Magnesium Anode

Quality Control (QC) and ASTM Testing

INTRODUCTION

High potential magnesium (Mg) anodes are more often used for projects. The production of this anode requires a high level of quality control (QC) during the production; therefore, the qualities of many high potential Mg anodes used in projects are often poor due to the lack of proper QC procedures. Some projects require the following items as their QC program:

a. The data sheet including chemical compositions and anode parameters
b. Manufacturing certificate and manufacturing test results
c. QC test results from a testing lab provided by the supplier
d. Sample of Mg anode before the installation for a project

However, based on our experience, these requirements do not often provide the actual information of the Mg anodes used in your projects because:

a. The data sheet including chemical compositions and anode parameters.

➡ The chemical compositions and parameters in the data sheets from almost all anode suppliers are the same.

b. Manufacturing certificate and manufacturing test results

➡ The certificate does not prove the actual anode quality. The manufacturing test results may not be for the anodes produced in the same heat for your project. Since the proper anode QC test for each heat requires additional cost and time to the manufacturer or distributor, your anode price does not include these cost to be competitive.

c. QC test results from a testing lab provided by the supplier

➡ If you do not witness the test, the QC results are made up or come from other anodes in the past.

d. Sample of Mg anode before the installation for a project

➡ The anode supplier provides you a high quality anode for the sample, which may not be the same anodes used in your project.

RECOMMENDED QUALITY CONTROL PROCEDURE ON SITE

The chemical compositions of high potential Mg anodes per ASTM 8843 is:

Chemicals	Composition
Aluminum (Al)	0.01% max.
Manganese (Mn)	0.05 – 1.3%
Copper (Cu)	0.02% max.
Silicon (Si)	0.05% max.
Iron (Fe)	0.03% max.
Nickel (Ni)	0.001% max.
Others each	0.05% max.
Magnesium (Mg)	Remainder

Anode Performance (efficiency or capacity and potential) is mainly influenced by the following both items:

- Impurities such as Cu, Si, Fe, Ni
- Homogeneity of the alloy elements

To eliminate or minimize the low quality Mg anodes used in your project, we recommend the following procedure:

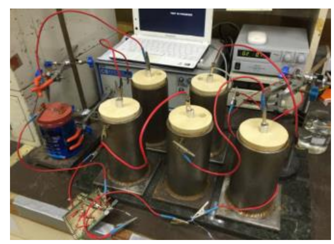
1. Immediately after all anodes arrive your job site, the project owner or consultant shall randomly pick up a couple of anodes for the third party testing. The number of anodes depends on the total number of anodes used for the project. We recommended 0.5% to 1% of the total number.
2. The anodes shall be sent to an independent testing laboratory approved by the owner. The laboratory shall conduct electrochemical performance test based on ASTM G97. It includes open circuit potential before after the test and the anode efficiency (capacity). This also visually shows the homogeneity of the alloy elements.
3. The test report including photo-documents shall be directly sent to the owner for review. If the owner finds out that the anodes on the job site are defective, he must decide the following conditions:
   - Immediately replacement of all anodes
   - Immediately replace the anodes made in the same “heats” or “lots”. This requires all anodes must show the heat number and serial number in the manufacturer at the time of the production.
   - Re-design of the anode weight or quantity base on the lab test results (if the test results are marginal.)

ASTM G97

Standard Test Method for Laboratory Evaluation of Magnesium Sacrificial Anode Test Specimens for Underground Applications

1. The anode is cut and milled to make 5 rod samples.

2. Each anode rod is impressed in the test solution and impressed by DC current to accelerate the corrosion.



3. The amount of DC current (amp-hour) discharged from the samples for 14 days is monitored with copper coulometer.

Copper Coulometer

Copper Coulometer Deposition

4. At the end of the test, the anode capacity is determined based on the weight loss and calculated the efficiency.

Test Results for Actual Project in 2005

The visual observation of the test specimens after ASTM G97 test.

Uniform corrosion indicates high anode efficiency (capacity) and homogeneity.

Sample A
Provided by a supplier for testing

Many corrosion pits indicates low anode efficiency and inhomogeneity.

Sample B
From project site (the same supplier of Sample A)

ASTM G97 Test Results

Sample Anode Batch No. 11011032	Sample A				
	Rod 1	**Rod 2**	**Rod 3**	**Rod 4**	**Rod 5**
Initial weight (g)	33.2384	33.2178	33.2752	33.2513	33.3565
Final weight (g)	33.8182	33.8019	32.8599	32.8271	32.8307
Weight loss (g)	0.4202	0.4156	0.4153	0.4242	0.4258
Capacity (amp-hr/kg)	1235.1	1247.9	1249.7	1223.5	1218.9
Efficiency (%)	56.1	56.7	56.8	55.6	55.4%
Test Results	Pass	Pass	Pass	Pass	Pass

Sample Anode Batch No. 11011032	Sample B				
	Rod 1	**Rod 2**	**Rod 3**	**Rod 4**	**Rod 5**
Initial weight (g)	35.0601	33.4788	36.1267	35.4522	34.8723
Final weight (g)	34.0812	32.4413	35.0191	34.4284	33.8585
Weight loss (g)	0.9789	1.0375	1.1076	1.0238	1.0138
Capacity (amp-hr/kg)	553.0	522.5	489.3	529.3	513.7
Efficiency (%)	25.1	23.7	22.2	24.1	23.4
Test Results	Fail	Fail	Fail	Fail	Fail

Note: The efficiency was calculated by percentage (%) of 2200 amp-hr/kg.