

Danfoss Hansen® Aluminium Flat Face ADB coupling

Aluminium offers significant reliability advantages in **liquid-cooling system applications**

In this article, **Christian Künstel** Global Product Management Leader, Connectors Business of Danfoss looks at the importance of material selection in couplings for liquid-cooling systems, outlining why aluminium is able to outperform thermoplastics in terms of reliability in these applications



Introduction

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

Although plastic couplings have been the historical choice in liquid-cooling applications, they can demonstrate a number of disadvantages, often due to the effect of heat. The higher the temperature, the weaker thermoplastic couplings become, which in turn has a negative impact on maximum pressure resistance. For instance, at 70°C, plastic couplings are only rated up to pressures of around 5 bar, while at temperatures in excess of 70°C, the maximum pressure rating declines.

Contrast this to the latest aluminium couplings, which are **typically rated up to 25 bar**, and the difference is clear to see. It is commonly assumed that plastic is the most cost-effective option for couplings in liquid-cooling applications, while its lightweight nature makes it the only choice. However, aluminium flat-face couplings now offer a viable alternative in a **wide variety of liquid-cooling systems**.

For instance, in the industrial machinery market, liquid cooling can be found on laser-cutting, injection-moulding, and drilling machines. Transportation is another exponent of this technology, for applications such as motor pre-heat systems on buses, as well as electrical converters in railway rolling stock. In the renewable energy sector, liquid cooling is utilised

for turbines at water plants, and in the converters employed by wind turbines and solar plant. Water cooling for mainframe computers in data centres, and fuel cells used in the broadcasting industry, are among numerous further applications for this increasingly popular solution.

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 breakage, which not only creates potential technical problems in the application, but difficult-to-clean spillages.

In comparison, the latest aluminium couplings, such as the ABD flat-face series from Danfoss, provide high strength, endurance, corrosion resistance, and life expectancy, while retaining light weight characteristics. The end result is reduced TCO (total cost of ownership). Importantly, the spill risk is minimised in critical electric cooling applications, offering the end user reduced maintenance requirements and higher operational safety.

Vibration

As a result of material characteristics, plastic couplings offer lower connection strength than metallic counterparts. In short, the connection can break more easily under the **vibration** conditions typically experienced in liquid-cooling applications. It is also possible for plastic couplings to disconnect above a certain temperature level.

Aluminium provides the solution as it offers high resistance to mechanical stress, which in turn provides a strong connection under both continuous vibration and heat. In fact, the latest aluminium couplings provide a **minimum safety factor of 4** (for a working pressure of 25 bar). 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

Although liquid-cooling is typically a low-pressure application, flow is an important consideration in the selected coupling as pressure drops can cause the fluid to heat up, reducing the efficiency of cooling systems. Here, an aluminium coupling with a flat-face design offers **29-62% higher flow** (depending on the specific application) in comparison with ISO 16028 requirements. This performance enables any drops in flow to be reduced, ultimately improving the efficiency of the cooling system.



The installed space

It is notoriously difficult to connect couplings when access or visibility is restricted, which is often the case in many modern liquid-cooling systems. Couplings such as the Danfoss ADB have a **convenient pre-guiding system** which helps users to pre-position the coupling before connection. The inherent ease-of-use of this

push-fit connection system both simplifies and accelerates the maintenance process in awkward access applications, which in turn boosts uptime.

Colour-coding is another advantage of aluminium couplings, a feature that promotes connecting without mistakes. Typically, plastic couplings can only be colour-coded in high quantities. In contrast, aluminium couplings can be processed in low batch sizes using anodising, even in gold colours, providing further assistance to maintenance teams.



Leakage

Leaks are a common pain point for users of electrical systems that rely on liquid cooling. Due to their lower resistance to chemical attack from 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 system stoppages.

To combat the situation, well-specified aluminium couplings offer a number of defence mechanisms against leaks. For instance, specifiers should look for couplings that provide **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 effectivity in the field.



Seal selection

Another factor that influences leakage resistance is selecting the **optimum seal**. Here EPDM seals are known to provide high levels of water-glycol compatibility. 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. Here, customers will benefit from utilising a single source to maximise production efficiency, with seals able to handle different cooling agents 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 minimised 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 upshot is that OEMs at last have a viable alternative to traditional thermoplastic couplings in liquid-cooling applications.