial anode for a number of.

8.2 On the basis of type test for each type of product in accordance with Article 7 of this Guideline, the manufacturer shall conduct the following tests during routine single unit/batch inspection. The sampling quantity and test results shall meet the relevant requirements of Article 5 and Article 7 of this Guideline.

- (1) Visual examination: to comply with the requirements in 5.5 and 5.6 of this guideline;
- (2) Weight and dimension examination: to comply with the requirements in 5.7 of this guideline
- (3) Chemical composition analysis of each batch: to comply with the requirements in 5.1 of this Chapter. Three anode products are random sampled, each sample analysis is taken from each of the three anode products respectively free of iron feet. each sample is more than 20 g

8.3 Criterion rule

If there is a sample does not meet the requirements in the test, double sampling will be inspected. If the re-examination still does not meet the requirements, This batch of products is not qualified. Product can be treated one by one if only surface quality is under standard.

The CCS inspection mark (for example, CCS steel seal) must be marked on products which have been inspected with satisfaction.

8.4 Record or report to be submitted by the manufacturer:

- (1) Visual inspection report;
- (2) Weight and dimension inspection report;
- (3) Chemical composition analysis report;
- (4) Raw materials certificate;

8.6.5 Product drawings(if applicable);

8.6. 6 Other documents which are deemed necessary by CCS surveyor..