Guideline No.: W-16(201510)

W-16 SACRIFICIAL ANODES

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Foreword:

This Guide is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

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Historical versions and release date :

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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

6 Unit/batch inspection

6.1 when the of the prototype test is qualified, 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.