Instrumentation Protection

Configuring Protective Enclosures for Offshore Applications

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Engineers tasked with choosing and configuring enclosures, cabinets and shelters for offshore applications face a multitude of conflicting demands. Not only must the unit provide protection against extreme cold or extreme heat – depending on platform location – but it must also be resistant to a host of environmental and other factors, such as salt spray, sour gas, high wind velocities, UV exposure and possibly high pressure blasts. Topping out this wish list, the enclosure needs to have a robust structural integrity, a very long service life and yet weigh as little as possible – as all topside weight on offshore platforms is an expensive commodity. Many of these demands are common to all types of protective enclosure, regardless of whether they are small instrumentation housings or relatively large shelters. This article looks at some of the issues behind each category.

Figure 1: Intertec's Diabox Protective Enclosures Provide Easy Access For Maintenance.

The degree of attention paid to instrumentation protection on offshore platforms varies significantly around the world. In some countries, engineers have even been known to regard enclosures as an unnecessary luxury. However, given that the cost of such enclosures forms an infinitesimal part of the build cost of a platform, this is an inexcusable short-term view.

Furthermore, since there is a steady industry trend towards lower manning levels, including completely unmanned platforms, maintenance costs can be extremely high, especially in difficult-to-access locations. The cost of shutting down production simply because of an instrumentation failure caused by inadequate protection hardly bears thinking about!

Instrumentation Enclosures

There is a variety of competitive designs for instrument protection. These all suffer from various problems. Custom-made insulation in the style of pipe insulation never provides the same level of thermal performance after being opened for maintenance purposes. Soft covers do not protect the instrument from corrosive media etc., and have a limited life cycle of around three years. Enclosures made from non-fibre-reinforced plastics with an integral polyurethane (PU) or polypropylene (PP) foam liner are vulnerable to impact damage and material degradation over time, and steel is heavy, weighing-in at about 8 g/cm3. Furthermore, even in its galvanised from, steel is susceptible to corrosion and pitting, making regular repainting mandatory and expensive. Stainless steel is sometimes used for some of the smaller enclosures, but its high cost and fabrication complexities tend to limit it to small esoteric applications. On top of this, there are the problems of providing adequate thermal protection for the instrumentation - steel is highly thermal conductive ($\lambda \approx 15 - 50$ W/mK).

Field instrumentation protection specialist Intertec, for example, manufactures the outer skins of its enclosures, cabinets and shelters from a special high performance grade of long glass fibre reinforced polyester known as GRP, which has a very low thermal conductivity ($\lambda \approx 0.2$ W/mK). The fabrication process depends on the type and size of enclosure – SMC is used mainly for instrumentation enclosures, while various combinations of resin transfer moulding (RTM), continuously made sheeting, pultrusion, or hand lamination are used for larger cabinets and shelters. The form of GRP used by Intertec offers numerous advantages over conventional enclosure fabrication materials.

Its strength virtually matches that of stainless steel, yet it weighs 75 per cent less – at just 1.2 gm/cm3 – and it is up to 100 times more stable than non-reinforced plastic. It is also inherently immune to corrosion, and has an excellent resistance to salt spray and harsh corrosive media.

Intertec produces a wide variety of GRP-based instrumentation enclosures in numerous different styles and form factors, with capacities ranging from ~20 to 300 litres, all of which are suitable for use on offshore platforms. A comprehensive range of options, including insulated exit and entry ports for tubes and electrical

Figure 2: Double-walled Grp Sheets With A Pu Foam Core Combine Excellent Thermal Performance With Rigidity.

connections, windows and mounting kits, simplifies configuration.

By way of example, the outdoor enclosure style in Figure 1 was recently supplied for a series of offshore platforms in Canada, where they will be used to protect small-bore valves and process transmitters. This style of enclosure facilitates installation and provides easy access for subsequent maintenance of the equipment mounted in the base half of the unit. Most engineers elect to mount these enclosures vertically, and to run tubes via the base or the rear.

In this particular case, the enclosures were produced under Intertec's Safe Link scheme, which facilitates a truly global custom design-to-delivery service. The enclosures were specified by an engineering design team in Malaysia and manufactured at Intertec's facilities in Neustadt, Germany, where they were also equipped with the necessary Intertec heaters and third-party process transmitters produced by another German company. The complete assemblies were then certified as being Canadian Standards Association (CSA) compliant, before being shipped to the platform manufacturer in the United Arab Emirates. This

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Figure 3 : Grp-based Fire Protection Enclosure For A Valve Actuation System.

type of collaborative approach to enclosure design, configuration and supply is becoming more common, as companies strive to reduce costs in their procurement processes.

Constructed entirely from hot-pressed GRP – which helps ensure a working lifetime in excess of 25 years – the enclosures feature an integrated continuous double seal, comprising a mechanical tongue and groove and a synthetic rubber sealing strip. For this application - in near Arctic conditions - each enclosure is fitted with an explosion-proof heater to protect against frost and condensation, and is internally insulated with lightweight closed-cell polyurethane (PU) foam to minimise heat loss, which delivers excellent thermal insulation (U ≈ 1 W/K) and helps to minimise energy consumption. In comparison, a steel enclosure (galvanised or stainless) of the same size would have a U-value of 6 W/K.

Insulation makes a very big difference in temperature performance. Typically, to maintain the same internal temperature, insulated enclosures require just one-sixth of the heating power of uninsulated enclosures. Furthermore, the conductive block heaters used in the Safe Link concept have five times better heat transmission. So a typical transmitter box requires only 50 W heating under Arctic conditions!

Another benefit of this construction technique is its rigidity. With enclosures that make any use of metal in their construction, it is almost impossible to avoid metal parts in some design elements (such as the door frame, door leaf, window, wall penetrations for cables and tubing etc.) because the stability of this type of housing is based on bent sheet metal, and insulation materials are typically soft. These metal elements can act as thermal short cuts between the interior and exterior, and can have a significantly detrimental effect on the protection performance.

Cabinets and Shelters

This kind of GRP sheet can also be used for larger cabinets, shelters and buildings – which can be fabricated to virtually any size. The author's company can produce single-piece sheets of GRP as large as 3x6 metres for example, providing enclosure designers with considerable freedom to adopt the optimum layout and configuration both for standard products and custom designs. Wall thickness and fibre alignment can be varied during manufacture to suit specific load-bearing and thermal design demands, and all shelters also employ the type of sandwich construction technique shown in Figure 2, to further increase rigidity and provide high levels of environmental protection.

The intrinsic strength of GRP sheets, especially those comprising double walls with a PU foam core, makes them highly suitable for the construction of large shelters. When combined with the high tensile strength of internal support posts made by pultruding GRP, and other support pieces fabricated using RTM, it enables such structures to be designed to withstand wind velocities as high as 240 km/hour, as well as high static and dynamic loads; Intertec verifies all stability calculations using advanced in-house developed software. Engineers seeking large enclosures for offshore platforms – for example to house emergency shutdown valves – face similar problems to instrumentation engineers, but on a more complex scale. The choice of enclosure material will be influ-

Figure 4 : This Analyser Containment Building Is Designed To Withstand Blast Loads As High As 300 Mbar This Image Will Be Provided Shortly.

enced by the same issues, such as weight, thermal insulation, corrosion resistance, etc. However, it is also likely to have to take into account factors such as fire resistance and possibly the need for antistatic precautions to prevent sparks being caused by electrostatic charging – the demand for explosion-proof equipment that meets the IEC 60079 standard for use in potentially explosive atmospheres is mandatory in many applications.

Although normal GRP is not fire retardant, the type produced by Intertec does have this characteristic, and is self-extinguishing. When used in sandwich type form with a special mineral wool core, it can provide fire resistance up to 120 minutes. This enables the fabrication of fire shelter designs that will keep equipment such as emergency shutdown valve and actuators within their operational temperature range for a specific amount of time, for example, 60 degrees C for 30 minutes, thereby providing a high safety margin. GRP is considerably better than metal materials in this role – its thermal conductivity can be up to some 250 times less. Another advantage of GRP, compared to steel, is the ease with which additional buildings can be added to existing working platforms.

Any relatively large metal structure would obviously add significant weight, possibly exceeding the platform's load bearing design limit. Intertec has recently built an entire fitness room for rig personnel – complete with exercise bicycles and a panoramic viewing window – on a working offshore platform for a French oil company. Constructed entirely from GRP sheets incorporating a PU foam core, the fitness room was manufactured off-site in the form of prefabricated sections, fully verified and then reassembled on the platform, where it is tightly integrated with the upper deck support structure.

Ultimate Protection

For offshore applications demanding the absolute maximum levels of protection against environmental conditions such as very high wind velocities and blast loads, a sandwich construction technique known as Arctic is employed. Again constructed from GRP sheets with an inner core of PU foam, this has the option of multiple wall layers, which can be designed to meet vigorous performance standards. Insulation thickness can be varied to suit the application. This construction technique is currently being used to build an analyser containment building for a North Sea platform that has to be capable of withstanding blast loads as high as 300 mbar. The analyser building shown in Figure 4 has an eight square metre footprint. Fully air-conditioned, it is a custom design, featuring several instrumentation enclosures with viewing windows attached to the external front and rear walls.

Another factor that is becoming increasingly important, especially in parts of the world such as Australia where exposure to UV radiation is a significant issue, is the type of 'gel-coat' used to protect the GRP sheets from premature ageing. The author's company uses a UV and scratch resistant covering material that is actually applied as part of the moulding process, which provides a very high integrity chemical bond with the sheet.

This approach results in a very thick protective coating, of the order of 800 μm; contrast this with the 80 μm coating of acrylic paint that normally gets applied to steel products such as cars and lorries, and it is easy to see why the 'gel-coat' has a lifetime in excess of 30 years. ❍

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