Elastomeric Coupling Failures on Fire Pumps

Reliability issues involving the common failure of elastomeric coupling in Fire Pump

Background

A fire pump is the heart of fire sprinkler system’s water supply that is responsible in providing the required water pressure as calculated by hydraulic design density. When a fire pump fails, the installed sprinkler system will not be able to provide the necessary protection in containing / extinguishing any developing fire.

A fire pump assembly is made up of many different components, with the motor/pump coupling being one of the most critical elements. By definition, the coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. In a fire pump arrangement, it is installed between the pump and rotating motor to act as a power transmitter between the two. Coupling these two (and/or any other driving and driven shafts) is efficient when perfectly aligned, machines do not vibrate, and the shaft never actually moved. But that’s not the case for most pumps, and thus the basic function of all couplings is to transmit power, accommodate misalignment, and compensate for axial movement.[1] Without it, the pump and motor would be damaged and fail to perform its designed function.

Elastomeric couplings utilize some type of rubber, urethane, or plastic flex element positioned between two connected shafts. Depending on the style, torque is transmitted either through shearing, or by compression. Elastomeric couplings are the most economical, maintenance free, and easiest to install coupling component available. They require no lubrication and are maintenance free. However, by design, elastomeric couplings are only intended for general non-emergency pump applications running up to 100 RPM. [1] They are designed to be fail-safe, meaning the elastomeric coupling will fail / break when the pump experiences an out-of-range misalignment in order to save the pump. This doesn’t support the fire pump's objective as it is much preferred to sacrifice the fire pump during a fire event scenario, for the purpose of saving the property it is protecting.

Figure 1  Centrifugal Fire Pump Assembly

Figure 2 – The most commonly found elastomeric Coupling installed in fire pump

Temperature is a restriction for elastomeric couplings. Frictional heating experienced by the coupling can cause degradation of the plasticizers within the component resulting in embrittlement of the material. The material loses its strength as the temperature rises. Eventually the strength reduces to zero. Temperature limits vary by type of elastomer, but generally 200 to 250°F (110°C) is the top operating limit. [2]

Elastomeric couplings are commonly installed on processing pumps, fans, blowers, compressors, conveyors, and mixers in a wide range of industries including chemical, commercial HVAC, oil & gas, pulp and paper.

Recommendations

Tests recently conducted by Underwriters Laboratories (UL) shows that couplings relying on all-elastomeric materials to transmit power from driver to pump can fail catastrophically and unpredictably with little to no warning. The failure will sever the connection between the pump and driver. If this were to occur during a fire, the loss of water flow and pressure to the facility sprinkler system could lead to an uncontrolled catastrophic fire event. Failure of the power coupling results in total impairment of the fire pump. The use of all-elastomeric couplings was prohibited in all fire protection standards since 2009.

Therefore, AIG recommends replacement of any identified elastomeric coupling(s) with a UL Listed or FM Approved fire pump coupling that rely on some / all metallic secondary connection. The coupling must have metallic components spanning the gap between driver and pump shafts as a means for power transmission, and must meet UL Test Standard 448A “Flexible Couplings and Connecting Shafts for Fire Pumps.” [3]
Resources / Standards

The references are:

[1] “Coupling Types for Different Applications”, Altra Industrial Motion, June 2009
https://www.altramotion.com/newsroom/2009/08/coupling-types-for-different-applications

http://www.couplinganswers.com/p/popular-elastomeric-coupling-types.html

https://standardscatalog.ul.com/standards/en/standard_448A_1


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