Guideline No.: W-16(201605)

W-16

SACRIFICIAL ANODES

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Foreword

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 .

Historical versions and release date : W-16(201510) 2015-10-20

Main changes:

Sampling proportion of product type test and factory test is provided clearly.

CONTENS

SACRIFICIAL ANODES

1 Application

1.1 This Chapter is applicable to inspection of marine sacrificial anodes.

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-Al-Cd Alloy;

(4) GB/T17848 Test Methods for Electrochemical Properties of Sacrificial Anodes.

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 ħ/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 ħ/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 Technical requirements

4.1 Chemical composition: the chemical composition of sacrificial anodes is to comply with Table 4.1

Zinc anode **Table 4.1 (1)**

Chemical elements	Al	Cd	Maximum impurities				Zn
			Fe	Cu	Pb	Si	
Content, %	0.3～0.6	0.05～0.12	0.005	0.005	0.006	0.125	Residual

Aluminum anode **Table 4.1 (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 at the user's request, however, the properties and quality are to comply with the requirements in the Guidelines.

4. 2 The electrochemical properties of sacrificial anodes are to comply with Table 4. 2

Electrochemical properties of sacrificial anode **Table 4.2**

Anode material	Open circuit potential (V)	Working potential (V)	Actual capacitance (Ah/kg)	Current efficiency (%)	Dissolution
Zinc anode	-1.09～-1.05	-1.05～-1.00	≥780	≥95	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	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	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.

4.3 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.

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

4.5 The working surface of the sacrificial anode is to be free from oxide skins, burrs, flashes or cracks with length exceeding 50 mm and depth exceeding 5 mm. The depth of shrinkage hole is to be less than 10% of the thickness of anodes and the depth is not to exceed 10 mm.

4.6 The working surface of the sacrificial anode is to be clean and free from paints or stains.

4.7 Weight tolerance of every sacrificial anode is ±3%,but the total weight should not be negative tolerance; length tolerance, width tolerance, thickness tolerance of every sacrificial anode is ±2%, ±3%, ±5% respectively and straightness is not greater than 2%

5 Requirements of prototype test

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

(1) Designing finalization of new product

(2) Production process changed

(3) Requested by Orderer

5.2 The test items for sacrificial anodes are given in Table 5.2.

Items of the prototype test **Table 5.2**

Serial number	Test items	Basis for inspection
1	Visual examination	4.6 and 4.7 of this Chapter
2	Chemical analysis of finished products	4.1 of this Chapter
3	Electrochemical properties	4.2 of this Chapter
4	Contact resistance	4.4 of this Chapter

5.3 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.

5.4 Sample quantity

5.4.1 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. Sampling can be directly taken from the product in unit/batch inspection. each sample is more than 20 g.

5.4.2 When the weight and size is be inspected, in the same batch, the same size model of the product, take ten samples to be taken randomly to determine its weight and size.

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

5.4.4 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.

5.4.5 When the contact resistance test was carried out, each of the five batches of sacrificial anode was randomly taken as the sample, and the contact resistance was measured between the anode and the iron feet.

5.5 Criterion rule

If there is a sample does not meet the requirements in the test, double sampling will be inspected. If the second examinations still does not meet the requirements, the batch of substandard products. Surface quality of products inspect according to one by one.

6 Unit/batch inspection

6.1 when the of the prototype test is qualified, rule of group batch, Sample quantity and Criterion rule shall be implemented respectively in accordance with the provisions of 5.3, 5.4 and 5.5,the detailed requirements for unit/batch inspection of sacrificial anodes as follow

(1) Visual examination: to comply with the requirements in 4.5 and 4.6 of this guideline;

(2) Weight and dimension examination: to comply with the requirements in 4.7 of this guideline

(3) Chemical composition analysis of each batch: to comply with the requirements in 4.1 of this Chapter.

6.2 Record or report to be submitted by the manufacturer

6.2.1 Appearance inspection report

6.2.2 Weight and dimension inspection report

6.2.3 Chemical composition analysis report.

6.2.4 Raw materials certificate

6.2.5 Product drawings

6.2.6 Copies of valid calibration certificate of inspection and test equipment.