Eaton Gromelle-Hansen Flat Face series coupling
Whitepaper

Eaton's Flat Face coupling series improves fuel efficiency and increases product life with offering higher pressure resistance

Powering Business Worldwide

Contents

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Executive summary

Eaton has enhanced its Flat Face series quick disconnect coupling, with several technical developments, to offer 60% higher operating pressure and up to 74% higher flow rates compared to ISO 16028 specification. Significantly improved corrosion resistance, with Eaton's Guardian Seal plating, and connect under pressure capability extends the service life of the product. The enhanced design of coupling features higher flow rates and higher operating pressure at the same time!

A flat face quick disconnect coupling is a double shut-off style high performance quick disconnect coupling (QDC), where valving on both halves of coupling are flush facing with body, significantly reducing spillage and air inclusion compared to traditional poppet style coupling. Quick disconnect couplings are used in a variety of industries such as Oil & Gas drilling, Agriculture, Construction, Mining equipment, and Heavy machinery, amongst others.

In most of these industries, quick disconnect couplings are used in machinery and equipment where frequent connection and disconnection of hydraulic lines is necessary, primarily for changing equipment attachments and implements to carry out different functions. This is where easy and quick connection of coupling without any special tools becomes value for the customer. Flat face coupling offers this with an added advantage of minimum fluid loss (spillage) and air inclusion in system per connection / disconnection.

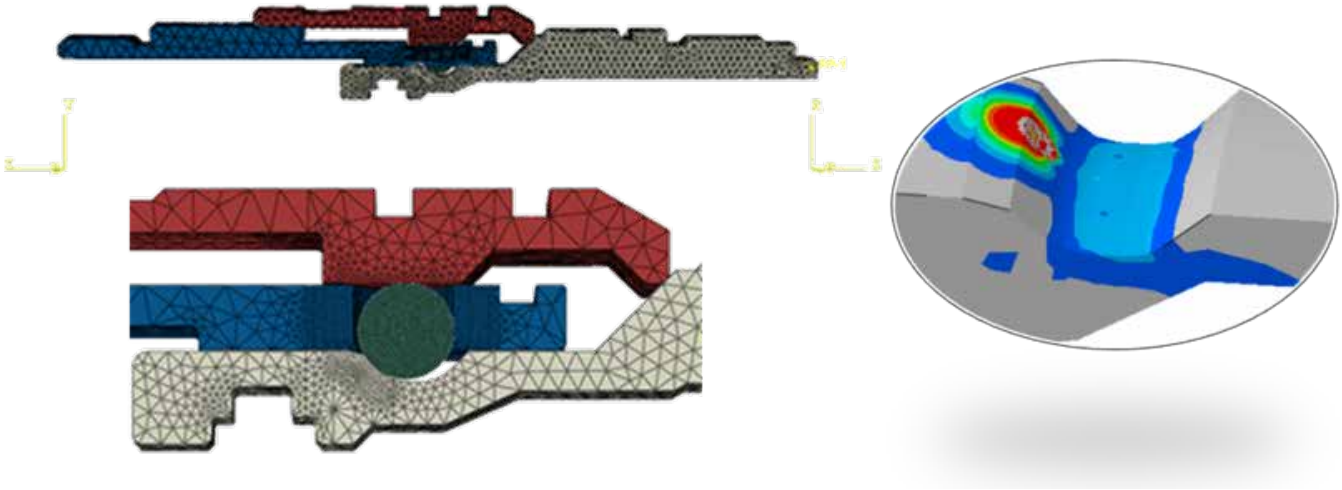
Over the past few years, industry trend has been to offer compact machines, but with the same power and operating capabilities of their larger equivalents. In turn, this demands higher pressure resistance capability from hydraulic system components, which essentially means higher force and torque is available from smaller equipment. Parallelly, with the cost of fuel being high in the twenty-first century, it is essential and actually of operator importance to ensure that fuel economy is optimized and maintained. Whilst there are many factors that contribute to the amount of fuel consumed, one such area that can dramatically affect a mobile machines performance is hydraulic pressure. In context of couplings, it is essential that coupling lets more fluid through. If the coupling isn't able to deliver enough flow, then the pump for the hydraulic oil will have to try and compensate, this means that the amount of energy it draws from the ICE (internal combustion engine) is greater, thus the amount of fuel utilized for this compensation is increased.

Briefly, higher pressure resistance, higher flow rates (low pressure drop) and reliable product for longer life are industry needs from quick disconnect coupling. Eaton's re-engineered Flat Face (FF) series coupling coupling caters to the requirements for these industry trends, and offers following salient features to meet the application demand.

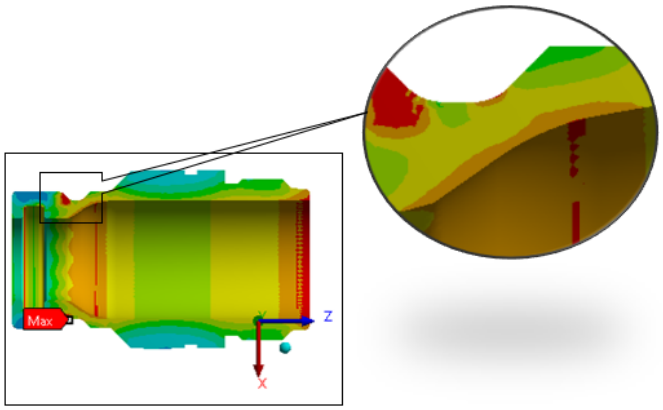
Pressure resistance- 60% higher operating pressure than ISO 16028 specification

With industry interchange design, engineers have very fine margin to play and because of this typically higher-pressure resistance comes with the cost of reduced flow rate (rate of fluid flow at 1 bar pressure drop). However, with use of superior high strength materials and design optimization efforts, Eaton's new Flat Face (FF) series coupling can withstand up to 400 bar (5800 psi) working pressure for static, non-pulsating applications, across 6 sizes. For applications causing pressure pulsations, this coupling is recommended to use up to 350 bar (5075 psi). Even with such higher working pressure, factor of safety has not been compromised, and FF series coupling has been designed to withstand 1400 bar (20300 psi) static pressure before fracture occurs. It is also ensured that there is no plastic deformation of metal components or any sealing is not compromised for pressure up to 600 bar (8700 psi), for safety against intermittent and sudden short term rise in system pressure.

Eaton`s Flat Face series coupling is qualified for one million impulse cycles, again at a good factor of safety of 1.33 for pulsating pressure, to ensure resistance to fatigue failure when subjected to hydraulic shocks in application. Often in products with ball latch mechanism, there is a probability of indentation in latching region, which can cause coupling to get locked in connected state. To prevent this phenomenon, FF series coupling plug is heat treated to increase hardness in this region of plug body. With increased hardness, FEA simulation is leveraged to optimize the material thickness of plug body, which resists the brinelling, to maintain the brinelling within limit.



Thanks to Eaton's finite element analysis capabilities, each component in FF series coupling has been otimized to great extent. With FEA simulations, followed by rigourous testing, it is ensured that coupling meets the pressure resistance requirements, but components are not overdesigned as well. These optimization efforts helped in complimenting to flow performance. All critical locations in assembly for stress concentration have been improved by adding stress relieving features. For example, image highlights the most critical region in FF coupling (near ball latch groove) for strength as well as flow performance, and how it was optimized to meet both requirements.

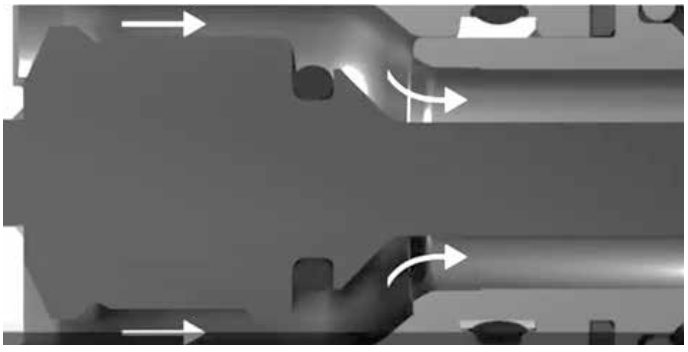


Pressure drop- superior flow rate up to 74% higher than ISO 16028 specification

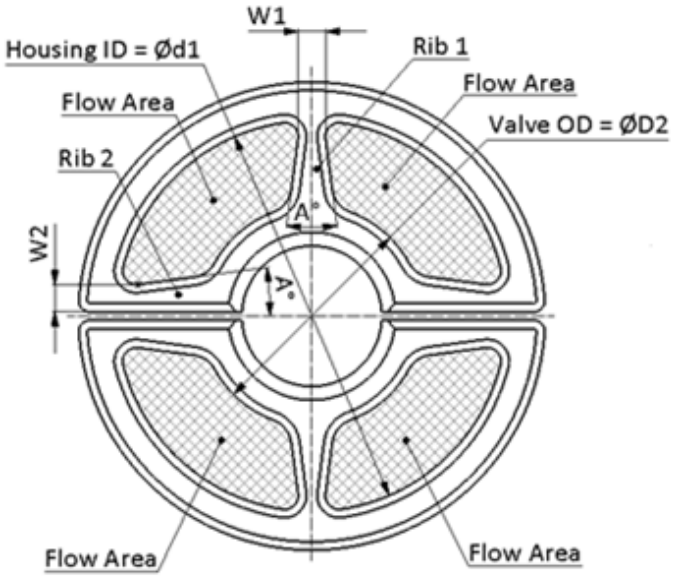
Hydraulic pressure drop is directly linked to energy loss for an equipment, in turn resulting in higher fuel consumption. In the world of quick disconnect coupling, typically pressure drop performance is measured in terms of rate of fluid flow possible through coupling at a pressure drop of one bar- meaning higher the flow rate, better the product is for pressure drop performance. Some of the key factors for lower pressure drop are:

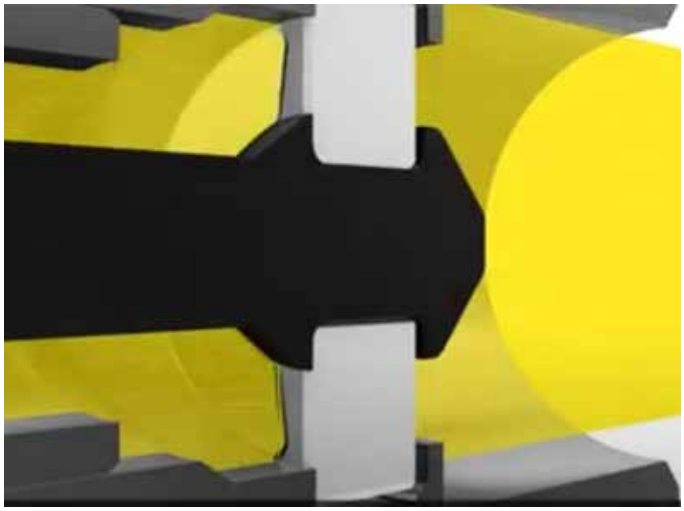
- Uniform flow area across length
- Low frictional losses
- Smooth transition of flow at junction

While upgrading FF series coupling, Eaton engineers ensured that fluid flow path is smoother across the length, and there is no boundary layer separation of fluid, which in turn reduces eddy's formation and helps in minimizing the pressure drop. Flow path at critical fluid transition areas like at plug and socket valve mating junction, have been made smoother to reduce the losses. Our world class manufacturing processes ensures that components in fluid flow path are having superior surface finish, resulting in lower frictional losses of pressure.

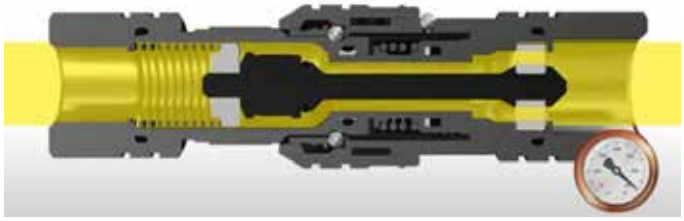


New valve holder design on socket side with kidney port flow passage helps in providing uniform flow area at this section, and improves pressure drop performance over previous design of drilled holes. These valve holder and its kidney ports are optimized using full factorial DOE using factors like rib widths and component thickness, so that maximum area is available for fluid flow, with meeting strength requirements.





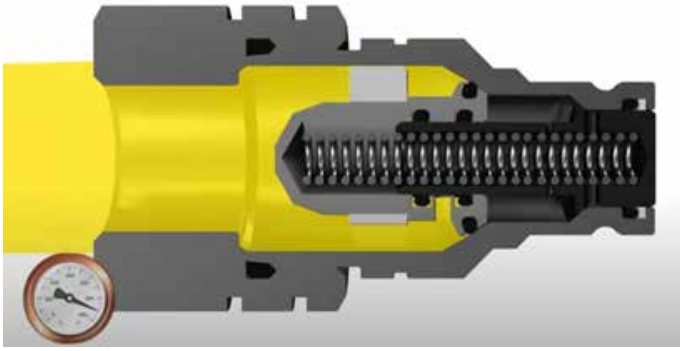
Albeit higher pressure resistance and high flow rate are opposite characteristics like if you add material thickness to improve the mechanical strength, flow rate is compromised and vice-a-versa. However, with multi-physics simulation techniques and by maintaining uniform flow area throughout its length, we have optimized new FF series coupling such that it can withstand higher pressure and at the same time provide improved flow rate



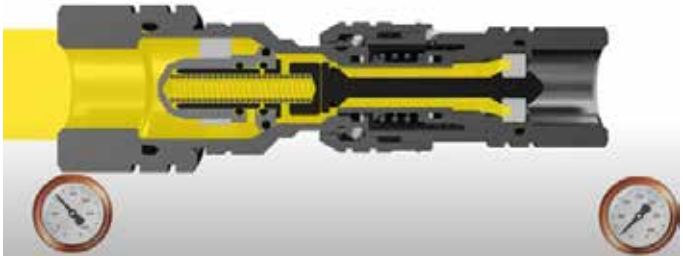
Connection under residual pressure

In certain applications, especially when equipment and attachments are stored/placed in an open environment, changes in sunlight temperature can cause residual pressure built up in hydraulic lines. In such cases, connection of quick disconnect coupling becomes difficult because valve does not get pushed easily. Either it requires very high force, or pressure needs to be bleed-off by starting an ignition and opening control valve to tank. Such forceful connection under high residual pressure can also damage internal seals permanently and can cause leakage. For such applications, Eaton's FFCUP series plug, having patented valve mechanism

is useful. In this plug, residual pressure in excess of 350 bar is bleed-off internally in coupling and allows operator to connect hydraulic line under pressure without any significant effort. Below images illustrates operation of patented valve mechanism.



Step 1: Pressure is blocked by secondary valve mechanism



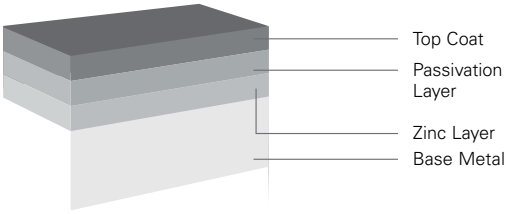
Step 2: Residual pressure is bled-off through secondary valve, and then plug valve is fully opened

Alternately, standard FF series coupling is also designed such that it can be connected under residual pressure up to 50 bar, without any damage to internal seals. Special inverted PTFE seal, installed in plug, protects polymer seal from abrasion and wear damage due to connection under pressure, and maintains coupling leak-free.

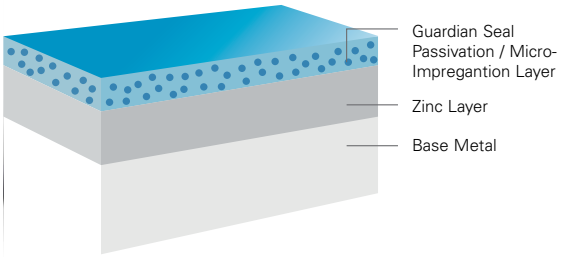
Corrosion protection- extended product life

In certain markets the role that aesthetics play cannot be underestimated. Manufacturers spend millions ensuring that their products are cutting edge in terms of performance. However, there can be no doubt that aesthetics plays a huge role in brand reputation. If the couplings used are not resistant to rust, then damage to the OEM brand can be done through a negative view point. However, there is an important underlying message here: The OEM machines can be shipped to many different places around the world and they have to be able to cope with the rigors of the environment. Elements such as water and salt spray (used on treated roads) can wreak havoc on system components, causing them to rust if not protected. Eventually rusty components will break down and hydraulic fittings could well leak thus causing reliability and maintenance issues.

With new Guardian Seal coating, which offers three times higher corrosion resistance protection compared to traditional Zinc trivalent chromium, Eaton guarantees minimum 720 hours of corrosion resistance against red rust, as tested in a salt spray test lab environment per EN ISO 9227 (ASTM B117). This new coating is also referred as environment friendly solution, because of its nickel and solvent free chemical composition which meets global RoHS, ELV and REACH requirements.



Guardian Seal Plating



Notes

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