



WORLD CABLE MARKET IMPLEMENTATION AND DEVELOPMENT FUNCTIONS

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Abstract:

One of the most important segments of the cable market is communication cables, that is, designed for the transmission of information signals. Created by Corning Glass (USA) more than 30 years ago. Furukawa Electric Co. A Japanese company and the New Energy and Industrial Technology Development Organization (NEDO) have “jointly developed a new superconducting material for HTS power cables that can carry 100 times more current than conventional copper cables at roughly the same manufacturing cost.” can weave”. European manufacturers have developed the MOST standard, which is accepted by 16 automotive companies. Cables, i.e. designed for transmission of information

signals, FiberFin Inc. The U.S. market is offered polymer optical fiber with a diameter of 750 and 1000 microns with a gradient refractive index profile. With a fiber length of 50 m, it has a bandwidth of more than 3 GHz.

Key words: Over the past 10 years, cable manufacturing companies around the world have replaced analogue technologies with digital ones.

Introduction

This article focuses on the leading countries in the world market, developed countries such as Europe, America and Japan, which were industrialized earlier and formed a mature cable industry chain in the late 20th century, and made a great contribution to the world's production capacity and demand at that time. Today, they still occupy an important position in the world's supply and marketing, leading the development of the industry and essentially monopolizing the world market for high-quality products. It should be noted that cables and wires serve to transmit information signals and electricity. In addition, the demand for them is increasing every year: it is necessary to lay new cable lines, reconstruct or replace old ones, and according to the rules of their use, accidents, wars, earthquakes, floods, natural phenomena of freezing, as well as elimination of the consequences of force majeure factors such as vibration, excessive wind loads, corrosion, etc. Over the past 10 years, the revenues and profits of cable manufacturing companies worldwide have been steadily growing. Thus,





according to a report by the British company Integer Research, the revenues of about 60 large manufacturers have been steadily increasing. The report also notes that a significant part of the global growth is due to the expansion of the Chinese cable market. The success of a cable manufacturer in the market is determined by the following characteristics: price-quality ratio, compliance with the requirements of current and future applications and minimum operational requirements, including those set out in national and international standards. In general, the demand for cable products is determined by the nature and pace of development of the networks that are its consumers. The standard service life of cables (the time during which they are guaranteed to work) is 25 years. One of the most important segments of the cable market are communication cables, that is, designed to transmit information signals. If earlier the simplest two-wire telegraph and telephone copper communication lines were used, now, in the conditions of the modern global telecommunications network, the main information flows are transmitted in digital format via optical communication cables, the functional basis of which is optical fiber. With the development of telephone communication, copper pairs of wires were replaced by twisted, shielded pairs. In addition, the number of pairs in communication cables reached 10 thousand. When replacing analog technology with digital, cables were required that could organize the transmission of up to 10,000 telephone channels over a physical pair. However, such cables had high signal attenuation and an insufficient operating frequency range.

As a result, problems arose in the creation and operation of communication lines and modern communication networks, the solution of which went beyond the scope of economic feasibility. The transition from providing the subscriber with only telephone communication capabilities to the entire imaginable range of information and communication services - video conferencing and "video on demand" - requires increasingly broadband and cost-effective transmission paths, which are formed by advanced telecommunication technologies. In parallel, work began all over the world to create a non-electric transmission path — optical fibers, which, in theory, can have the necessary operating frequency range with low linear attenuation. Such fibers were created by Corning Glass (USA) more than 30 years ago. Currently, many companies around the world produce optical cables suitable for use as transmission paths both on short lines and on long-distance communication lines — and on global lines with a transmission rate of up to hundreds of Gbit/s (at a transmission rate of 10 Gbit/s, one pair of fibers can transmit a signal corresponding to approximately 30,000 telephone channels). Later, national ultra-wide optical communication lines and international land and submarine lines were created, connecting countries and continents: America





and Europe, Europe and Africa, Europe and India, Japan, Australia. In 2005, the total length of optical fiber laid in optical cables around the world exceeded half a billion kilometers. At the same time, “modern fibers and new optical technologies make it possible, in principle, to achieve transmission speeds equivalent to tens of Tbit/s”. European manufacturers have developed the MOST standard, which has been adopted by 16 automobile companies. This standard defines the characteristics of an optical ring designed to connect electronic devices using plastic optical fibers. FiberFin Inc. offers the US market a profiled polymer optical fiber with a graded refractive index of 750 and 1000 μm in diameter. With a fiber length of 50 m, it has a bandwidth of more than 3 GHz. In addition, “a cable made of this fiber can be used with any standard connector and standard components”. One of the most capacious sectors of the cable market is the electric power industry, where wires and cables are used to provide consumers with electricity. In developing economic zones, growth in demand for electrical wires and cables installed in buildings is guaranteed. At the same time, manufacturers whose products comply with national and international standards that establish fire safety standards have a competitive advantage in the market, namely in terms of the amount of smoke emitted during combustion and the amount of toxic and corrosive substances in combustion products, as well as the content of harmful substances in the structural materials of wires and cables and their operation. However, we also see that there is a shortage of electricity all over the world. At the same time, “electricity consumption is constantly growing. According to forecasts, it will increase by an average of 1.5% per year in the EU member states”. In almost all respects, the products presented on the cable market, both in Uzbekistan and abroad, do not fully meet the requirements of power engineers. They suffer great losses due to accidents on power lines and the need to restore their operation as soon as possible, often in extremely harsh climatic conditions - at temperatures from +50, and sometimes -60 $^{\circ}\text{C}$, in strong winds, in difficult geographical conditions - in the mountains, swamps, permafrost, deserts - without access roads and power supply. Currently, many leaders in the cable industry are closely cooperating with energy distribution companies to improve the design of power cables using cross-linked polyethylene (XLPE). This led to the creation of fire-resistant compounds, high-quality materials for the production of cable sheaths, waterproof cables, etc. As a result, it became possible not only to install high-voltage cables, but also to reduce the cost of using ultra-high-voltage cables made of cross-linked polyethylene. A natural promising area for the use of high-voltage cables is their use in underwater DC and AC power transmission lines. However, it is worth noting the high cost of underwater high-voltage cable power transmission lines. A fundamentally new promising area in





the development of cables for the transmission of electricity at high current values is the creation of cables based on high-temperature superconductivity (HTSP). This is due to the fact that HTSP cables are capable of transmitting 3-5 times more power than conventional ones. Their use in transmission lines is expected to have fewer licensing and permitting issues because they are more efficient, reduce transmission losses by 7-10%, and reduce carbon emissions by allowing power to be transmitted at lower voltage levels, which will reduce the number of step-up and step-down transformers. It is worth noting, however, that "HTSC cables use non-flammable liquid nitrogen for cooling instead of the oil used in traditional cables, which prevents fires or even explosions due to current leakage or overload." Japan's Furukawa Electric Co. and the New Energy and Industrial Technology Development Organization (NEDO) "jointly developed a new superconducting material for HTS power cables that can carry 100 times more current than traditional copper cables at about the same production cost." The wires used to make the new cable are made from a thin film of a high-temperature superconductor such as yttrium. The material is deposited as a thin film on a nickel base. Twenty such wires were used to make a meter-long prototype cable with a capacity of 1,459 A. Most of the work at HTSC uses materials such as bismuth. Making such wires requires large amounts of silver, and the cost of cables on the world market is high. The cost of a cable based on yttrium-type material is about 5 yen per ampere, which is about the same as the cost of conventional copper cables and a quarter of the cost of a cable based on bismuth-type material. One of the promising areas for improving electrical cables is the use of pure hydrocarbon nanotubes, known as quantum wires, as conductors. They can conduct 10 times more current than copper, while weighing six times less than copper wire. The importance of solving the problem is due, among other things, to the situation on the world copper market - its deficit and constantly rising price. In the United States, the Hydrocarbon Technology Laboratory at Rice University is developing a prototype of a power cable based on nanotubes. In the future, nanomaterials can be successfully used in HTS power cables to increase efficiency and safety, as well as to reduce their diameter. In this case, "there is no need to transmit electrical energy at high and ultra-high voltage levels. Research is currently underway to achieve superconductivity at temperatures close to room temperature". We believe that solving this problem will make it possible to do without cryogenic cooling of cables.

A cost-effective alternative to copper conductive elements for power and high-frequency cables are bimetallic conductors based on copper-plated aluminum (APM). When transmitting high-frequency signals, the latter flows along the outer copper layer, and the lighter and cheaper aluminum core ensures the integrity of the





structure. ApM is used as a lightweight conductor that combines the properties of copper conductors, such as corrosion resistance and reliability at contact points, with the low weight and good conductivity of aluminum conductors.

Current prices of base materials make ApM a significant advantage over copper for any application. Although the plating process requires advanced technology, which increases the cost compared to the cost of the base metal, ApM remains an economical starting material for use in the cable manufacturing process. If an ApM conductor has a conductivity of 64% of pure copper, its mass is only 34% of copper. And when the diameter of the ApM conductor is increased to achieve the same conductivity as a copper conductor, it becomes another 40% lighter. For example, an AWG 12 (3.3 mm²) copper conductor can be replaced with an AWG 10 (5.5 mm²) bimetallic conductor, which is not only lighter but also has a lower cost. Power cables made from ApM wire are not only lighter in weight and cheaper on the world market than equivalent copper, but they also have another positive quality - they do not form surface oxides that occur at the joints of aluminum conductors. Even greater benefits from using ApM conductors can be obtained when they are used for signal transmission. In this case, there is no need to increase the cross-section to obtain the same "impedance value, and the weight reduction can be more than 60%, and the cost reduction can be significant. These properties have already been realized in coaxial cables, where ApM is widely used as a center conductor. Similar savings can be achieved in other applications, such as data cables". Another promising type of bimetallic wire is nickel-plated copper conductor. This is nickel, which has good resistance to high and low temperatures, oxidation and corrosion, so it is used mainly in wires and cables operating at high temperatures and in aggressive environments. According to some estimates, "more than 10 metric tons of copper are plated with nickel or silver worldwide each year". These wires are mainly used to make wire current-carrying elements in high-quality electrical cables for use in aerospace, aviation, defense, computer and telecommunications technology, etc. It is worth noting that nickel-plated wires can withstand temperatures up to 750 °C. They are resistant to corrosion and can be soldered. Stranded wires are coated with materials that are resistant to high temperatures. This process occurs at high temperatures (silver-plated wires oxidize). The disadvantages of nickel-plated copper conductors include the difficulty of easily soldering them without the use of special fluxes and the need to carry out nickel plating under carefully controlled conditions to prevent porosity and obtain a flexible coating.





Methodology

Implementation and Development of the World Cable Market The method of cables with nickel-plated copper cores is used in aviation and astronautics, as they can withstand thermal shock, long-term continuous heating and temperatures above the melting point of the copper base for some time. A promising direction for improving wires (and cables based on them) are hybrid metal-polymer conductors, which are polymer fibers covered with a conductive metal layer. They are designed to replace traditional copper cores in wires used to transmit information signals. Syscom Technology Inc. (USA) has developed a wire with a braid of durable and at the same time flexible cores of high-quality polymer fibers with a metal coating. Such wires are "300% stronger than copper and 50% lighter". The company received a \$600,000 federal grant to continue developing a composite wire for the Air Force and NASA to replace copper wires, which deteriorate over time and lose their conductivity when used in confined spaces on aircraft. Today, the search for alloys that can effectively replace copper and aluminum in the production of superconducting elements continues. The American company Phelps Dodge has released a "new high-quality copper-based alloy with high conductivity for the production of wires". This alloy, which does not contain cadmium and beryllium, meets environmental requirements and has the necessary physical, electrical and mechanical properties. It can be used to manufacture wires for twisted structures of various diameters, as well as profile wires. They can be successfully used in the aerospace, military and automotive industries. The alloy is not subject to the European RoHS Directive on the restriction of hazardous substances.

Literature Analyzed

When writing this article, it should be noted that wires and cables have been in constant demand on the world market for three centuries. The traditional basis of cables is copper (less often aluminum) cores. A number of cables and wires for various purposes have been created and offered to the market on their basis. Such characteristics as strength, flexibility, weight, corrosion and chemical resistance of cables, fire resistance, release of toxic and caustic substances during combustion, resistance to radiation, compliance with electromagnetic compatibility requirements are being improved. All these problems must be solved for new, non-traditional types of cables. In particular, it is planned to create wires for power transmission lines that meet the requirements of operation in extreme conditions (freezing of wires, exposure to wind loads and vibrations, resistance to corrosion and lightning, etc.).





A fundamentally new direction in the development of electrical cables is the creation of cables based on high-temperature superconductivity. Really working samples of such cables have been created. It is assumed that with the creation of mass production technology, they can become competitive. Promising areas for improving superconducting elements are nanotechnology, the development of which will not only allow producing wires with unique properties, but also speed up the process of creating cost-effective electric cables based on high-temperature superconductivity. There are also real prospects for creating, improving and expanding the areas of their use of new bimetallic wires, alloy wires and hybrid wires. All this will affect digital technologies, which will play a significant role in the economic development of the global cable market.

Conclusion and Suggestions

In the development of the global cable market, digital technologies play a key role in improving product quality and increasing productivity.

The introduction of new digital design and production systems allows us to create cables with high technical characteristics and high reliability. Virtual modeling and simulation technologies accelerate the design and testing of cable systems, reduce development times and increase production efficiency. In general, digital technologies play an important role in the economic development of the global cable market of Uzbekistan. They ensure improved product quality, increased production efficiency and the development of the country's digital infrastructure. Companies that use modern digital technologies in the production of cable products remain competitive and contribute to the growth of the entire economy.

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