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Amarinth looks at issues to consider when winterising oil and gas pumps for extreme sub-zero conditions

Exploration and production of oil and gas is taking place in ever more remote regions of the world and the attention of companies in recent times has turned to areas of the globe that are ice bound for much of the year. This poses new challenges for manufacturers to design equipment that can operate reliably in these hostile environments.

Amarinth, a leading company specialising in the design, application and manufacture of centrifugal pumps and associated equipment to Oil & Gas, petrochemical, chemical and industrial markets, has supplied pumps into just such environments but found little written on the subject of winterising pumps to work reliably in sub-zero temperatures.

In this article, Oliver Brigginshaw, Managing Director of Amarinth, looks at some of the lessons learned from ensuring its own pumps operate reliably in these testing conditions, drawing on experiences of pumps it supplied to the Prirazlomnoye oilfield, located south of Novaya Zemla in northern Russia.

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Winterisation

When thinking about oil and gas processing equipment such as industrial pumps, winterisation is the process of designing oil and gas processing equipment to withstand extreme low temperatures. Winterised pumps will be specified by the contractor or end user on their datasheet to potential suppliers along with the extremity (i.e. the temperature range). Amarinth has been engaged by many global oil and gas companies to provide advice and design pumps that can withstand the hostile environment of the sub-arctic ice. Winterising pumps requires careful selection of materials and coatings and design of seal systems, couplings, motors and base plates.

Sub-arctic ice sheets

One such sub-arctic location which Amarinth has recently supplied winterised pumps into is the Prirazlomnoye oilfield located south of Novaya Zemla in northern Russia on the Pechora sea shelf, at a distance of 60km from the shore. This region is subject to extremely low temperatures and strong ice loads. It is ice free for only 110 days a year and the cold period lasts 230 days. The ice thickness is up to 1.7m and the annual average temperature is -4°C with a minimum of -50°C.

What API 610 says

Interestingly when it comes to selecting pumps for extreme low temperature conditions, the purchaser will simply note on the technical data sheet that the pumps need to be winterised, usually in the note section or added to the environment section. Amarinth has not been able to find any industry standard definition of what winterisation actually means in relations to pumps and what should be done to the equipment achieve this. Therefore Amarinth has developed its own list of considerations to ensure that its pumps will operate reliably in sub-arctic conditions such as the Prirazlomnoye oilfield, some of which are shared below.

Materials

Stainless steel is the minimum choice of material for extreme low temperatures as it is much stronger and less brittle than normal carbon steel as the temperature falls. However, other factors such as the pumped fluid have also to be considered. For example, produced water is often rich is hydrogen sulphide (H_2S), which would corrode a stainless steel pump. The best material for produced water pumps, such as those Amarinth supplied to the Prirazlomnoye oil field, is duplex stainless steel, and so designers must always take care to balance the temperature requirements of the site and the material requirements of the pumped fluid and then find a suitable compromise.

Base-plates

Base plates are usually manufactured from low carbon steel which is suitable down to -25C. However, beyond this point stainless steel should be considered as low carbon steel will start to suffer from brittleness. Tests such as Charpy Impact Testing should be carried out on the chosen material to make sure it will be suitable for the temperatures that will be experienced on site.

Couplings

In sub-arctic regions such as the Prirazlomnoye field where minimum temperatures can reach -50C, components for couplings have to be carefully selected for Very Low Temperature and it is important that in these extreme conditions that the coupling manufacturers work closely with the pump manufacturer to define the operating conditions. Steel variations must also be considered, for example, Drive Bolts can be induction hardened and made suitable for higher strength applications when resistance to shock is also required.

Seals and seal support systems

Seal systems, particular for hazardous fluids such as the produced water being treated by the nutshell filters in the Prirazlomnoye field, must be carefully considered with safeguards built into the design to allow the storage and operation of the systems when conditions are as low as -50C.

Low temperature materials and elastomers must be selected, such as low temperature nitrile bladders for accumulators. Stainless steel materials are stronger at low temperatures and generally recommended to replace any carbon steel components within the seal support systems. For cold duties, the systems can also be trace heated or lagged.

Finishes

For temperatures as low as -50C, specialised paint finishes may be required such as two pack epoxy abrasion resistant coating which would have low ice adhesion and low frictional resistance. The typical film thickness for extreme low temperature would be in the region of 400-500 microns.

Motors and drives

Motor manufacturers are usually able to certify their equipment down to -55C and they continue to use and guarantee their grey cast iron housings at this temperature. However the shaft steel will be alloyed and heat treated for cold temperatures and specialist grease and shaft seals will be used. Needless to say, fans need to be made from steel, brass or aluminium, certainly not plastic.

Instrumentation

Although LCD displays can work in temperatures down to -20C, below this any instrumentation is best mounted within environmental heated enclosures. Silicon oil filled gauges will operate at much lower temperatures than normal gauges and tanks and pipework should be lagged or provided with immersion heaters to maintain barrier temperatures.

Shipment, storage and installation

There are various storage and preservation procedures recommended to ensure the integrity of the equipment between shipment, storage and installation/start-up. The pump manufacturer must work closely with the contractor and/or end user to ensure storage and installation procedures are detailed to prevent damage to the pumps before operation.

Other considerations

In addition to the winterisation design considerations, in regions such as Russia where such pumps are frequently used, there are further challenges associated with access, passports, language, documentation (GOST-R or GOST-K). Overcoming these additional challenges is also crucial to the overall success of any project and should not be underestimated when selecting a pump manufacturer as the costs for this alone can be significant.

More information

The points above are by no means exhaustive but illustrate some of the design considerations for operating pumps in extreme low temperature environments. Further technical details are available on the Amarinth website in its Winterisation Technical Bulletin. As API 610 does not define winterisation though, Amarinth also recommends that as much information as possible about the operating environment is provided to the pump designers in order to ensure reliable operation, rather than simply relying on a note on the datasheet that winterisation is required.

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OPTIONAL PANEL or BOX ITEMS

Oil & Gas processing in extreme low temperature environments

NOTES TO EDITORS:

Founded in 2002, Amarinth has harnessed the skills, creativity and passion of people who have worked in the pump industry for many years. Amarinth delivers world-leading expertise in the design, application and manufacture of centrifugal pumps and associated equipment to ISO, ANSI & API standards, primarily for the industrial, chemical & petrochemical markets. Their portfolio includes:

- **Pumps**: Horizontal and vertical API 610 pumps, chemical and industrial pumps, many of which are interchangeable with the Girdlestone pump ranges, eliminating the need for expensive modifications when replacements are required.
- **Pressure Vessels**: Protect System Plan 52 and 53A and 53B sealant systems with inbuilt condition monitoring for pumps and mixers that are suitable for Safe area up to Zone 1.
- **Spares & Service**: High quality, fast lead-time re-engineered spare parts to improve performance and extend pump life, including many which are directly interchangeable with the Girdlestone pump ranges.
- **Packages & Modules**: Condensate Recovery Units manufactured for Spirax Sarco incorporating the innovative Ci-Nergy intelligent variable speed control system, plus bespoke packages & skids built to order.
- **Business Systems**: state-of-the-art e-commerce technologies that deliver 24/7 support enabling customers to select pumps and place orders on-line and then track every stage of manufacture through to delivery, any time, anywhere in the world.

The company operates globally from its base in Rendlesham Suffolk, United Kingdom and has a customer base of world-leading companies, including BP, Shell, ExxonMobil, GlaxoSmithKline, Pfizer, Spirax Sarco, Diageo, AMEC, Fluor and Halliburton.

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