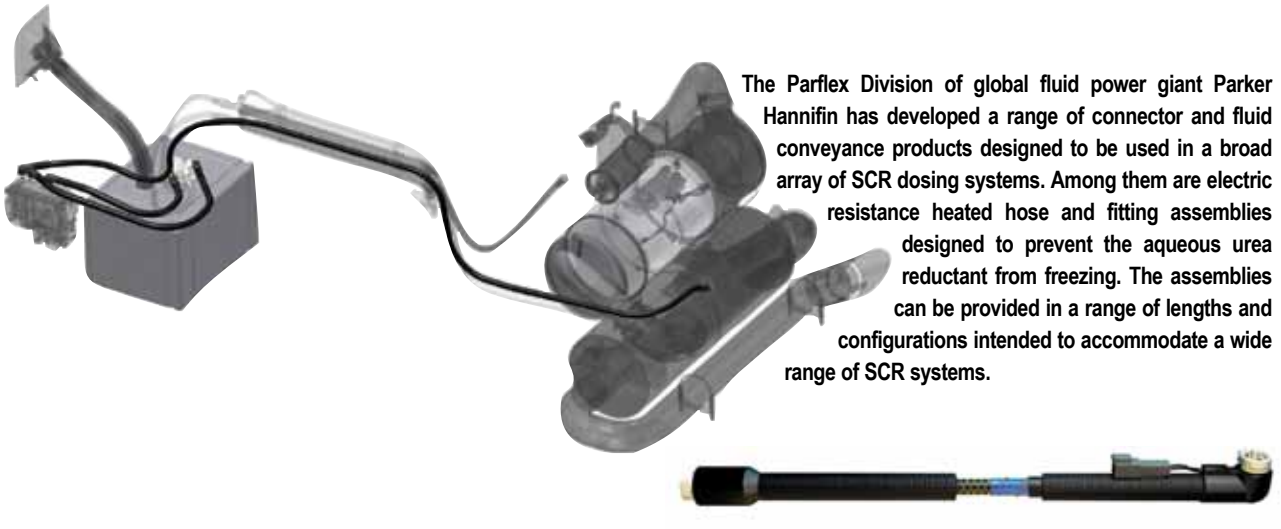


The Parflex Division of global fluid power giant Parker Hannifin has developed a range of connector and fluid conveyance products designed to be used in a broad array of SCR dosing systems. Among them are electric resistance heated hose and fitting assemblies designed to prevent the aqueous urea reductant from freezing. The assemblies can be provided in a range of lengths and configurations intended to accommodate a wide range of SCR systems.

MEETING FLUID CHALLENGES

Successful implementation of SCR technology requires understanding of aqueous urea properties and addressing DEF management issues

The use of selective catalytic reduction (SCR) systems continues to expand as engine and equipment manufacturers implement designs to meet EPA 2010, Tier 4 interim and final and Euro 6 diesel exhaust NO_x reduction requirements. A key element of SCR systems is the reductant, most commonly an aqueous urea solution known as diesel exhaust fluid (DEF) or AdBlue.

The physical properties of DEF can present specialized fluid conveyance challenges for the manufacturers of on- and off-highway vehicles and equipment using SCR systems. As a global supplier of fluid power and fluid handling technology, Parker Hannifin — and most notably its Parflex Division, headquartered in Ravenna, Ohio — has developed a range of connector and fluid conveyance products designed to be used in a broad scope of SCR dosing systems.

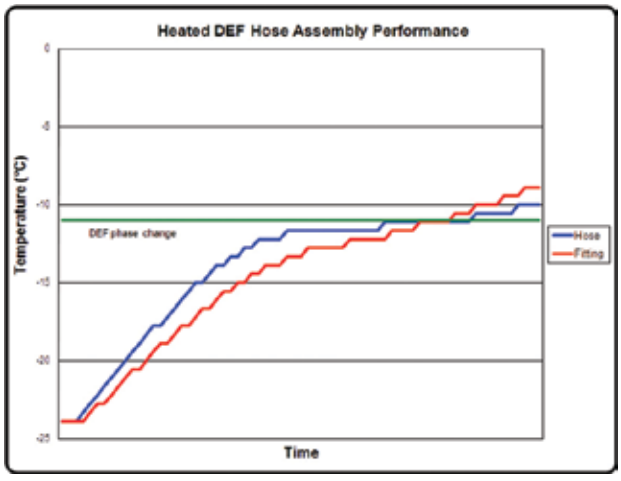
In moving from its traditional stationary applications — it was first used in the late 1970s in power generation and chemical processing — SCR technology has faced a range of new challenges. One of the chief among them has been ensuring proper system performance in colder climates. Heavy-duty trucks can often travel from hot to frigid areas in a cross-country haul. Similarly, nonroad machinery such as construction and mining equipment can be used from the tropics to near-arctic regions.

The 32.5% aqueous urea solution has a higher resistance than water to freezing, but it will adopt a thickened, slushy consistency before reaching a solid state at approximately 12°F (-11°C). For effective dosing and movement through hoses, etc., DEF needs to remain liquefied.

One of the solutions often employed is heating the DEF tank, often by routing engine coolant lines around the outside of the tank or by incorporating electric heaters into the tank's construction. While these can be effective, they do not prevent freezing of residual DEF in the lines between the tank and the dosing unit or in the dosing module itself.

Parker's Parflex Division has focused its product design efforts on the development of electrically heated hose assemblies. Most dosing systems support electrically heated hoses, the company said, and electrically heated hoses take up little space and can be easier to route than hoses carrying engine coolant. And as the hose does not require draw heat from the engine cooling system, the diesel engine can reach its operating temperature more quickly, enabling faster cab heating and shorter DEF circuit thaw times when compared to coolant-based heating systems.

Parker's SCR hoses utilize an electrical heating system, which both the hose and fittings are heated with



The thaw performance of a heated DEF assembly. The thaw performance and final hose assembly lengths are limited only by the maximum available power of the dosing system, Parker said.

the same continuous variable resistance wire heating elements. This patent-pending approach is intended to minimize the number of electrical components and electrical connections, enhancing reliability, the company said. The design of the electrical heater is also very flexible and adaptable in manufacturing, which Parker said allows for the creation of SCR hose assemblies that can meet wider performance ranges and/or greater length requirements. Parker said its hose and fitting assemblies are optimized based on customer performance requirements and dosing system specifications. The thermal performance is balanced to ensure even heating throughout the assembly length and power densities can be customized for different dosing control systems. The thaw performance and final hose assembly lengths are limited only by the maximum available power of the dosing system, the company said, and 12 and 24 Vdc systems are standard.

All Parker SCR assemblies come standard with electrically heated fittings, which are designed to ensure complete thaw of the DEF throughout the entire assembly. Most customers, Parker noted, have adopted SAE J2044 quick-connect style end fittings, which are lightweight, durable, chemically resistant and easy to assemble, for DEF lines. Parker offers DEF lines with 0.25 to 0.375 in. fitting options in both straight and 90º elbow configurations. Parker's standard heated fittings incorporate polyphthalamide (PPA) polymer, which the company said provides increased strength, improved temperature resistance and superior chemical resistance when compared to SAE J2044 fittings made from polyamide (PA, nylon).

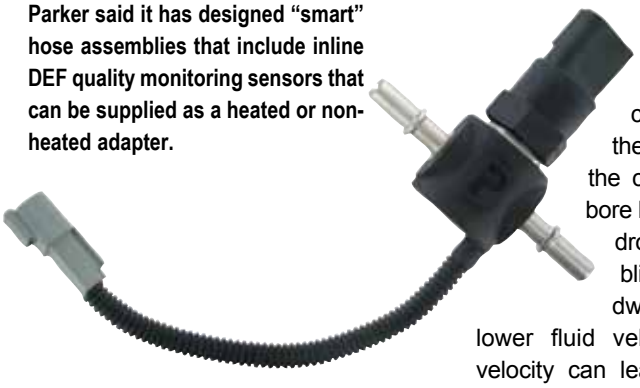
An additional proprietary feature of the Parker SCR assembly design is the encapsulation of the fittings, heating elements and electrical connections within a compact (less than 1 in. wide), high-temperature, sealed thermoplastic over-molding that is less than 1.2 oz. per end. This over-molding serves to protect the fitting from environmental damage while providing a strain relief to the hose at the fitting interface.

Another important consideration of SCR systems involves how a dosing system manages the DEF when the engine is shut down. DEF expands approximately 10% when frozen, which can damage system components if not planned for in the system design. Some SCR fluid systems purge the DEF during shutdown so that no fluid remains to freeze in the dosing circuit. Other systems keep fluid in the lines and rely on components such as hoses to expand and absorb the additional DEF volume when frozen. Parker said its multiple hose material options allow for selection of optimal solutions for both purge and nonpurge dosing systems.

A fiber-reinforced EPDM rubber hose construction offers the greatest volumetric expansion to accommodate DEF expansion due to freezing, Parker said. Inner tube compatibility with DEF is essential to prevent fluid contamination and fouling of the catalyst or damage to dosing system components. The inner tube of the EPDM hose is specially formulated for DEF compatibility and is designed to offer excellent flexibility. Parker offers both 4 and 5.5 mm bore EPDM hose products designed exclusively for high-volume expansion.

For SCR systems not requiring high-volume expansion, Parker identified polyamide as a hose inner tube option, as it offers broad chemical compatibility (DEF and diesel fuel), reduced wall thickness and lighter weight assemblies. Polyamide also permits the hose to be thermally formed into a three-dimensional shape to aid with routing and installation. Parker offers both 4 and 6 mm bore hose products utilizing specialty grade polyamide for enhanced heat resistance, cleanliness and DEF compatibility.

Parker said it has designed "smart" hose assemblies that include inline DEF quality monitoring sensors that can be supplied as a heated or non-heated adapter.



Dosing system performance characteristics and assembly length requirements are critical when selecting the hose inside diameter, the company said. Larger-bore hoses reduce pressure drop across long assemblies, but increase fluid dwell time because of lower fluid velocity. Reduced fluid velocity can lead to increased DEF

An additional proprietary feature of the Parker SCR assembly design is the encapsulation of the fittings, heating elements and 12 and 24 Vdc electrical connections within a compact, high-temperature, sealed thermoplastic over-molding.

temperatures through heat transfer from nearby engine or exhaust system components. Specifying a smaller I.D. hose increases fluid velocity, improves hose flexibility and reduces overall connector envelope size. High fluid velocities through long assembly lengths can, however, result in significant pressure losses that can limit the dosing system's total performance. Parker said it offers a range of fluid connectors designed to work with common dosing system flow rates and assembly length requirements.

As mentioned, many SCR systems incorporate coolant heat exchanger systems to warm DEF storage tanks. Some dosing systems also use coolant lines to carry excess heat away from dosing components that are attached directly to the exhaust system. These types of coolant lines must be extremely robust, as they can be exposed to extremely high temperatures. To meet such requirements, Parker's Industrial Hose Products Division has a variety of suitable options including silicone hoses, while a wide range of SAE J2044 fitting options are available from the company's Fluid System Connectors Division. In addition, Parker's Fluid Controls Division manufactures solenoid-actuated Lucifer Valves to control the flow of coolant to the DEF storage tank.

The Parflex Division also supplies complete coolant-heated tanks in a variety of sizes and shapes through a collaborative partnership with Shaw Development. Coolant control valves and DEF tanks are available in 12 and 24 Vdc configurations, the company said.

Along with its standard offerings, Parker also offers custom fluid conveyance systems for SCR applications and is able to supply rapid turnkey heated hose assembly prototypes. The company's capabilities include DEF circuit design, connector installation, maintenance and routing best practices. Its custom hose products include heated fluo-ropolymer designs with hose sizes ranging from 0.1875 to 2 in. inside diameters. Specialty materials and compounds are available for SAE J2044 fittings for use with both polyamide and EPDM rubber hoses and a flexible dust boot option is offered to encapsulate the entire J2044 connection for SCR systems operating in challenging environments.

Parker said it has also designed "smart" hose assemblies that include inline DEF quality monitoring sensors that can be supplied as a heated or nonheated adapter. **dp**

For more information on SCR hose from Parflex, contact:

Matt Peter
Parker Hannifin Corp., Parflex Division
1300 N. Freedom
Ravenna, OH 44266
330-298-4032
email: mpeter@parker.com