GALVALUM® III

GALVALUM® is the exclusive trademark of Cathodic Protection Technology Pte Ltd (CP TECH)*. CP TECH's proprietary GALVALUM® III material has been long-term tested by Det Norske Veritas (DNV) and obtained its Type Approval Certificate, complying with DNV's recommended practice B401 and NORSOK Standard M-503 Cathodic Protection Long-Term Testing.

GALVALUM® III represents the latest technological breakthrough in aluminium alloying for sacrificial anode applications. Its unique properties overcome many of the shortcomings of aluminium and zinc anode materials. It is the most versatile aluminium anode with advantages in a variety of environments.

GALVALUM® I was introduced in 1966 following research and testing to replace zinc and magnesium-based alloys used at that time.

GALVALUM® II followed in 1972 for application in anaerobic conditions existing in saline mud at the bottom of the sea.

GALVALUM® III offers the widest use of the three alloys in general seawater and saline mud applications.

GALVALUM® III

PROPERTIES AND ADVANTAGES

Although GALVALUM® III is designed for general seawater use, experience has shown it to be especially suited for protection of hot pipelines in saline mud environments. The higher potential of GALVALUM® III also permits its use in semi-saline or brackish water environments with resistivities up to about 400 ohm-cm. Although GALVALUM® III has a slightly lower ampere hour capacity in seawater than GALVALUM® I, its higher driving voltage results in more current output for any anode size and weight. More current per anode means that cathodic protection systems can be designed using fewer GALVALUM® anodes. Fewer anodes means lower installation costs. In the case of diver-installed anodes, the total installed cost of a 10 year GALVALUM® III design in seawater depths up to 46 metres (150 feet) is approximately 19% below that for other anodes. A 20 year GALVALUM® III design costs 13% less than designs using other anodes. In water depths of 46 to 92 metres (150 to 300 feet), savings using GALVALUM® III are 26% and 20%.

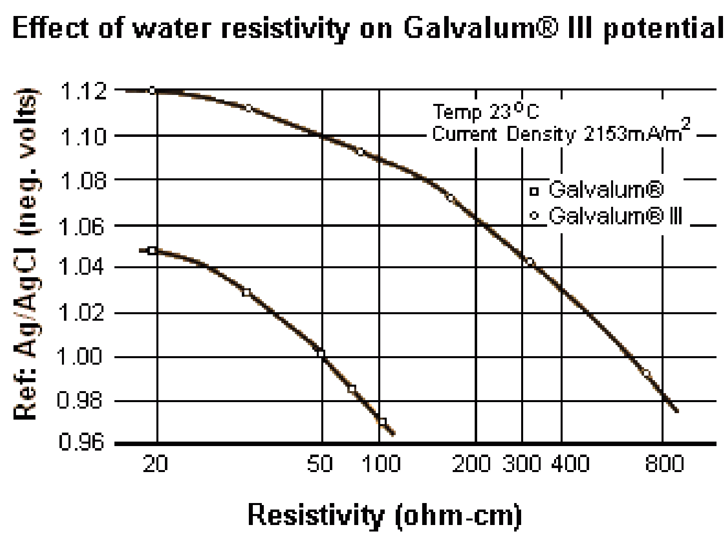

FIGURE 1

** for more information on CP TECH, please refer to http://www.cptech.net*

GALVALUM® III

PROVES TO BE VERSATILE FOR CATHODIC PROTECTION IN SALINE AREA

The GALVALUM® III anode has proven to be better and more economical than zinc based material in saline muds, for protecting buried pipelines and similar applications.

GALVALUM® III has proven itself in low and high temperatures and at great depths. The alloy does not show intergranular cracking at elevated mud temperatures.

Figure 3 demonstrates GALVALUM® III behaviour versus high purity zinc with respect to temperature. Zinc showed voltage polarisation at elevated temperature.

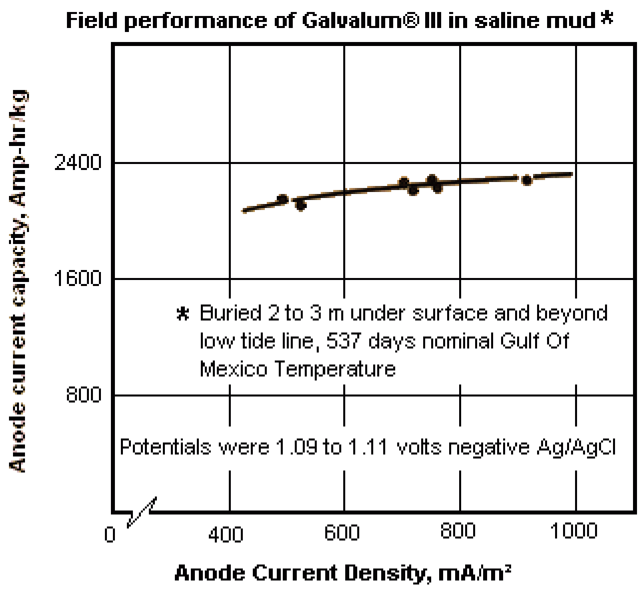

FIGURE 2

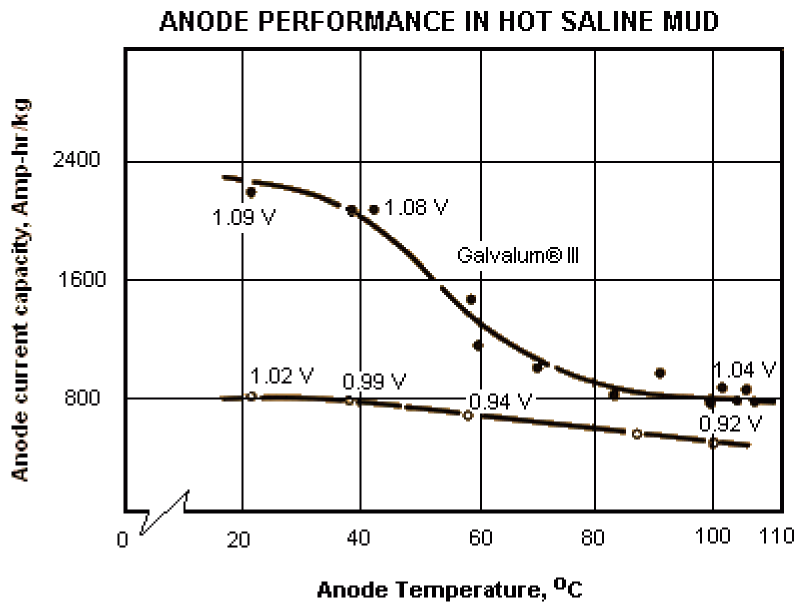

FIGURE 3

Curves comparing GALVALUM® III and high purity zinc anodes in 1-4 month exposures at 1,076 mA/m². Points are average of 2-6 anodes. Potentials are negative Ag/AgCl.

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GALVALUM® III

OFFERS ADVANTAGES IN A VARIETY OF SALINE ENVIRONMENTS

SALINE MUD AT AMBIENT TEMPERATURE

GALVALUM® III anodes provide higher current capacity and more negative potentials than aluminium-zinc-mercury anodes or zinc alloy anodes for superior cathodic protection.

SALINE MUD AT ELEVATED TEMPERATURES

Functioning effectively at elevated temperatures, GALVALUM® III anodes protect hot oil pipelines that most other anodes cannot. GALVALUM® III anodes are not susceptible to intergranular corrosion and can be used in applications where zinc anodes made to MIL-A-18001K cannot be employed.

SEAWATER

Cathodic protection systems can be designed to use fewer anodes because GALVALUM® III anodes have a higher driving potential than either aluminium-zinc-mercury or zinc alloy anodes. Fewer anodes mean significantly lower installation costs.

HOT BRINE

GALVALUM® III outperformed other aluminium alloy tested in a variety of hot brine applications.

ALL ENVIRONMENTS

GALVALUM® III does not contain any environmentally controversial elements, a factor which makes GALVALUM® III the best choice for applications of special environmental concern.

GALVALUM® III

THE CHOICE OF IS CLEAR

FOR SUBSEA PIPELINES

GALVALUM® III costs 1/3 less than zinc bracelet anodes.

GALVALUM® III has less potential decline than other aluminium anodes in higher resistivity saline environments such as those typical of ocean bottom muds (see Figure 1).

GALVALUM® III is the only anode material with proven performance in hot saline muds and hence is particularly well suited for hot oil pipelines (see Figures 2 & 3).

FOR OFFSHORE PLATFORMS

GALVALUM® III is the most economical anode material when both labour and material costs are considered.

GALVALUM® III contains no environmentally controversial elements.

GALVALUM® I ANODES

HIGH CURRENT CAPACITY FOR SEAWATER APPLICATIONS

The most often used material for cathodic protection systems are alloys of zinc, magnesium and aluminium. Until the mid-60's, alloys of zinc constituted the most widely used anode in saline environments. Magnesium alloy anodes gained reasonable acceptance in this environment in applications which required higher driving potentials or voltages.

The use of larger structures offshore increased the need for an anode with a potential lower than magnesium and a current capacity greater than zinc.

Aluminium was considered to be the best candidate for such an anode because of its theoretically high ampere-hour capacity per kilogram. Since 1966, it has been available to industry an alloy trademarked as GALVALUM®. The alloy has a nominal composition of 0.45% zinc and 0.045% mercury in an aluminium purity of approximately 99.85% and requires no heat treatment. This alloy was later designated GALVALUM® I after other commercial alloys were introduced.

A comparison of nominal GALVALUM® I properties with zinc and magnesium is shown in Table 1.

	Typical Current Capacity		Operating Potential Ag/AgCl (Reference)
	Amp-hr/kg	Amp-hr/cm²	Negative Volts
GALVALUM® I Anode	2,877	7.45	1.05
Magnesium Anode (AZ63A)	990	1.89	1.53
Zinc Anode (high purity)	780	5.49	1.03

TABLE 1

WHY GALVALUM® I OFFSHORE?

PROPERTIES

Properties of GALVALUM® I anodes that make them stand out from other seawater anodes:

1. High current capacity under variable conditions.
2. Current capacity maintenance with time.
3. Desirable operating potential.
4. Constant potential with time (no polarisation).

CURRENT CAPACITY CHARACTERISTICS

The current capacity of an anode is a very important consideration in anode selection because it is ampere hours per unit currency that the corrosion engineer is buying for any cathodic protection system. Field testing of the GALVALUM® I anode has proved its reproducible current capacity under the full range of the environmental and operational variables encountered in seawater.

Figure 4 provides data on GALVALUM® I anodes of various sizes and shapes operating for nearly two years in flowing and still seawater at current densities ranging from 860 - 15,100 mA/m². These data illustrate that the current capacity is not significantly affected by environmental and operational variables.

OPERATING POTENTIAL CHARACTERISTICS

The operating potential of a galvanic anode also is very important and should be; (a) high enough to provide the driving voltage needed to furnish the current required to protect a structure, (b) not too high or excessive current will be produced resulting in shortened anode life, (c) relatively unaffected by current density, (d) constant during the life of the installation and not subject to polarisation.

GALVALUM® I anodes meet all of these requirements. In Figure 5 the potential of 1.05 volts (Ag/AgCl ref.) exhibited by GALVALUM® I anodes over a wide range of current densities is a highly desirable value for seawater applications. The consistency and maintenance of voltage was demonstrated by potential measurements made in conjunction with the 21-month field test reported in Figure 4.

The consistency in both capacity and potential behaviour exhibited by GALVALUM® I anodes enables the corrosion engineer to design a highly reliable and efficient cathodic protection system.

Curve demonstrates the high current capacity of various sizes of Galvalum® I anodes and the maintenance of current capacity with time.

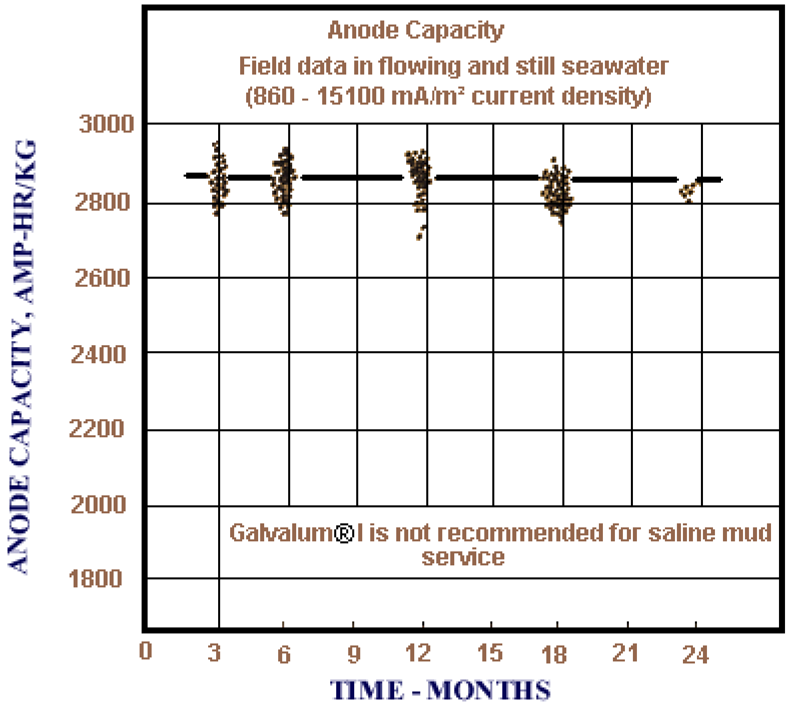

FIGURE 4

Curve shows the effect of current density on closed circuit potential - Galvalum® I

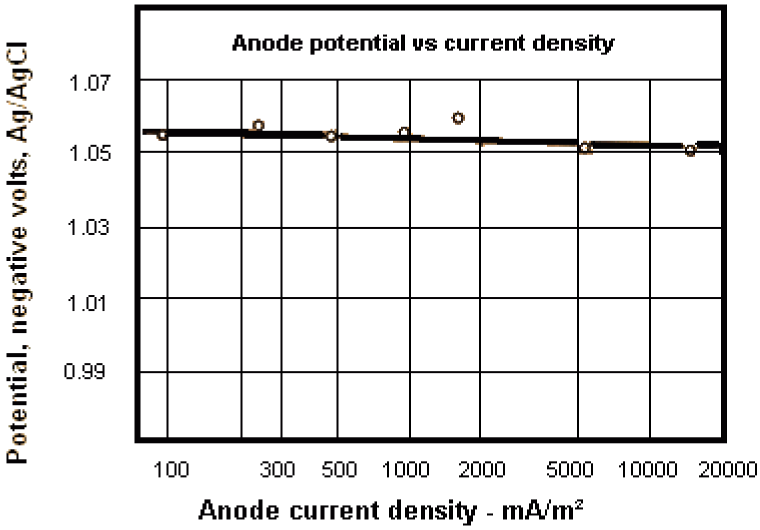

FIGURE 5

GALVALUM® I: THE PROVEN ANODE OFFSHORE...

As a customer you can be sure of protection with GALVALUM® I since 65,000 tons of this material is currently in service and doing the job as designed.

GALVALUM® I anodes provide economic cathodic protection for offshore and marine structure including not only platforms but tanks, steel piers, ballast tanks, marine hulls and a variety of support structures. On offshore structures, an anode system design life of ten or twenty years is routine using GALVALUM® I anodes weighing up to 329kg (725lb).

GALVALUM® II ANODES

A high current capacity anode for cathodic protection applications where a mixed seawater and seabed (saline mud) service may be encountered.

The GALVALUM® II anode was specifically developed to overcome the lower performance shown by GALVALUM® I in mud covered with seawater compared to its performance in open seawater. A tenfold increase in the zinc concentration over that of GALVALUM® I was found to be beneficial.

The action of sulphate reducing bacteria in the muds is the likely cause of reduced current capacity occuring within aluminium anodes.

One possibility is that the microorganisms remove the protective hydrogen from the cathodic areas of the anode, thereby making it easier for local corrosion to take place on the anode. Another possibility is that H_2S generated by microorganisms reacts with the aluminium anode. Hydrogen sulphide has been detected in mud electrolytes where low current capacities were observed.

The ability of high zinc concentrations to offset the effects of microorganisms is thought to be due to the insolubility of zinc sulphide. The formation of a substantial amount of this material apparently blocks the aluminium anode from attack by hydrogen sulphide.

The current capacity-current density relationship for this anode in seawater-covered mud is given in Figure 6.

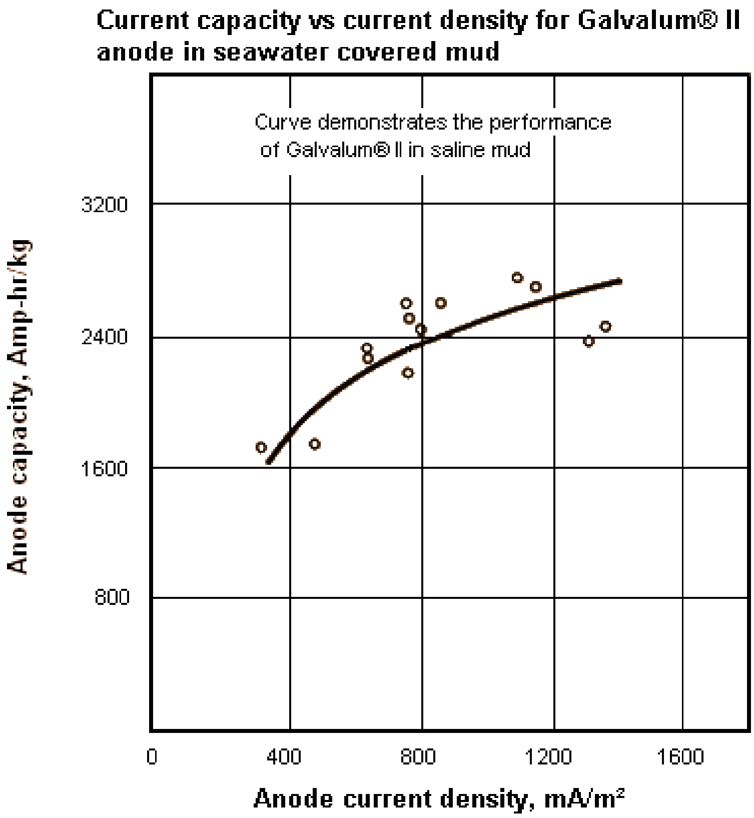

FIGURE 6

GALVALUM® ANODES: ELECTROCHEMICAL PROPERTIES

	Electrolyte	Temp. °C	Current Capacity Amp-hr/kg	Ref. Ag/AgCl Negative Volts	Current Density mA/m²
GALVALUM® I	Seawater	0 - 35	2,756 - 2,877	1.05	860 - 15,100
	7% Brine	40	2,640	1.03	2,155
		40	2,778	1.03	6,460
	7% Brine	80	1,980	1.01	2,155
		80	2,400	1.01	6,460
GALVALUM® II	Seawater	10 - 35	2,680 - 2,750	1.10	860 - 15,100
	Below Mudline	10 - 35	2,400	1.10	500 - 1,000
GALVALUM® III	Seawater	0 - 35	2,535 - 2,650	1.10	860 - 15,100
	Below Mudline	0 - 35	2,100 - 2,200	1.10	500 - 1,000
		40	2,050	1.08	1,076
		60	1,323	1.05	1,076
		80	880	1.04	1,076
		105	880	1.02	1,076
	Hot Brine				
	3% NaCl	66	2,690	1.03	2,153 - 6,460
	7% NaCl	66	2,690	1.06	2,153 - 6,460
	7% NaCl + 500 ppm H_2S	66	2,094	1.01	4,300 - 12,900
	15% NaCl	77	2,095	1.08	2,153
	27% NaCl	43	2,560	1.09	2,153

GALVALUM® ANODES: SOME TYPICAL APPLICATIONS

GALVALUM® I — Offshore structures and allied equipment; marine hull; sheet piling with seawater contact; ballast tanks; jetties, seawater inlet cooling systems (power plants); offshore pipelines in seawater service.

GALVALUM® II — Offshore pipelines which may encounter intermittent seawater-saline mud service, seabed service where H_2S generated by micro-organisms may react with the aluminium anode (an extension of GALVALUM® I but not restricted to seawater applications).

GALVALUM® III — Offshore structures and related equipment; steel piling; bulkheads; dolphins (sea or brackish waters); marine hulls, ballast tanks, compartments of tankers, ore carriers, ore/oil carriers and dry cargo carriers; offshore pipelines in seawater and saline mud; brine treatment equipment; inlet water systems; heat exchangers; jetties and oil field heat treaters.

GALVALUM® ANODES

CHEMICAL COMPOSITION

CHEMICAL COMPOSITION	ALUMINIUM GALVALUM® III	ALUMINIUM GALVALUM® I	ZINC US MIL SPECS 18001K
Fe	0.13 max	0.13 max	0.005 max
Si	0.08 - 0.20	0.11 - 0.21	0.125 max
Cu	0.006 max	0.006 max	0.005 max
Cd	–	–	0.025 - 0.070
Hg	–	0.03 - 0.05	–
In	0.01 - 0.02	–	–
Pb	–	–	0.006 max
Al	Remainder	Remainder	0.10 - 0.50
Zn	2.00 - 6.00	0.35 - 1.00	Remainder
Others	0.02 max	0.02 max	–

Other compositions also available on request.

GALVALUM® III, an aluminium-zinc-indium alloy developed for use in seawater, saline mud, hot brines, estuarine applications.

GALVALUM® I, an aluminium-zinc-mercury alloy developed for seawater applications.

GALVALUM® is a registered Trade Mark of CP TECH.

ZINC is a well proven anode material in use since 1824 with stable current capacity, virtually unaffected by the operating current density. CP TECH manufactures zinc anodes conforming to the composition of US Mil Spec 18001K.

CP TECH's GALVALUM® III material has undergone type approval by Det Norske Veritas (DNV) and comply with DNV's recommended practice B401 and NORSOK Standard M-503 Cathodic Protection Long Term Testing.

GALVALUM® III represents technological break through in aluminium alloying for sacrificial anode applications. Its unique properties overcome many of the shortcomings of aluminium and zinc anode materials. GALVALUM® III was developed specifically for all offshore conditions. The series began with GALVALUM® I in 1966 following research and testing to replace zinc and magnesium based alloys used at that time. GALVALUM® II followed in 1972 for application in anaerobic conditions existing in saline mud at the bottom of the sea. GALVALUM® III offers the widest use of the three alloys in general seawater and saline mud applications.

TECH
http://www.cptech.net

LIST OF GALVALUM® ANODE PUBLICATIONS

1*. Lennox, J.R., T.J., R.E. Groover and M.H. Peterson, "Electrochemical Characteristics of Six Aluminium Galvanic Anode Alloys in the Sea", Paper 104, NACE 26th National Conference, March 2-6, 1970. This paper by the Naval Research Laboratory presents field test data for the Galvalum® I composition and other anode compositions.

2*. Reding, J.T., "Sacrificial Anodes for Ocean Bottom Applications", Paper 70, NACE 28th National Conference, March 22-26, 1971. This paper was presented at the introduction of the Galvalum® II composition. It presents long term field test data for this alloy.

3*. Schrieber, C.F. and R.W. Murray, "Supplementary Studies of the Galvalum® III Anode - Hot Saline Mud and Brine Environments", Materials Performance, Vol. 20, No. 3, pp. 19-23 (1981) March. This paper presents additional performance data for the Galvalum® III composition in a variety of saline environments.

4*. Schrieber, C.F. and R.W. Murray, "Effect of Hostile Marine Environments on the Al-Zn-In-Si Sacrificial Anode", Materials Performance, Vol. 27, No. 7, pp. 70-77 (1988) July. This paper presents performance data for the Galvalum® III composition in a wide variety of saline environments.

5*. C.F. Schrieber, "The Aluminium Anode in Deep Ocean Environments", Paper No. 580, Corrosion/89, April 17-21 (1989), New Orleans Convention Centre, New Orleans, Lousiana. This paper presents results of field and miniplant studies on Galvalum® anodes in varying depths of natural seawater.

* *above publications available for purchase from NACE International (www.nace.org)*

FOR FURTHER INFORMATION...

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