



LAST INOVATIONS IN ZIPPER MARKET

Review paper
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ABSTRACT: For nearly a century a construction and materials of the zippers are constantly improved, however significant innovative changes has been offered only during the last decade. Increased functionality zippers are developed to support water and airproof properties of final textile goods, to ease their closing and opening process and to extend the life cycle of zippers making them repairable by their users. Sustainable zippers are made from recycled or bio-based polyester and nylon while their tapes can be woven from organic cotton, linen or hump. Finishing process of metal teeth is done using low-emission coatings. The raw materials, production methods or disposal ways of eco-friendly zippers support environmental protection aims. The leading zipper company YKK has developed the most revolutionary solutions, such us, toothless zippers, tapeless zippers, touch-link and self-propelled zippers.

Keywords: zippers, waterproof, recycling, bio-based materials, organic materials.

POSLEDNJE INOVACIJE NA TRŽIŠTU PATENTNIH ZATVARAČA

APSTRAKT: Tokom gotovo jednog veka konstrukcija i materijali za izradu patentnih zatvarača kontinuirano su unapređivani, dok su značajne inovativne promene razvijene tek tokom poslednje decenije. Savremeni patentni zatvarači unapređene funkcionalnosti doprinose poboljšanju vodoodbojnih i vazduhonepropusnih svojstava finalnih tekstilnih proizvoda, olakšavaju proces otvaranja i zatvaranja, kao i produženju njihovog životnog ciklusa. Održivi patentni zatvarači izrađuju se od rekliranih i biobaziranih poliesterskih i najlonskih materijala, dok se njihove trake tkaju od organskog pamuka, lana ili konoplje. Dorada metalnih zubaca se izvodi sa ekološki prihvatljivim metodama niske emisije. Vodeća kompanija u proizvodnji patentnih zatvarača YKK razvila je najrevolucionarnije inovacije u ovoj oblasti, uključujući patentne zatvarače bez zubaca, bez trake, čipovane i motorizovane patentne zatvarače.



Ključne reči: patentni zatvarač, vodoodbojnost, recikliranje, biobazirani materijali, organski materijali.

1. INTRODUCTION

The first metal teeth zippers were invented in 1913 by Swedish engineer Gideon Sundback. After World War II when polymer technology and die-casting process for plastics improved, moulded plastic teeth zippers were created [1]. Being lighter, corrosion resistant and easy manufactured in wide variety of colours, they replaced metal zippers in many applications. In late 1840s fastener companies introduced the third kind of zippers - nylon coil zippers. The construction of their teeth allowed to create very light fasteners used with light fabrics and invisible /reverse side fasteners for applications where fastener has to be unnoticeable [1,2].

For nearly a century a construction and materials of the zippers are constantly improved, however significant changes for such kind of fastening system has been offered only during the last decade. Today's manufacturers are developing zippers with increased functionality, sustainable zippers, water and air impenetrable zippers [1]. The most revolutionary ideas are offered by leading Japanese company YKK designing their tapeless, toothless, and self-propelled zippers. The well-known manufacturers of zippers in the market are: SBS (China), KCC (China), Riri Group (Switzerland), Talon International (USA), LenZip (USA), ZlideOn (Sweden), Olympic zippers (India), others.

2. ZIPPERS WITH INCREASED FUNCTIONALTY

Increased functionality zippers are developed to widen the application of such kind of fasteners, (for example, to use them in conditions where closure have to be water or even air proof), to ease closing or opening of garments and to extend the life cycle of zippers making them repairable by their users.

2.1. Waterproof zippers

To block water penetration the tape, gare system and a slider section of waterproof zippers are manufactured from special materials using new and advanced technologies [2, 3]. The tape of a zipper is created from waterproof plastic, rubber or tightly woven polyester, nylon, or vinyl base which is covered with hydrophobic polymer - polyurethane (PU) or thermoplastic Polyurethane (TPU) film. TPU coating is suitable for heavy duty waterproof zippers as it ensures high strength, water, moisture and corrosion resistance (see Fig.1).

The molded teeth are made from flexible plastic or rubber covered with PU film. They use to be squeezed by a slider closing the zipper. After the slider passes, the teeth relax and with it close any gap in between them. The teeth of waterproof coil zippers are placed on the reverse side to expose the tape not the teeth to the moisture and water (see Fig.1). [4,5]. If a zipper has metal teeth they are coated with TPU film.



Figure 1: Waterproof reverse side coil zipper by a company OSO

There are available also toothless waterproof zippers. Instead of teeth they have kind of rails made from TPU (TRU® Zip by YKK). Highest level water protective zippers are also airtight [3]. Waterproof zippers are important and critical component of many final products used in marine industry, different sports, camping and travel gear, mobile phone accessories, others.

2.2. Quick-Release (QR) zippers

A quick-release zippers are created to open them rapidly and easily. The most often they have molded plastic teeth and specially designed their upper part or an innovative slider. The teeth of quick release zippers can be separated in two ways [6,7]:

1. Pulling the slider a little more up than normally - the user pulls the slider up to disengage and release it from one side of the zipper's teeth. When it is done a zipper opens easy by itself. (quick release zippers by YKK, KCC, SBB, Nyguard, others), (see Fig.2), [6],
2. Pulling the garment apart – specially designed asymmetrical slider of QuickFree® zipper by YKK gets released easy from one side of zipper teeth and a garment opens rapidly without moving the slider down (see Fig.3)

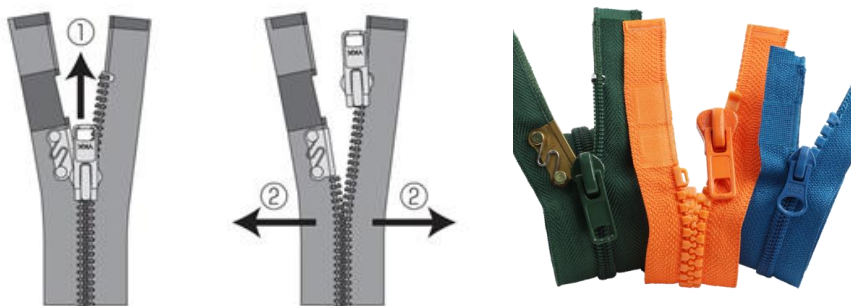


Figure 2: Quick release zippers by company KCC

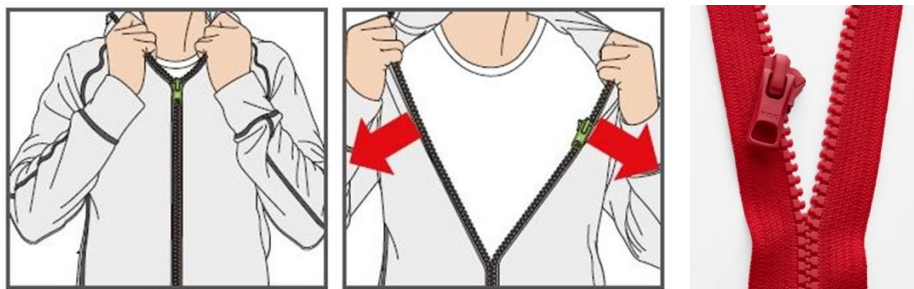


Figure 3: QuickFree® - molded separating zipper by company YKK

Often quick release zippers also have advanced closing system to ease connecting of two sides of teeth closing the zipper. Self-aligning mechanism uses small magnets inserted in the both bottom parts of a zipper (see Fig.4) [7]. Closing the zipper they join its two halves together easy without additional attention.

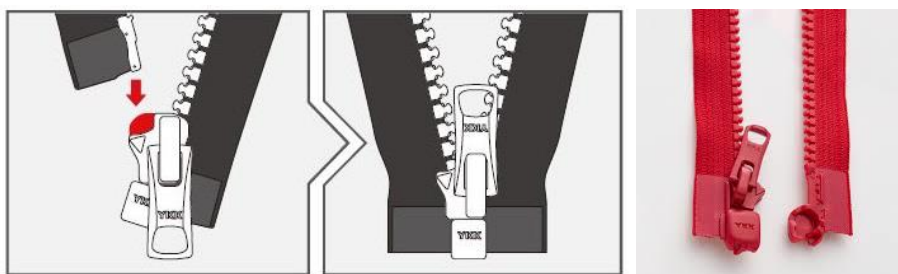


Figure 4: Click-TRAK® Magnetic by company YKK

Quick-release zippers are used for sportswear and safety clothing where quick actions are demanded. As well as, they are preferable in children, elderly and disable people garments to ease them garment taking on and off process.

2.3. Customer-repairable zippers

Zippers are very popular functional and decorative accessory used in wide variety of clothing and other textile goods. However, their repairing is almost impossible as every tooth is fixed to the tape of the zipper in special factory conditions. If only one or few teeth get damaged, the zipper has to be replaced in time and work consuming process, often reducing the original quality of the garment. As the process is complicated and also expensive, many users of the damaged textile goods decide to thrown them out, not to repair [2].

During the last decade fashion industry try to ensure the circularity of its production and extend the life cycle of textile products. Zipper companies (YKK, SBS, others) support them offering new methods to repair zippers. They have invented tools to replace broken

plastic teeth with new plastic or metal teeth in simple and easy process (see Fig.5,6), (2,8,10).

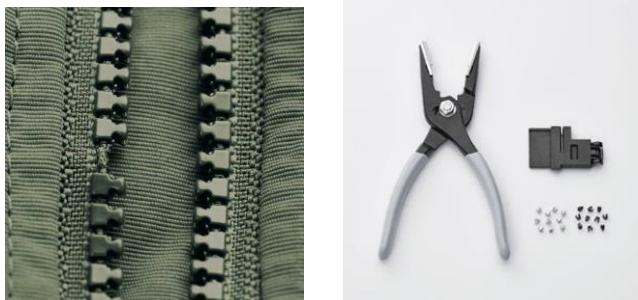


Figure 5: Repair set from special pliers, a set plate and metal teeth by company YKK

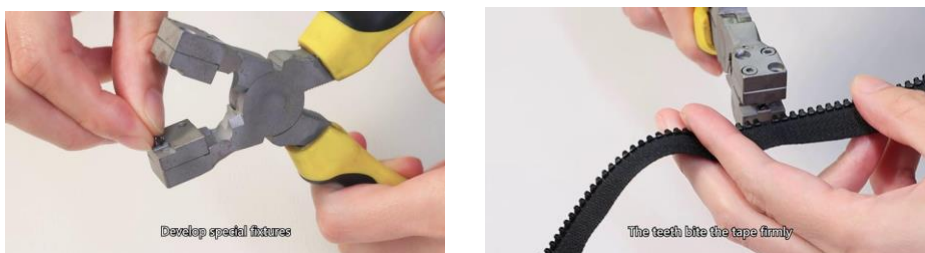


Figure 6: Mold equipment for new plastic tooth inserting by company SBS

Several companies have also developed solutions to change a damaged slider and a puller of a zipper (YKK; SBS, ZlideOn, LenZip, orhers). These parts of a zipper are specially redesigned to make possible their easy removal and replacement with new ones (see Fig.7), [2,9,1].

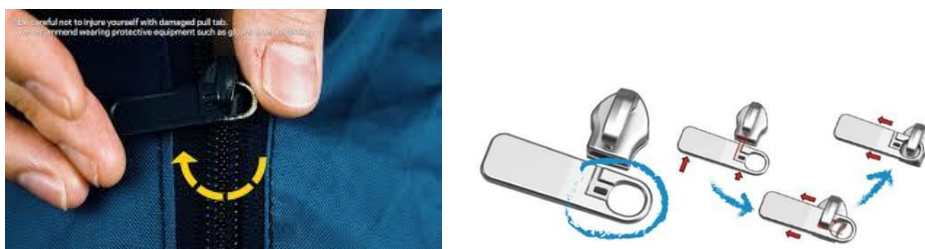


Figure 7: Replacement Puller for Coil zipper by YKK

3. SUSTAINABLE ZIPPERS

Conventional zippers are manufactured from nylon and polyester - polymers which are derived from petroleum using high energy and generating high carbon emissions. Eco-

friendly zippers are made from recycled or bio-based raw materials using low-emission coatings. Their raw materials, production methods or disposal ways support environmental protection aims (10,11,12,13).

3.1. Recycled raw materials

The most part of sustainable zippers are currently manufactured from recycled polyester or nylon. PET bottles, fishing nets, industrial scrap and textile waste are mechanical recycled, [10] melted, purified, and extruded into new filaments to create zipper tapes [11,12,14,16]. Recycled polyamide can be used to manufacture teeth, sliders and pullers of zippers [3]. Teeth of metal zippers can be made from recycled brass, stainless steel and copper. Recycled raw materials have identical structure and durability as virgin ones, their processing does not demand retooling of machinery while their use helps to reduce plastic waste and support very actual recycling efforts [2,11].

3.2. Bio-based synthetic materials

Bio-based nylon and polyester are derived from plant-based sugars, starch, cellulose, or plant oils. Company YKK is using bio-based polyester component in their GreenRise zippers [14]. It is obtained from molasses - a by-product of sugar production. Zippers of LenZip and Nyguard are manufactured from bio-based nylon which is derived from castor bean oil [12]. Mono-material and recyclable zipper Ny2Life by Italian company Nyguard is made of polyamide 6.6 [17]. The most often such zippers have teeth from bio-based materials while their tapes are made from organic cotton or other organic materials.

3.3. Organic materials

Certificated organic materials, such as cotton, linen, hemp, and Lyocell are typically used manufacturing tapes of zippers. Italian company Riri (c) offers zippers with a tape from 100% organic linen (see Fig.8). Companies YKK, Lenzip and Riri use organic cotton [18]. The most often zippers from organic materials are sold unbleached in natural colour to be dyed together with a garment. They are certified by the Global Organic Textile Standard (GOTS) [19] and are used manufacturing high-end sustainable clothing.



Figure 8: Sustainable zippers with organic linen tape and stainless steel Teeth by company Riri zippers

3.4. Eco friendly finishing

Electroplating is finishing method which is traditionally used to cover metal teeth of zippers with thin metallic layer. It is done to ensure durability, corrosion resistance, and aesthetic appearance to ready zippers. However, the process is time-consuming and performed by help of hazardous and toxic chemicals. To avoid complicated finishing process many companies have started to manufacture teeth from stainless steel (SBB, YKK, Olympic zippers, Riri, others) [11,14,20]. This material is resistant to corrosion and abrasion and eliminates need to perform galvanic treatment. As the alternatives to electroplating process a company YKK uses advanced eco-friendly metal finishing methods. They use less water and energy, as well as perform metal finishing without hazardous chemicals.

4. REVOLUTIONARY ZIPPERS

Japanese company YKK is a leader in a world's market, as well as, a company which has created the most revolutionary and fully new concepts for design and functionality of zippers.

4.1. Toothless zippers

Toothless zippers Zip/Nite Ize® manufactured by YKK have two extruded TPU profiles designed like rails instead of traditional teeth. They lock together by help of ball-and-socket joint mechanism (see Fig.9) and mechanical and vacuum forces (1,21).

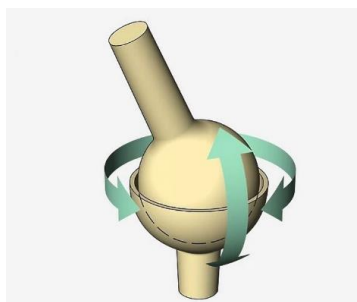


Figure 9: Ball-and-socket joint mechanism

The zippers have high strength and durability and can be used for heavy duty applications (Fig.10). The closure is dustproof, airtight and fully waterproof (IP67 rated) [3]. As the zipper does not have separate teeth it cannot break like traditional zippers. If the rails accidentally separate, the zipper can be easy repaired just pulling a slider back. The toothless zippers are used manufacturing waterproof travel gear, backpacks, storage bags, others.



Figure 10: Toothless zipper

4.2. Tapeless Zippers

YKK has also developed a zipper AiryString™ which does not have a tape (see fig.11). The teeth of the zipper are directly attached to the garment using a sewing machine. Such zippers are more flexible and lighter than zippers with a tape. Tapeless zippers create finer appearance to a seam in which they are inserted ensure almost invisible closure in a ready garment [2,22].



Figure 11: Upper left: Regular VISLON® zipper / Lower right: “AiryString™”

To fix a tapeless zipper into the garment, company JYKI has developed a special zig-zag stitch sewing machine. The machine is equipped with a mechanism to synchronize the feed of teeth of the zipper and the fabric during stitching process (see Fig.12) [23].



Figure 12: JUKI sewing machine for sewing “AiryString™” tapeless zippers

4.3. TouchLink® Zippers

The molded thermoplastic polyurethane puller of a YKK zipper can contain a built-in NFC chip. Tapping the smartphone against a puller of the zipper textile product manufacturers and their final users can easy get access to different kind of digital information (see Fig.13) [2]. Fashion brands can use TouchLink zippers to track manufacturing and sell process of their textile goods. In fashion business such zipper can link the brands with the users of their garments and with it to provide the valuable information used to improve new products and their sell results [2, 24].



Figure 13: Jacket with a TouchLink® zipper by Swedish sportswear brand Houdini

The puller of a Touchlink zipper can replace material content and care instructions labels, as well as, warranty registration of textile goods. It can easy keep the information of a product all its life time. The information is kept saved, even in severe weather conditions, during laundering processes or rough handling of a garment [25]. By help of the NFC chip

built-in a zipper the user of the garment could reach different apps on his smartphone, for example, music playlist or running tracker. The zipper could also keep an emergency contacts for a person with health problems or ensure his saved tracking by his family members.

In nearest future the zippers with NFC chips will help to create more sustainable fashion goods. As zipper will always keep information about the origin of materials and processes (dying, finishing) used manufacturing the textile product, it will be possible to perform its correct recycling [22].

4.4. Self-propelled zippers

In 2025 YKK announced the first prototype of a zipper with a built-in motor and gear mechanism. The zipper is developed for use in large dimension tents, shelters, banners, where very long zippers have to be inserted and their closing and opening is complicate and time consuming (Fig.14) [26,27]. If company succeeds to minimize the technology, such self –opening/closing zippers could be used also in clothing.



Figure 14: Self-propelled zippers used to close the separate part of a tent

5. CONCLUSIONS

Zipper manufacturers as co-operators of textile good producers have to support all latest tendencies that are actual in fashion, sport and other industries which use such kind of fastening systems. Sustainable ready goods can be created if every detail in final product support sustainable manufacturing process, its use and final recycling or degradation processes. The most part of latest innovations in market, such as, the use of recycled, bio-based and organic raw materials, repairable, tapeless zippers or zippers with chips already support sustainability aims. Other important tendency in the market helps to increase comfort and functionality of ready goods with zippers. Here could be mentioned water and air proof zippers, quick release zippers, toothless and tapeless zippers, zippers with built in chips or motors. While leading Japanese company YKK is creating fully new concepts and technologies, other zipper manufacturers improve their products constantly.



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