TechTIPS

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Moving Energy Made Easy:

Tips and tricks for designing with cable carriers

igus...moving energy made easy

INTRODUCTION TO CABLE CARRIERS

CABLE carriers are the lifeline of modern machinery. Industrial cables and hoses transmit energy, data, and fluids from their source throughout moving machinery, and are subject to external stresses that are commonplace in environments of an industrial nature.

Cable carriers are able to guide and protect cables and hoses in moving equipment and machinery. Cable carriers are structures that surround the cable package while facilitating controlled travel and maximizing the life of these energy sources. Cable carriers are available as extremely lightweight, open-style models, to fully-enclosed heavy-duty tubes for extreme environments and applications, and they are also available in a variety of materials, and known by a variety of names including cable track, energy chains, or e-chains. Whatever the name, cable carriers are an ideal way to protect electric and data cables, hydraulic and pneumatic hoses, and all other lines in the correct position throughout their movement, while also protecting them from abrasion, tangling, and over-bending.

For applications such as welding or CNC machining, closed carriers are able to provide protection against weld spatter, hot chips, chemicals, and other abrasive material. Cable carriers are used in other industries, as well, ranging from printers and sliding doors to offshore rigs and agricultural equipment. By protecting and guiding cables, they enhance machine safety and reliability, reduce system downtime and maintenance, and lower operating costs. Despite this, cable carriers are often an afterthought for equipment designers, and are tacked on late in project development. Many times, carriers are selected on delivery time and lowest price alone, but an inappropriate carrier can quickly cost you more in repairs than the initial savings.

Here are a few tips on selecting the best cable carrier system to reduce operating costs over the lifetime of an application.

Cable Carrier Options

Cable carrier design and construction varies, but the basic structure almost always consists of parallel side links joined by perpendicular crossbars. Additional components, including external rollers, hose extenders, and internal separators, are usually available from the carrier's manufacturer. While enclosed, tube-like carriers are available for heavy-duty applications, other, lighter-weight styles are available for less harsh environments, and

INTRODUCTION TO CABLE CARRIERS CONT.

others still are easy-open styles with quick cable access.

Most carriers on the market today are made completely out of plastic or metal, or a hybrid of the two (typically plastic side links with metal crossbars. A major argument for using all-plastic carriers is weight: heavier systems require more power to move, increasing power needed to run the entire application. There are relatively low-cost plastic carriers on the market made of nylon, which are suitable for moderate loads and speeds, but can become problematic with temperature changes and increased forces. Many of these carriers also absorb water, swelling and becoming useless in wet or high-humidity environments.

Other plastic cable carriers are available that are both light in weight, but also strong in a wide variety of applications. Carriers fabricated with engineered plastics, like Ultrahigh-molecular-weight polyethylene, PTFE, Delrin, or other materials are able to combat high and low temperatures, higher loads, and faster travel speeds than their nylon counterparts. Motion plastic specialist igus has manufactured their own line of plastic materials especially for cable carrier systems. These materials, in conjunction with igus' wide range of cable carrier designs, lets all-plastic carriers almost completely eliminate the need for metal or hybrid cable carriers. igus' plastic carriers referred to as Energy Chain Systems, are quiet in operation, corrosion free, and do not require external lubrication, in addition to being light in weight and suitable for temperature and humidity changes.

Energy Chains are available in closed, open, easy-open, and even zipper styles, and range in size from link widths ranging from 0.25 inches to approximately 3 feet. Travel lengths can reach more than a quarter-mile, and can be used for linear or torsional movement up to 360° or more per yard, as well as a combination of the movements joined in one application.

Carrier Selection Criteria

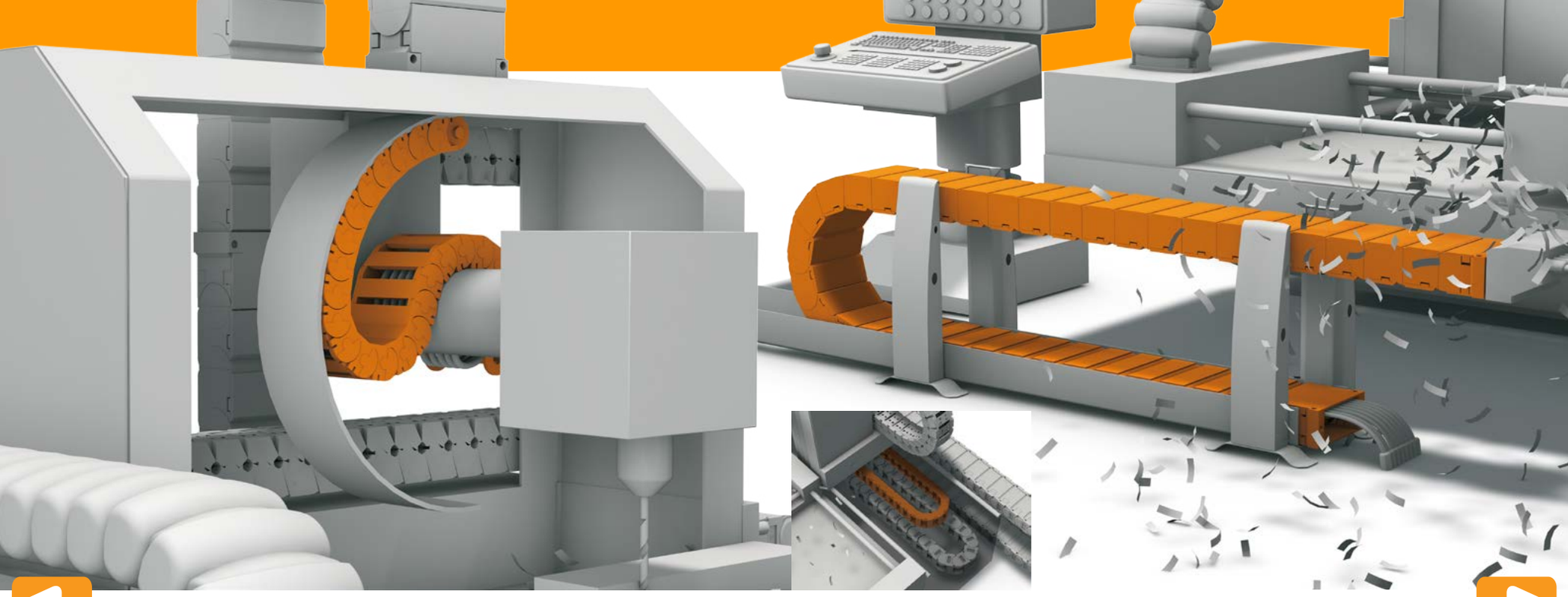
While deciding on the type of cable carrier for an application, design engineers should gather data about the installation, including travel length and acceleration, the size and weight of the cable bundle, machine speed, and the operating environment. The two most important factors when choosing a cable carrier are the size and the strength.

Size

When sizing a cable carrier, a rule of thumb to stick to is allow 10% clearance around cables, and 20% around hoses inside the carrier to prevent binding, and allow your total result determine the minimum size for your carrier selection. In general, avoid filling the carrier more than 60% to avoid damage – over-filling is a common mistake. It is also important to allow enough space inside the carrier for linear variation, preventing unnecessary abrasion among hoses, which can vary in length by 2-4% with changes in pressure.

Strength

While size is important, the strength is critical. Strength-related factors to consider when selecting a cable carrier is the total weight of the conduits (including fluid in hoses!) the travel length, unsupported span, and rate of acceleration. Check your manufacturer's website or catalog to determine the carriers' load limits; some manufacturers, like igus, offer online product selectors to help choose appropriate carriers based on these limits, as well as necessary movements, certifications, and other qualities, like their bend radius.



INTRODUCTION TO CABLE CARRIERS CONT.

Bend Radius

Each cable carrier is designed with its own bending capabilities, and manufacturer suggested minimum bend radius. When choosing your carriers, keep in mind that the minimum bend radius should equal or exceed the recommended minimum bend radius of the stiffest cable or hose in the cable bundle. As a rule, keep the bend radius at least 8-10 times the outer diameter of the largest cable or hose. When measuring bend radius, measure from the center of the curve loop to the center of the pivot pin on the carrier's side link, not just the overall curve height.

Length

The length of a cable carrier installation depends on the mounting and application configurations; however, total length is typically approximately half the total travel plus the curve length. Applications where the carrier is mounted in the center of travel allows for the shortest possible cable carrier, saving installation costs.

Support

For short travel distances and light loads, most carriers can be self-supporting. However, without providing proper support and guidance for the carrier, problems can arise. Manufacturers supply data on individual carriers' unsupported span. Once a carrier exceeds the recommended unsupported travel length, it begins to sag. While some sag is acceptable in many applications, eventually a carrier drops and rides on itself – catastrophic with a steel carrier, where it will simply saw itself to pieces. Support systems are available to prevent excessive friction and wear. Support can consist of rollers, conveyor support, or a framework that supports the entire system.

Plastic carriers have a much lower coefficient of friction, and can often times be permitted to glide on themselves. Plastic carriers can also use glide pads – bearing surfaces that ride inside guide channels to allow even alignment and wear.

Properly selected and installed, a cable carrier system should guide and protect power lines on an application for thousands of cycles. When choosing a carrier or determining the layout, it's recommended to contact your carrier's manufacturer for the best design and installation advice. igus is provides a variety of online tools and product selectors (www.igus.com/energychains) for engineers to use on their own, and their customer service is available over the phone at 800-521-2747.

Plastic Versus Steel Cable Carriers

ARE there still engineers who prefer to use steel cable carriers over plastic? Why is this?

The first cable carriers were made from steel so, as is often the case, the assumption is that the older the technology, the better it is. However, nowadays plastic cable carriers can achieve almost anything steel can. Made from a high performance polymer blend, they offer lower cost, reduced weight and are corrosion resistant.

Plastic cable carriers have replaced steel on most types of automated machinery in recent years. This is because plastic cable carriers are lighter weight and so enable a higher number of cycles, faster speeds, and an increase in production throughput. The cost advantage is another reason for the use of plastic cable carriers in this area.

Steel cable carriers still dominate in some industries, such as on boom trucks, and also the steel working and mining industries. This is not to say that plastic cable carriers cannot be used in applications in these environments, but these industries have been slow to change.

What are the advantages and / or disadvantages of each?

Plastic cable carriers are typically superior to steel in that they are low cost, lightweight and corrosion proof. Steel chains typically have a special coating applied to make them corrosion resistant. Alternatively, a stainless steel cable carrier can be used to eliminate corrosion issues - however, these can be very expensive. Plastic already offers a price advantage over steel cable carriers, and this advantage is even greater when compared with stainless-steel chains.

Plastic cable carriers are also modular - you only need a screwdriver to take them apart. Steel cable carriers, on the other hand, require wrenches and tool kits for dis-assembly. This means they are not as easy to take apart and replace. Whereas with a plastic cable carrier, you can easily replace a link if it becomes damaged or broken.

An additional advantage for plastic cable carriers is that they can glide on themselves in long travel applications. In contrast, a steel cable carrier requires an elaborate support system to support the upper run over longer distances, because they can't slide on themselves.

Can you give an example or examples of a plastic cable carrier being used in an extremely demanding environment?

Plastic cable carriers can be used in offshore applications such as

PLASTIC VERSUS STEEL CABLE CARRIERS CONT.

oil rigs, as well as brick plants, coal-burning power plants, road construction vehicles, refuse incineration plants, tunnel drilling machines, steel mills, waste handling, mining, and more. They can handle heavy loads, high speeds and long distances.

One example is a long travel application over 1,447 feet on two ship-unloading cranes at a coal power plant in Malaysia. Plastic cable carriers were installed as a fully pre-harnessed system and supply energy and data to the trolley and cabin. The cranes unload up to 1,500 tons of coal per hour at docking stations on a man-made island situated roughly a mile offshore.

In the USA, Virginia International Terminals operates and maintains six cranes to handle containers and break-bulk cargo in its second largest ship-to-shore terminal. One of these cranes is a 30 year old Paceco crane.

The company had been experiencing wind problems and roller and tow cable failures on all its festoon systems responsible for supplying communications and power from the back of the crane to the operator's cab. This prompted the terminal operators to replace festoons with pre-harnessed plastic cable carriers, which provide a higher reliability at lower cost.

Why has igus® always only focused on plastics throughout all its product lines?

igus® started out as a plastic injection molder and has made a name for itself based on its goal of making functionally advanced, yet affordable polymer components and accessories. Its extensive research over the years into triboplastics means we have been able to develop better materials and better products delivering longer life at lower cost than most, if not all, steel-chain alternatives.

What are some of the latest product developments involving plastic cable carriers?

igus® has developed a special material for high temperatures - igumid HT ('HT' for high temperatures) - to withstand hot flying debris, such as metal chips, up to 1,500 degrees Fahrenheit and higher. This was previously only possible with steel chains.

igus® also recently unveiled the largest plastic cable carrier in the world in the form of E4.350 (pictured: right). Energy Chain® E4.350 is wear proof, maintenance free and resistant to seawater and mineral oil. The giant cable carrier was primarily developed for demanding applications exposed to ice, wind, storm, salt water, oil and drilling mud in applications on offshore oil-drilling platforms. E4.350 can move nearly 50 feet up and down, which guarantees any heavy hydraulic cables are protected and guided when a drilling rig is skidded on to an oil platform, or during a drilling head's stroke, for example. DW

Green Automation: Rolling cable carrier for fast, quiet movement

SECURE energy and data transmission for indoor and outdoor crane equipment and conveyor systems

With the development of the rolling cable carrier more than a decade ago, igus® has successfully designed a safe solution for the transmission of energy and data in crane and conveyor applications. Since then, igus® Energy Chain Systems® have proven their abilities in the most demanding crane applications in the world. Since 2006, the number of large shipyard cranes equipped with igus energy chains has been steadily on the rise. To date, igus® has equipped more than 2,500 RTG and RMG cranes worldwide.

New System P4 for smooth, quiet operation

The demands made on Energy Chains® are increasing all the time. Smooth running properties and low noise levels are becoming increasingly desirable as many ports and industrial sites are moving closer to residential areas, and travel speeds are ever-increasing. After three years of development and testing, igus has released a completely new generation of rolling Energy Chain Systems®. The low-maintenance System P4 is a modular system that makes safe energy and data transmission possible over very long distances up to 3,280 feet, or 1,000 meters. Specially developed for indoor or outdoor crane and conveyor systems, it is particularly quiet and wear-resistant at high speeds and high fill-weights. Thanks to the use of additional center links, there is practically no weight limit. System P4 is also particularly well suited to high-speed applications, and has been successfully operated at speeds up to 23 ft./s on a 410 foot test fixture at the igus test laboratory.

Technical Design

The design of the P4 Energy Chain® causes the upper and lower runs of the chain to roll offset from one another. This means that the plastic profile rollers do not roll directly over each other, but rather travel on a consistent, flat surface, decreasing vibration and total system noise. Additionally, the pitch of the chain links is now identical with and

GREEN AUTOMATION CONT.

without rollers, allowing the chain to achieve particularly smooth, vibration-free movement in the chain's radius.

Reduce drive power by up to 57% with the igus® P4 Energy Chain®

Cable carrier systems not only transport energy data and media to various types of machines, but also greatly influence energy costs. To keep energy costs low, one important consideration is the amount of push-pull forces, or drive force, which is required at a given speed to move the cable carrier. Energy Chain® carriers, combined with Chainflex® continuous-flex cables from igus can reduce the required drive power, energy consumption, and costs for environmentally conscious applications.

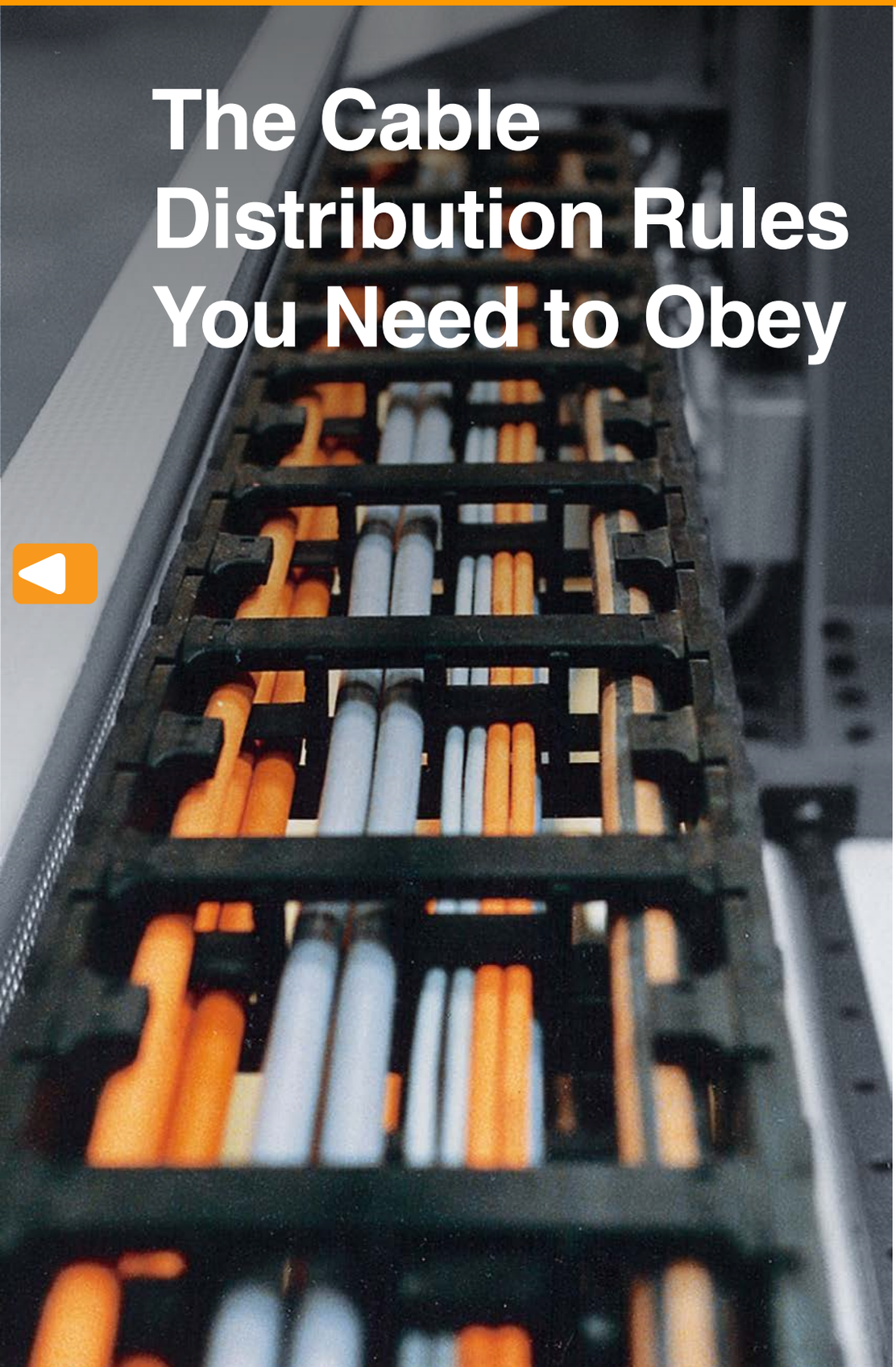
Rolling instead of gliding

Recent tests and sample calculations performed at igus®' test laboratory prove that energy consumption can be drastically reduced by simply using the correct cable carrier system, especially in long-distance, high-load applications. igus® P4 "RoI E-Chain®" is designed with built-in wheels that roll the system over itself instead of gliding, to facilitate travel over long distances.

If such a rolling E-Chain® is used, the coefficient of friction of the system is reduced from 0.3, for a standard gliding system, to less than 0.1 for a rolling one. This correlates to a 37 percent reduction in drive power with the P4 RoI E-Chain® when compared to a traditional gliding system, leading to a decrease in overall energy costs.

Technical Design

Chainflex® continuous-flex cables can also reduce energy consumption. igus® tests show that using high-performance sheathing and insulating materials, depending on the combination of cross-sections and number of cables used, can provide between a 5 and 30 percent reduction in energy. High-quality sheathing materials can be extruded with an extremely thin wall, which saves both size and weight. In addition, these insulating materials can often allow for reduction in conductor cross-section without compromising the electrical performance. These factors enable weight reductions of up to 30 percent when compared to conventional cables, which serves to reduce the required drive power.



The Cable Distribution Rules You Need to Obey

THE key advantage of a cable carrier is that bus and motor cables, pneumatics, electrics and hydraulics can all be guided safely in one system. However, correctly arranging each cable and hose within your chosen cable carrier according to the recommended spacing requirements is vital if you want to prolong the service life of your system.

Although we would welcome the opportunity to recommend the optimal separation layout for your cables or hoses (call us anytime at 1 800-521-2747 or e-mail techupdates@igus.com), as the customer it's still you who makes the final decision.

For this reason, I wanted to explain in more detail the essential distribution rules to consider when organizing your cable and hose packages.

Why use interior separation in the first place?

Interior separation is crucial in order to extend the service life of cables and hoses in your application.

Cables and hoses with different diameters and outer jacket materials need to be laid out separately using modular separators. A minimum clearance between cables, hoses and the cable carrier should also be maintained. (The maximum outside diameter we give for each cable series corresponds directly to this - ask us if you're unsure.)

Moreover, the faster and more frequently a cable carrier moves back and forth, the more important the exact positioning of the cables and hoses inside is.

Cramming in as many cables as possible into a cable carrier simply won't work. Cables can become permanently deformed - 'corkscrew' - or become tangled up with one another. If cables with different outer jacket materials - for example PVC and PUR - are placed side by side, then these can wear against each other and become 'stuck' together. All these scenarios can lead to premature failure.

Two essential rules

There are two key rules of distribution that should always be followed, so that cables and hoses can move freely at all times with no tensile force exerted at the radius of the cable carrier:

THE CABLE DISTRIBUTION RULES YOU NEED TO OBEY CONT.

Rule 1: D1 + D2 > 1.2 x hi

If D1 + D2 > 1.2 x chain inner height, no separation between the two cables/hoses is necessary. Two cables or hoses should never be left unguided on top of one another or be allowed to become tangled.

Rule 2: d1 + d2 ≤ 1.2 x hi

If d1 + d2 ≤ 1.2 x chain inner height, a vertical separator or a horizontal shelf must be used to reduce the inner height, thereby preventing the entanglement of d1 and d2.

Further guidelines for distribution:

1. The cumulative weight of the cables and hoses should be evenly distributed across the width of the chain.
2. No more than two cables or hoses should be installed on top of one another.
3. Cables and hoses should always be strain relieved at the moving end and, whenever possible, at both ends. The exception is that hydraulic hoses should only be strain relieved at the moving end.
4. For high-speed applications and high cycles, cables or hoses must not be laid on top of each other without horizontal separation.

Note: The standard values for this are: travel speed over 1.64 ft/s and cycles over 10,000 p.a.

igus® interior separation offers a safe solution for this situation. There are, of course, exceptions to every rule, which is when our technical specialists come in. They can help you ensure your system will operate properly, with the maximum service life for your application.

The Energy Chain® Configurator tool

The Energy Chain® Configurator program allows you to quickly custom build a cable carrier online with any of the cables and internal separators we offer from stock.

You can then generate CAD files and a parts list, or submit a quote request directly to us.

Interior separators, shelves, cables and hoses can be installed virtually in just a few clicks and a complete Energy Chain System® can be configured in just minutes.

The cable carrier configurator is designed to be as simple as possible. An integrated control device forbids component parts to be dragged into the chain link anywhere they will not work, for example. This avoids the potential for error.

A step-by-step guide to using the Configurator is available online by clicking here. Our technical team is always on hand to optimize the configuration you generate, if required. DW

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