

Thermoplastic hydraulic hose: Versatile solutions for complex designs

By: Kuriyama of America and Piranha Hose

Hydraulic systems have significantly enhanced efficiency within the industrial machinery and power sectors, with hydraulic hoses being central to these systems. The design and materials of construction of hydraulic hoses has made extensive progress over the years, including the incorporation of polymer technology.

This white paper explores the fundamentals of hydraulic hose design, the associated standards and guidelines, as well as advancements in construction materials, with a focus on thermoplastic hydraulic hoses and their applications in modern machinery. This white paper also highlights the innovative range of Piranhaflex™ Thermoplastic hydraulic hoses and their advantages over conventional options based on their designs and materials of construction.

Hydraulic hose history and design basics

During the 19th and early 20th centuries, the increasing demand for efficient and powerful machinery led to the exploration of hydraulic systems, resulting in the development of the hydraulic hose. Early hoses were made of natural materials such as rubber and braided fabric, which were prone to deterioration and leakage. As technology advanced, so did the design and materials used for their construction. This was highlighted by the introduction of thermoplastics, which offered natural resistance to the dry rot and flaking caused by exposure to the elements.



Figure 1. Piranhaflex™ thermoplastic hydraulic hoses.
Source: Kuriyama of America

Hydraulic hoses are specifically designed to transfer force using pressurized fluids, distinguishing them from industrial hoses that transfer liquids, materials and gases. A hydraulic hose consists of three main components: the inner tube, the reinforcement and the cover. The inner tube directs the media through the hose, the reinforcement provides strength to handle pressure, and the cover protects the reinforcement from external conditions. Understanding these components is essential for selecting the right hose for specific applications, as each part plays a vital role in the hose's overall performance.

Hydraulic hose design

Braided construction

A common type of hydraulic hose construction is braided construction. This design features layers of steel wire or yarn arranged in a crisscross pattern, resembling a cloth. Braided hoses offer greater flexibility and can achieve tight bend radii, making them suitable for routing through confined spaces and sharp bends. They are typically designed

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for moderate pressure applications and may not perform well under frequent pressure spikes. In systems where elevated pressures and excessive impulsing (i.e. the cyclic application of pressure) are present, the intersection of the wire braids can wear on each other, potentially leading to failure.

Spiral construction

Another method used in hydraulic hose design is spiral construction, which is particularly useful for high-pressure systems. In this construction, steel wires are wound in opposite spiral patterns around the hose, with a skim of rubber between each layer to prevent the wires from wearing against each other. While spiral hoses are not as flexible as braided hoses, they offer superior resistance to high pressures, impulses, spikes and surges. This makes them ideal for applications where durability and reliability under extreme conditions are paramount. The choice between braided and spiral construction depends on the specific requirements of the hydraulic system, including pressure levels and the presence of pressure spikes.



Figure 2. Rubber braided versus spiral hydraulic hose designs.
Source: Kuriyama of America

Hydraulic hose regulatory classifications

Critical to the performance of hydraulic hoses is adherence to stringent standards set by bodies such as the Society of Automotive Engineers (SAE) and the International Organization for Standardization (ISO). SAE standards focus on construction and reinforcement methods, whereas ISO standards emphasize specific performance characteristics such as pressure ratings and environmental resistance.

SAE guidelines help manufacturers produce hoses that meet specific performance criteria, ensuring they can handle the demands of various applications. Adhering to these standards is crucial for maintaining safety, performance and reliability in hydraulic systems. By understanding and following these guidelines, users can select the most suitable hose for their requirements, reducing the risk of system failures and enhancing overall productivity.

SAE standards cover a wide range of hose types, including both rubber and thermoplastic versions, specifying factors such as pressure ratings, temperature limitations and fluid compatibility. For instance, SAE 100R7 and 100R8 are classifications designed for thermoplastic hydraulic hoses, with 100R7 designed for medium pressure applications (1,000 PSI to 3,000 PSI) and 100R8 for higher pressures (2,000 PSI to 5,000 PSI). Ultimately, it is the responsibility of the hose user to understand all relevant regulations and ensure compliance with industry-specific requirements.

Couplings, adapters and compatibility

Hydraulic hoses are commonly coupled using either one-piece or two-piece fittings, with a wide variety of termination types to meet the wide variety of applications in the original equipment manufacturer (OEM), aftermarket and maintenance, repair and overhaul (MRO) markets. One-piece fittings have the crimp ferrule attached to the coupling stem for convenience, while two-piece fittings have the crimp ferrule separate from the hose stem allowing for more interchangeability of parts.

It is important to note that 'mixing and matching' hoses and fittings from different manufacturers can lead to serious issues, as each manufacturer designs their products to work together as an engineered system. Using incompatible components can result in premature hose failure and potentially catastrophic consequences.

Proper hose selections

Selecting the appropriate hose for an application involves several key considerations, reflected in the acronym STAMPED — size, temperature, application, media, pressure, ends and delivery.

Of these, pressure is of particular importance to hydraulic hose, and understanding some key pressure concepts will help users select the most suitable hose. When a hose is under pressure, two forces are typically at play: end force, which increases with pressure and tries to

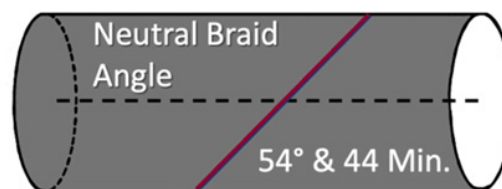


Figure 3. The angle design is intentional for preventing distortion. Source: Kuriyama of America

push the fittings off, and hoop force, which causes the hose to expand outward, like a balloon inflating. Also, since pressure is calculated as force divided by area, as the hose size increases, so does its area, causing the pressure to drop (provided that hose construction remains the same).

Another fundamental aspect of hydraulic hose design is the neutral braid angle, set at 54° and 44 minutes. This angle stabilizes the hose's dimensions under pressure, preventing distortion. This principle is universally applied in the production of reliable hydraulic hoses.

Working pressure versus burst pressure

Hydraulic hose performance is heavily influenced by the hose's pressure rating, specifically the working pressure and burst pressure. The working pressure is described as the maximum pressure at which a hose and fitting can operate safely, while the burst pressure is the threshold at which the hose assembly will fail or 'burst.' A safety factor, typically set at 4:1 for hydraulic hoses, is incorporated to account for unexpected pressure surges, spikes or impulses. Understanding these pressure parameters is crucial for selecting the right hose, and ensuring both safety and performance.

Bend radius versus flexibility

Flexibility and bend radius are distinct characteristics of hydraulic hoses. Bend radius refers to the minimum radius a hose can be bent before damage occurs and performance is impacted. Flexibility is the force required to bend the hose from its natural position. While rubber hoses are generally more flexible, thermoplastic hoses offer smaller bend radius, making them ideal for installation in tight spaces or applications where the hose is subjected to tight bends.

The mid-20th century saw significant innovations in hose technology, including reinforced structures that improved performance. While rubber hydraulic hoses have remained the traditional choice, thermoplastic hydraulic hoses continue to grow in popularity due to their various performance benefits over rubber.

The emergence of thermoplastics

Thermoplastic hydraulic hoses have emerged as a superior alternative to traditional rubber hoses in certain applications. Made from materials like polyurethane, polyester, nylon and PTFE, these hoses offer higher abrasion resistance, smaller bend radii and performance at extreme cold temperatures. Thermoplastic hoses do not degrade, dry rot or swell after prolonged contact with hydraulic fluids, reducing the risk of system contamination. Also, their smooth covers and smaller diameters facilitate easier installation in tight spaces, making them ideal for equipment with aggressive bends, such as forklift masts and aerial lifts.

Thermoplastic hydraulic hoses perform well in extreme temperatures. Unlike rubber hoses, which are not recommended for use below -40° F, thermoplastic hoses can flex at temperatures as low as -65° F, making them suitable for cold environments like refrigerated storage facilities and poultry plants. Thermoplastic hoses are also non-conductive, providing added safety in applications near electrical lines.

Piranha® Hose Products factory and testing

Established in 1945, Piranha Hose Products exemplifies innovation and quality in the high-pressure hose industry. Known for their advanced technology in sewer hoses, Piranha developed the Piranhaflex hydraulic hose. This hose has been subjected to rigorous testing to ensure it meets and exceeds industry standards. Piranha's ISO 9000 registered facility guarantees adherence to the highest quality standards.

The Piranhaflex hydraulic hose range includes various SAE 100R7, 100R8 and 100R18 hose options, tested to meet ANSI 92.2 and SAE J517 requirements at their Cadillac, MI manufacturing facility. These hoses are available in various constructions, including low-temperature options and special covers with additives to reduce friction and enhance durability. These hoses are available in single, twin and multi-line configurations, to meet diverse customer needs.

Innovation at work

The featured product in the line is the PF267 and PF267NC series SAE 100R7 hoses, manufactured using Piranha's innovative kink resistant technology. The hoses incorporate unique manufacturing techniques that provide up to 53% better kink resistance than similar competitive hoses, making them perfect for tight bends.

Another standout product in the Piranhaflex range is the PFP354 series hose, which is available in conductive (black) and non-conductive (orange) versions. This hose meets ANSI 92.2 compliance and performs well in low-temperature



Figure 4. Piranha's ISO 9001 Quality Testing Lab. Source: Kuriyama of America

conditions, rated to -60° F. The unique Slither® additive in the hose cover and special slip additives reduce friction, simplifying installation and maintenance where long lengths of hose need to be routed such as on aerial equipment.

For higher pressure applications, the PF628 and PF628NC series hoses, meeting SAE 100R8 requirements, offer higher pressure ratings and the same low-temperature performance as other hoses in the Piranhaflex range. The PF528 and PF528NC versions further improve kink resistance and bending force, meeting the rigorous demands of various industrial applications.

The PF427 and PF427NC hoses, classified as SAE 100R18 thermoplastic hoses, are rated for 3,000 PSI across all sizes, providing consistent pressure resistance across all sizes.

Conclusion

The evolution of hydraulic hoses has been critical in enhancing industrial machinery by significantly improving safety, durability and allowing for ease of installation and adaptation to challenging equipment design parameters. Understanding the various construction methods, such as rubber versus thermoplastic, key performance factors such as pressure, and the requirements of industry standards such as SAE and ISO, are essential for selecting the most appropriate hose for specific applications.

Users can achieve greater productivity and operational efficiency by leveraging these advancements, and deliberately selecting the correct hoses, to provide them with maximum, application matched performance. Visit <https://www.piranhaflex.com/> to learn more about the line of Piranhaflex hydraulic hose and fittings.

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ABOUT KURIYAMA OF AMERICA AND PIRANHA HOSE

Piranha Hose Products, Inc. is a Kuriyama of America, Inc. company. Kuriyama of America, Inc. is a global manufacturer and distributor of industrial hose and couplings, for manufacturing, agriculture, food processing, mining, construction, oil and gas. The Kuriyama network consists of multiple hose manufacturing and distribution facilities, located throughout North America, South America, Asia, Oceania and Europe, and includes well-known, manufactured brands Piranha, Kuri Tec, Tigerflex, Hose Tec and Tipsa.