ENGINEERING TOMORROW

Article

Why Danfoss Hansen® **Aluminium Flat Face ADB couplings** offer significant reliability advantages in liquid-cooling system applications

In this article, Ophélie Pezard of Danfoss Power Solutions , looks at the importance of material selection in couplings for liquid cooling systems, outlining why aluminium is able to outperform thermoplastics.

Introduction

Increasing numbers of vehicle, machinery, and equipment OEMs are utilizing liquid cooling in their electrical systems because the fluid loop transfers heat far more efficiently than air. This helps to ensure the safe and effective operation of system components at stable temperatures.

For instance, in the industrial machinery market, liquid cooling can be found on laser-cutting, injection-moulding, and drilling machines.

In the renewable energy sector, liquid cooling is utilized for turbines at water plants, and in the converters employed by wind turbines and solar plant.

Finally, in the data center market, liquid cooling is becoming increasingly popular. The increase in the amount of data being exchanged, combined with an increase in the performance of IT equipment, means that there is a real need for a reliable and durable cooling system, such as liquid cooling.

Although plastic couplings have been the historical choice in liquid cooling applications, they can demonstrate a number of disadvantages due to the effects of heat on plastics. The higher the temperature, the weaker thermoplastic couplings become, which in turn has a negative impact on maximum pressure resistance. It is also possible for plastic couplings to disconnect above a certain temperature level.

For instance, at 70°C, plastic couplings are only rated up to pressures of approximately 5 bar, while at temperatures in excess of 70°C, the maximum pressure rating declines. Contrary to this, the latest aluminium couplings are typically rated up to 25 bar.

It is commonly assumed that plastic is the most cost-effective option for couplings in liquid cooling applications because it is a lightweight material.

However, aluminium flat face couplings now offer a lightweight alternative in a wide variety of liquid cooling systems. In fact, the latest aluminium couplings provide a minimum safety factory of 4 (for a working pressure of 25 bar).

Environmental exposure

Environmental exposure to UV/sunlight or extreme cold is a known cause of premature degradation in plastic couplings.

As a result, users can sometimes experience early replacement due to deterioration, which not only creates potential technical problems in the application, but also results in messy clean-up.

In comparison, the latest aluminium couplings, such as the ADB flat face series from Danfoss, provide high strength, endurance, corrosion resistance, and greater life expectancy, while retaining lightweight characteristics. The end result is a reduced TCO (Total Cost of Ownership). More importantly, the spill risk is minimized for critical electrical components, offering the end user reduced maintenance requirements and higher operational safety.

Vibration effects

As a result of material characteristics, plastic couplings offer lower connection strength than their metallic counterparts. In short, the connection can break more easily under the vibration conditions typically experienced in thermal management applications.

In excessive vibration applications, such as those found in the rail industry, versions offering enhanced vibration resistance can be sourced that are tested in accordance with EN 61373, which specifies shock and vibration tests for rolling stock equipment.

Flow requirements

Although liquid cooling is typically a low-pressure application, flow is an important consideration in the selected coupling as pressure drops can cause inefficiency at the pump and hindering the fluid getting to the hot components. Here, an aluminium coupling with a flat face design offers good flow suited to thermal management applications.

This performance enables any drops in pressure to be optimized, ultimately improving the efficiency of the cooling system. This feature is very important in systems such as data center liquid cooling.

Optimal connection

In many modern thermal management systems, access to the connection can be quite restricted. Couplings such as the Danfoss ADB, feature a convenient guide system that helps users pre-position the coupling before connecting it. The ease of use inherent in this push-fit connection simplifies and speeds up the maintenance process in hard-to-reach applications, increasing uptime.

In addition, in certain types of cooling applications, such as data center configurations, some connections at the rear of the system may be inaccessible or difficult to see. This is why it is necessary to use "blind mate" type connections.

This new type of coupling offers a connection that can be made without seeing the location of the connection. Danfoss is, therefore, working on extending its portfolio to include the ADB blind mate version so that users of liquid cooling systems can choose between manual or blind connections depending on the needs of the thermal management application.

Leakage effects

Thermal management systems are very demanding in terms of component reliability. System owners try to minimize downtime to ensure a good return on investment. If a component malfunctions or is damaged, the whole system risks coming to a standstill. The risk of coupling leaks must, therefore be avoided.

Due to their lower chemical compatibility with water-glycol cooling agents, users of thermoplastics couplings can sometimes experience leaks. Moreover, any leaked agent can prove difficult to clean, an activity that frequently leads to prolonged downtime.

To combat the situation, well-designed aluminium couplings offer a number of defense mechanisms against leaks.

For instance, specifiers should look for couplings that provides flat face, non-spill functionality (dry-break with no liquid loss), which makes them particularly suitable for use in electrical environments. This functionality reduces the risk of technical failure and safety concerns, promoting higher effectiveness in the field.

Seal selection

Another factor that influences leakage resistance is selecting the optimal seal. EPDM seals are known to provide excellent fluid compatibility with water glycol.

However, engineers should look out for coupling suppliers able to provide a host of different seal compounds, not simply EPDM alone.

The driver behind this issue is the requirement for many manufacturers to build several cooling system types, in a multitude of different formats. In this case, customers will benefit from using a single source to maximize system, with seals able to handle different cooling agents such as liquids or gases.

Manufacturers will also enjoy advantages from selecting couplings available in a range of end connections, such as inside flat, outside flat and elbow solutions. Put simply, choosing a supplier that is able to provide a full range of optional seals, end connections and sizes, will deliver long-term benefits.

Conclusion

Ultimately, aluminium couplings offer extended operational life and minimized spill risk in all critical electrical cooling applications, providing the end user with safer operation and reduced maintenance costs. In addition, thanks to advantageous material characteristics over plastic, aluminium couplings can be deployed with higher levels of success in environments where high vibration or heat exposure is unavoidable.

The advantage is that OEMs, at last, have a viable alternative to traditional thermoplastic couplings in liquid cooling applications.

It is worth noting that our ADB is available with color-coding option (as you can see below) for all the 5 available sizes.

In conclusion, the Danfoss Aluminium dry-break coupling ADB series offers, the right solution in thermal management applications.

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