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Welcome to ICorr – Institute of Corrosion (ABZ), November 2021 Technical Event.

Institute of Corrosion (ABZ) partnering with:

IOM3 and Aberdeen Foundries

30th November 2021

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…….Part of our Continuing Education Programme

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“Sacrificial Anodes: Material Specifications, Manufacturing and Anode Design for Effective Cathodic Protection Systems”

About the Presenter

- Dr Nigel Owen, B.Sc., D.I.C, PhD, MIMMM, MICorr.
- Operations Manager - Aberdeen Foundries

- Nigel has worked in the Aluminium Industry for over 35 years after completing a B.Sc. Metallurgical Engineering at Salford and PhD Materials at Imperial College. He then worked in the Research & Development of cast and rolled Aluminium products in Australia & USA along with smelter waste recycling in New Zealand. Nigel also worked as a Materials Consultant and in the Galvanising industry before joining Aberdeen Foundries as Sales, Technical and Plant Manager. At the Foundry he is in charge of manufacturing, testing and technical specification of Marine and Subsea Sacrificial anode supplies..

About the Topic

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- Typical process for manufacturing anodes were presented, from a ‘metallurgical standpoint, the alloying, testing poring and finishing of various product types used for a multitude of applications.

- The presentation then moved on to discuss the design of Sacrificial Anode Cathodic Protection systems for a Marine Environment, which involved selection of anode configuration, a detailed calculation process, rules of thumb and practical experience to design an effective working CP system.

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Q&A

Presentation – “Sacrificial Anodes: Material Specifications, Manufacturing and Anode Design for Effective Cathodic Protection Systems”

Questions and Answers – ICorr ABZ Technical Event **November** 2021

- Q1. What the effect of increase or decrease the presence of a % of impurities in anode efficiency and current.

- A1. The impurities cause passivation at noted levels. Its not necessarily proportional or gradual, with copper and iron being the one's to watch. Mechanism still not fully understood. The Data used to establish standards is not necessarily published. Just keep within max levels of impurity of written compositions

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- Q2 What is roughly the price difference between A2 and A3 (%)? thank you.
- A2: Going from <0.10%Fe to < 0.06%Fe Al Base ingot does have some LME premium, and this can equate to say +5-10% cost increase to customer.

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- Q3 Nigel, would you comment on whether any composition within the BS EN 12496 each of A1, A2 and A3 can be expected to perform equally? More clearly, taking say alloy A2, can any new foundry expect to produce optimum anodes using the full range of compositions permitted within the EN 12496, without the expertise of the original alloy developers, like Dow, British Aluminium and Sumitomo. Many think they can; the licenced producers had 'secret' tighter optimised compositions.

- A3 The different alloys will perform same in standard conditions such as the lab in which tested (as say in Type Approval), but A1 may fail in deep/cold water environment. I am not sure there are any secret pockets of high performance in the composition's and anyone can make these anodes to the recipe and they should work if used in right environment. It's the application of say A3 alloy in high H_2S, low salinity or extreme environments that is uncertain and an Al alloy maybe fail. This is when use of zinc has to be a consideration.

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- Q4 Electrochemical capacity : how important is the 12 month testing on every supplier material ?

- A4 One year test is ‘Type Approval’ Testing for which certification can be obtained for a given plant / Company anode material. Most Plants are making same material (like Galvalum III) – but the lab tests seem to yield different capacity and potentials (!). The sampling matrix in plant for the multi-element compositional variations is generally inadequate and there is no statistical significance in the results apart from averages. It is traditional that you get a cert. and some purchasers expect it.

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- Q5 Can you please advise the minimum distance between anode ID and steel core that we should specify on bracelet anode drawings to make sure that anode is manufacturable (and still keep utilisation factor around 0.8)?

- A5 You must have some metal on back of mounting cage to encase it. Thin Bracelets are not easy to make and ~5-6mm spacing for thinnest shells is perhaps minimum gap, (increasing for thicker ones).Bracelet min practical thickness is about ~40mm ……and there is no need to push for thinner shell thicknesses.

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- Q6 Nigel, totally agree on predominance of composition and the lesser value of short-term electrochemical testing. BUT they are a final check that there has not been an unusual pollutant in the alloy mix that may not be covered in your spectrometer analysis. Famous case in the USA, years ago, industrial disputes and furnace 'poisoned' with coins: 'nickels'... Passed analysis but poor anodes.

- A6 Analysis by OES is ~ 14 element assessment of common elements and contaminants from ingot / foundry operations. Sabotage can maybe not be guarded against.

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- Q7. What about Contacts and continuity ?
- A7 The electrical connection of retrofit anodes/bracelets is through cables, extension straps welded to anode pads, or Volcano Bolts through the bands.

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- Q8 Thanks. can you please share pictures of mechanical fitting options for retrofitting CP of steel piles?

- A8 I assume you are retrofitting with anodes mounted on bracelet bands as a quick installation? There is a picture in the presentation of rolled bands with gusseted tabs, also hinged for quick install slung open and wrapped and bolted by the divers. Or you can weld stand-off anodes to channel or beams and lower them in, welding only above water.

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- Q9 If there is no place to put the anode horizontally for underground pipeline is it possible to be under the pipeline bottom at least half metre?

- A9 Land based CP in soils, maybe using sacrificial Mg anodes, but is not our area of expertise. I cannot really advise on this.

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- Q10 DNV-RP-B401 requires no cracks visible to the naked eye for zinc anodes. is it easy to achieve?

- A10 Zinc doesn’t really crack at all when cast if casting shrinkage properly fed. There are normally, no visible cracks-easy!

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- Q11 Do you know how much validation of the DNV anode resistance calculation formula have been performed in seawater, including this stand-off distance, the spacing between anodes and so on ?

- A11 The data has been established historically and the formulas from academic studies. DNV formulas and guidance has been established bya panel of experts (this data is not released to my knowledge) but all parameters are conservative and work well. Interference between anodes can be calculated and it can reduce the individual anode outputs. To avoid any interaction, spacing has been proven to be more like 2m between anodes on, say, skids.

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- Q12 Hi Nigel. Can you please advise if you produce high temperature zinc anodes (>50 deg. C)? thank you.

- A12 I believe that beyond 50°C Zinc has a potential similar or less negative than steel. I don’t think there is a high temp zinc anode alloy in production anywhere. It does not perform well at higher temperatures.

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- Q13 On which basis or criteria can I choose anode weight for good current distribution if we have Mg anode of 3.2 ;7.7 ;14.5 kg.

- A13 In your design you should have all anodes equal weight and distribution uniform relative to the steel (cathode) area that it protects.

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- Q14 In the retrofit photos, the internal surface of the attachment bracelets were painted, should they be or is it better to be uncoated for continuity once clamped to the existing?

- A14 The electrical connection of retrofit anodes/bracelets is through cables, extension straps weld to anode pads or Volcano Bolts through the bands, We don’t rely on the Mounting Bands/Strap contact as this is the support structure. Painting the Anode brackets helps increase Anode life.

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- Q15 Are you aware of a solution that protects both carbon steel and doesn't overprotect duplex. i.e. -1100mV verses -500mV.

- A15 Sacrificial Anodes only work at one level/output. You must separate/isolate systems and protect them individually. You could use Alloy A4, Al-Ga to protect Duplex these days.

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- Q16 DNV provides just generic recommendation for CP designers to be qualified to ISO. but some oil and gas operators require qualification to certain levels of ISO or NACE. Pls comment ?

- A16 I suppose the Risk has to be assessed by the Operators as they have to pay insurance and therefore may insist on higher levels of qualification. The rules vary by contract and not all CP designers are qualified ‘CP Engineers’, some are, say, Civil or Mechanical engineers who possess Professional Indemnity insurance that covers this.

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Should you have any further questions related to this Webinar,

Please contact: Dr Nigel Owen **n.owen@aberdeenfoundries.co.uk**
who will be very pleased to assist you. Thank you.

THANK YOU FOR ATTENDING

This Webinar was brought to you by ICorr Aberdeen working in partnership with **IOM3 and Aberdeen Foundries.**