MAIN CHARACTERISTICS OF WATERPROOF ZIPPERS

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Abstract: *Waterproof zippers are critical components of many final waterproof products used across industries. They are manufactured from special materials using advanced technologies. The tape of a zipper is coated with hydrophobic PU or TPU polymers. The zipper is attached to the finished waterproof product using welded seams. The molded teeth of a waterproof zipper are designed with very high precision from flexible plastic or rubber. The teeth of the coil zippers are placed on the reverse side. Toothless, waterproof zippers use rails instead of teeth. Waterproof zippers are marked with IPX6, IPX7, and IPX8 Ingress protection codes. Highest IP code zippers are also airtight. There are also water-repellent and water-resistant zippers available in the market, which have lower-level protection against water penetration.*

Keywords: waterproof, water-resistant, water-repellent, molded teeth zipper, coil teeth zipper, welded seams, ingress protection code.

OSNOVNE KARAKTERISTIKE VODONEPROPUSNIH PATENT ZATVARAČA

Apstrakt: *Vodonepropusni patent zatvarači predstavljaju ključne komponente brojnih finalnih vodonepropusnih proizvoda koji se primenjuju u različitim industrijskim oblastima. Izrađuju se od specijalnih materijala primenom savremenih proizvodnih tehnologija. Traka zatvarača presvučena je hidrofobnim polimerima na bazi poliuretana (PU) ili termoplastičnog poliuretana (TPU). Zatvarač se na završni vodonepropusni proizvod najčešće pričvršćuje primenom tehnologije zavarivanja šavova. Liveni zupci vodonepropusnih zatvarača izrađuju se sa visokom preciznošću od fleksibilnih polimernih materijala, poput plastike ili gume. Kod spiralnih zatvarača zupci su pozicionirani na poleđini trake. Bezubni vodonepropusni zatvarači koriste specijalne vodilice umesto klasičnih zubaca. Vodonepropusni zatvarači obeležavaju se IPX6, IPX7 i IPX8 kodovima zaštite od prodora (Ingress Protection). Zatvarači sa najvišim IP stepenom zaštite ujedno obezbeđuju i hermetičku nepropusnost. Na tržištu su dostupni i vodoodbojni (water-repellent) i vodootporni (water-resistant) zatvarači, koji pružaju niži nivo zaštite od prodora vode.*

Ključne reči: vodonepropusni, vodootporni, vodoodbojni, rajsferšlus sa livenim zupcima, rajsferšlus sa spiralnim zupcima, zavareni šavovi, kod stepena zaštite (IP).

1. INTRODUCTION

Waterproof zippers are important and critical component of many final products used in marine and military industries, different sports, camping and travel gear, mobile phone accessories, others. They ensure protections against any kind of water jets and water penetration [1]. To block water the tape, gare system and a slider section (see Fig.1) of waterproof zippers are manufactured from special materials using new and advanced technologies [15].

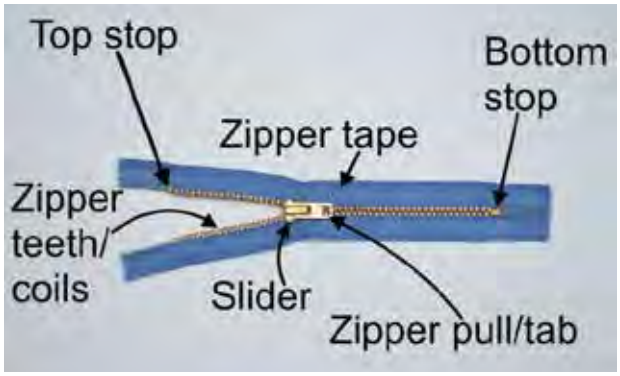

Figure 1: The main parts of a zipper

2. CHARACTERISTICS OF THE MAIN PARTS OF WATERPROOF ZIPPERS

2.1. Tape of waterproof zippers

The tape of a zipper is made from waterproof plastic, rubber or tightly woven polyester, nylon, or vinyl base which is covered with hydrophobic polymer - single or double coated polyurethane (PU) or thermoplastic Polyurethane (TPU) film [2-12]. In case of fabric tape, the polymer can also be fully irrigated into woven tape (DynaPel® by YKK) [13]. TPU coating is used for heavy duty waterproof zippers as it ensure higher strength, high water, moisture and corrosion resistance. YKK company uses also PVC and chloroprene (Neoprene) tapes [2]. The tape of waterproof zipper has a smooth and rubber like surface (see Fig. 2).

Figure 2: The coated and non coated zippers

Manufacturing waterproof final products the thermoplastic tape of the zipper is attached to them by help of welded seams (see Fig.3). Special machines use high-frequency waves (RF), ultrasound or hot air to melt and fuse the tape of a zipper to shell material of the final product. If traditional stitching with thread is used, seams are sealed afterwards with a waterproof tape or sealant to close holes created by a needle [14].

Figure 3: Zipper attached to the shell fabric with welded seams

2.2. Teeth of waterproof zippers

The molded teeth of waterproof zippers are designed with very high precision, often from flexible plastic or rubber covered with PU film. Such teeth are lightly squeezed closing the zipper by a slider. After the slider passes, the teeth relax and with it close any small gap in between them fully [15].

Figure 3: Coil teeth and molded teeth and zippers

Manufacturing waterproof coil zippers, their teeth are placed on the reverse side of a zipper (see Fig.4). Then the waterproof tape, not teeth is directly exposed to the water and moisture [12]. To support and prolong water protection properties some of the waterproof zippers in their use period have to be lubricated along their interlocking elements (TIZIP® brand zippers) [9].

Metal teeth waterproof zippers are not typical, however some companies use them coated with PU or TPU film [16]. There are available also toothless waterproof zippers. Instead of teeth they have kind of rails made from TPU (TRU® Zip). The zipper is sealed by mechanical and vacuum forces [17].

Figure 4: Waterproof reverse side coil zipper by YAB zipper company

Figure 5: Water-proof and airtight zippers by YAB zipper company

3. WATER-REPELLENT AND WATER-RESISTANT ZIPPERS

In fastener market it is not always clear determined what level of protection against water penetration zippers have. Zippers use to be described as waterproof, water-resistant and also water-repellent. What is the difference? The water-repellent product have to provide protection against splashing water (light rain) without harmful effects, while water-resistant ones can withstand water jets (moderate rainfalls) [18]. Water-repellent zippers are usually standard coil or mould plastic zippers which are spray-coated with water repellent substance to decrease surface tension of its tape and with it, to repel the water. The water getting on a such zipper, beads up. The water-resistant zippers are also standard zippers however, their tape is coated with hydrophobic PU film not to allow water to soak in. They are not completely sealed and cannot withstand prolonged exposure to water. Water-repellent and water-resistant zippers are often used in casual outdoor clothing, sportswear, backpacks, tents, others goods.

To recognize water protective qualities of zippers precisely and with it to find their correct application, the zippers use to be marked with *Ingress protection codes* [19, 20]. The IP code consists of two numerals. The first one refers to a level of protection against solid objects, where a letter X means that there is no

Table 1: Water protective zippers in the world market

IP code	Resistance to	Categorization	Tape coating	Teeth	Application	Companies
IPX4	splashing water	Water-repellent	PU	molded, coil, metal	outdoor clothing, sportswear, backpacks, tents	YKK, SBS, TIZIP, IDEAL, Riri, Cremalleras Rubi, Talon, YAB, Zili Zip, others
IPX5	water jets	Water-resistant, proof	PU, TPU	molded, coil, metal	casual outdoor clothing, sportswear, backpacks, tents	YKK, SBS, RHF, IDEAL, TALON, YAB
IPX6	strong water jets	Waterproof	TPU PU	molded, coil, metal	Sportswear, special clothing, covering goods	YKK, SBS, TRU, KIN
IPX7	underwater up to 1 meter deep for 30 minutes	Waterproof and airtight	TPU	molded, coil, rails	aerospace, medical, military, outdoor sports	TRU, YAB, KIN
IPX8	continuous submersion beyond 1meter, prolonged water exposure	Waterproof and airtight	TPU	molded	Water sports, fishing, inflatable	TIZIP
	submersion beyond 1-meter, prolonged water exposure	and airtight			sport, fishing, inflatable	

data about this kind of protection. The second numeral shows the protection level against liquids. It uses scale from 0 to 9. For example, IPX4 code shows that the product/zipper is resistant to splashing water and can be categorized as water-repellent, while zippers with IPX5 code ensure protection against water jets and could be called water-resistant. The water protective zippers of next levels are already waterproof. IPX6 zippers withstand strong water jets and provide a higher-level protection against water penetration. IPX6 and IPX7 zippers withstand submersion beyond 1 meter and prolonged water exposure (see Table 1). Waterproof zippers are often also airtight.

Water-resistant zippers are manufactured by companies: YKK Group (Japan), [11], SBS Zipper (China), Riri Group (Switzerland), Cremalleras Rubi (Spain), Talon (USA), IDEAL Fastener (USA), Zili Zip (China), others.

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4. CONCLUSIONS

During the last decade the waterproof zippers have find very wide application in many industries. Their producers are searching for new possibilities to improve their water protective properties, as well as, strength, durability, protection against corrosion, salt water, UV radiation. The fasteners in the most part of final waterproof goods are very much critical as they are a part of many different components which have to support whole water-proof system of the final product. The most important innovations during the last years are done by Japanese company YKK Group and Chinese company SBS Zipper.

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