Highly flexible cables for power chains

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Fully automated process sequences permit effective transport and processing times for industrially manufactured goods. These processes generally demand defined movement sequences in parts of the technical equipment. These are functional components of the whole, and must therefore be integrated into the system of the energy, control and auxiliary functions of the entire machine or plant. Economic function and reliability of the entire system depend to a great extent upon the quality of this combination.

Integral quality of the system "power chain" in automation technology only begins with an optimally coordinated combination of different elements, i.e. quality of the selected constructional solution, the technical production facilities /components and the translation/execution/installation.

Quality begins at the design stage

The design engineer knows the constructional optimum necessary for effective, economic process sequences:

- shortest paths with a minimum of moved masses
- low number of different, preferably standardised elements and components
- low material and assembly costs
- minimum space requirements
- no maintenance required
- high degree of reliability and service life even under (adverse) environmental influences

Component quality of power chains

The quality of the overall solution depends – in addition to the material quality of the selected components – at least just as must upon precise observation of the project and assembly instructions of the component manufacturers. Premature breakdowns are admittedly seldom, but investigations of breakdowns in recent years show that, in power chains and cables in more than 2/3 of problems investigated on-the-spot, unmistakable project and installation errors were subsequently discovered. Power chains are moving guide elements for precise retention and guidance of slack elements, such as electric cables, pneumatic and hydraulic hoses in the predetermined location formed by the chain arrangement. In accordance with the indicated targets, the arrangements must be as light as possible but as robust as necessary. Apart from the costs, the most important requirements are:

- low mass/weight combined with high strength
- high torsional resistance
- minimum wear and tear in the slide zone and the links, long service life
- high variability with regard to arrangement of separators and chain access
- large variety of types with regard to chain size, supplementary load and chain radius
- simple, rapid assembly

The number of companies manufacturing power chains is small and comprehensible. They offer a great variety of power chain types in plastic, some in metal, also – although plastic chains are considerably lighter and more economical to produce. The design engineer seeking advice can obtain extensive project and planning help, generally in the form of CD-ROM

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software suitable for CAD. In difficult cases, however, he should make use of direct, individual planning support, which is generally offered free of charge.
At the present time, LAPP KABEL does not manufacture power chains, but has acquired a great deal of experience concerning the behaviour of power chains made by different manufacturers. These result, so to speak, as a by-product of the longterm qualification and service life tests carried out on high flexibility FD cables on company-owned test beds. These are equipped with different types of power chain supplied by well-known manufacturers. The tests provide valuable results on the reciprocal influence between the power chains and the cables, but also on the strengths and weaknesses of the different types of power chain.

Special cables for power chains

A long service life, which may be represented as the sum of the attainable alternating bending cycles under defined test conditions, is only possible for cables qualified for use in power chains. Power chain cables absolutely necessitate special design and materials optimally suited for the application. The most important development targets for FD cables are:

- As flexible as possible – smaller cable diameters = less space requirement in the chain
- As flexible as possible – smaller masses reduce the surface loading of the chain, wear of the chain and the energy consumption for the movement sequence, thus permitting higher acceleration values. The advantage: higher efficiency of the equipment due to optimised movement sequences.
- As flexible as possible – small bending radii with small cable diameters function as multiplicators, permitting the use of power chains with minimal chain radii. A smaller chain radius also means less space requirement for the entire moving chain assembly
- As flexible as possible –continually moving cables, like the power chains themselves, are wearing parts. Maximum service life means maximum efficiency of the system.

FD cable technology today

High flexibility power chain cables comprise at least superfine copper strand conductors acc. to VDE 0295 Cl. 6 with short strand lay lengths. This strand structure is the basis for a high alternate bending resistance with minimal bending radii. FD cables are designed for at least 5 million alternate bending cycles. On our test beds, cables of representative sizes have

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undergone far more than 10 million cycles under the most severe conditions, without failure. One cable reached more than 60 million alternate bending cycles.
With the use of special alloys, even longer service lives are possible.
Among high flexibility cables, PVC-insulated cables predominate even today. The LAPP special PVC compound P8/1 possesses considerably better electrical and mechanical properties than stipulated in harmonised standards for comparable PVC-insulated cables. Thus PVC-insulated cables of the ÖLFLEX-CLASSIC-FD® 810 series are produced suitable for power chains, i.e. thin and light. In machinery and plant construction, on the whole, there is a stronger trend to the use of environment-friendlier materials (e.g. halogen-free, PVC-free, lead-free PVC cable, which has to be followed.
In addition to PVC, therefore, many other modern thermoplastic elastomers (TPE) are used today. These include materials which are excellently suited for use in high flexibility cables. The ÖLFLEX-CLASSIC-FD® 855 P series fulfils such stringent requirements. One particular feature in the field of metal-machining is worthy of note: here, a trend to the use of environment-friendly, biologically produced and biodegradable cutting and lubricating oils is evident. However, these oils are extremely aggressive towards ordinary thermoplasts and elastomers. LAPP KABEL has therefore developed P4/11, which is resistant and environment-friendly, and at the same time has excellent power chain characteristics. Cables made of this material are available as the ÖLFLEX-FD® Natur version.

Unit stranding versus layer stranding

Basically, two different principles are applied for the stranding of power chain cables at the present time: unit stranding and layer stranding. Most manufacturers of high flexibility control cables work by the well-proven layer stranding method. Within the framework of current research and testing, LAPP KABEL has also dedicated its efforts to developing various different stranding concepts. Apart from LAPP's own prototypes, competitors' products have been examined in longterm tests. The knowledge acquired up to now on the behaviour of unit stranded cables in power chains, particularly in the case of long paths, show no advantage in terms of application technology, especially with regard to service life. The slight advantage given by the more torsion-free structure of unit stranding is offset by cables which are up to 60% thicker and unproportionally heavier. Also, unit stranding is only meaningful with cables of twelve strands and more. The use of cables in other countries is frequently subject to severe norm and legal restrictions. Within the European Union, thanks to harmonisation due to the Low-Voltage Equipment Guidelines, the sale and use of such cables is not a problem – they are CE-conform. Outside Europe, unfortunately, the matter is not so simple. Especially in the important North American markets USA and Canada, UL/CSA approvals are absolutely necessary. Because the German engineering industry is present in all important world markets, more and more multi-norm products are needed. The overall quality of the installed connection depends upon the manual or professional skills of the personnel concerned. In carefully prepared training courses, they must be taught a basic understanding of the principal functions of all components and their reciprocal effect in the system. Only a consciousness of the tremendous importance of observing installation guidelines will lead to the desired result: satisfaction engendered by reliable and failure-free operation of the machine or equipment throughout the entire planned service life.