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## O POVIJESTI TRAKASTIH TRANSPORTERA ABOUT THE HISTORY OF BELT CONVEYORS

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**Sažetak:** U ovom se radu govori o povijesnom razvoju trakastih transportera. Oni se koriste u mnogim granama industrije jer omogućavaju brz i učinkovit transport raznih vrsta materijala. Trakasti transporteri omogućuju siguran transport materijala s jednog mjesta na drugo, dok bi upotreba ljudskoga rada u tom slučaju bila naporna i skupa. Oni se mogu postaviti gotovo svugdje i prenositi terete svih oblika, veličina i težina. U nanotehnologiji istražuju se trakasti transporteri nanoveličine.

**Ključne riječi:** - trakasti transporter  
- transportni sustav  
- povijest

**Summary:** This paper deals with the history of belt conveyors. Belt conveyors are used throughout a range of industries due to the numerous benefits they provide. They allow quick and efficient transportation of a wide variety of materials. Belt conveyors are able to safely transport materials from one place to another, which when done by human labour would be strenuous and expensive. They can be installed almost anywhere, and they transport loads of all shapes, sizes and weights. Nanoscale belt conveyors are a current subject of nanotechnological research.

**Key words:** - belt conveyor  
- transportation system  
- history

### 1. UVOD

Trakasti transporteri bitan su čimbenik u suvremenoj industriji. Koriste se za transport materijala iz jednog procesa u drugi, u suradnji s različitim transportnom i strojnom opremom. Važnost trakastih transportera često je zanemarena jer se oni uobičajeno promatraju kao dio opreme koji ne stvara probleme i koji radi dugo vremena bez kvara.

Ljudi se koriste načelima trakastih transportera tisućama godina [1]. Drevni narodi su, koristeći balvane kao valjke, prevozili teške terete, poput velikih kamenih blokova za gradnju palača i hramova. Prvi trakasti transporteri bili su podosta jednostavni. Imali su drvene valjke i traku koja je putovala preko njih (Slika 1. lijevo). Najranije transportne trake bile su izrađene od kože, kanvasa ili gume. Ti su primitivni trakasti transporteri bili vrlo popularni za prijevoz rasutog tereta. U dvadesetom stoljeću njihova primjena postaje sve šira.

Konstrukcija trakastih transportera stalno se poboljšava pa su postali neizbježan dio suvremene industrije i svakodnevnoga života (Slika 1. desno).

Izum elektriciteta i električnih motora omogućio je izradu trakastih transportera za prijevoz materijala i ljudi u proizvodnim postrojenjima, tvornicama, rudnicima, lukama, skladištima, zračnim lukama, trgovinama, itd.

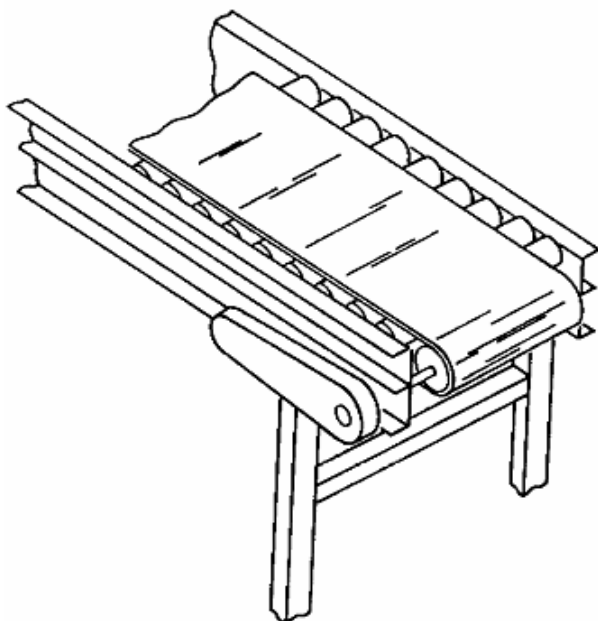
### 1. INTRODUCTION

Belt conveyors play an important role in the industry. They are used to transport material from one process to another, and they are used in conjunction with various transportation and machine equipment. The role of belt conveyors is often overlooked, as they are normally a piece of equipment that never makes too much trouble and runs for a long time before breaking down.

People have used the principles of belt conveyors for thousands of years [1]. The ancients used logs as rollers to convey the large stone blocks that built palaces and temples. Belt conveyors were quite simple in ancient times. They had wooden rollers and a belt that traveled over the wooden rollers (Fig. 1. left). The earliest conveyor belts were made of leather, canvas or rubber. These primitive belt conveyors were very popular for conveying bulky items. In the 20th century, their application became more widely applied.

Design of belt conveyors has improved over the years and now belt conveyors are an inevitable part of modern industry and everyday life (Fig. 1. right).

The invention of electricity and electric motors provided the means for building belt conveyors which could transport material and people in processing plants, factories, mines, ports, warehouses, airports, markets, etc.



Slika 1. Najraniji, primitivni trakasti transporter (lijevo) u usporedbi sa suvremenim trakastim transporterima (desno)  
Figure 1. The earliest, primitive belt conveyor (left) compared with modern belt conveyors (right)

## 2. POVIJEST TRAKASTIH TRANSPORTERA

Povijest trakastih transporterera počela je u drugoj polovici 17. stoljeća i otada su oni neizbježni i sastavni dio transporta materijala. Najraniji trakasti transporteri bili su vrlo primitivni i sastojali su se od kožne ili platnene trake koja je putovala preko ravne drvene platforme ili preko drvenih valjaka. Prva upotreba trakastih transporterera u Sjedinjenim Američkim Državama opisana je u knjizi "A Millers Guide" izumitelja Olivera Evansa, a objavljena je u Philadelphiji 1795. godine [2]. Prva upotreba lijevanih potpornih valjaka zabilježena je 1891. godine u Edisonvim proizvodnim pogonima u New Jerseyju i Pennsylvaniji.

U početku trakasti su se transporteri koristili samo za prijevoz vreća žita na kratke udaljenosti, ali njihova se konstrukcija polako poboljšavala. U 19. stoljeću postajali su sve pouzdaniji pa se i njihova upotreba proširila (Slika 2. lijevo) [1]. Trakasti transporteri počeli su se koristiti i za prenošenje težih tereta.

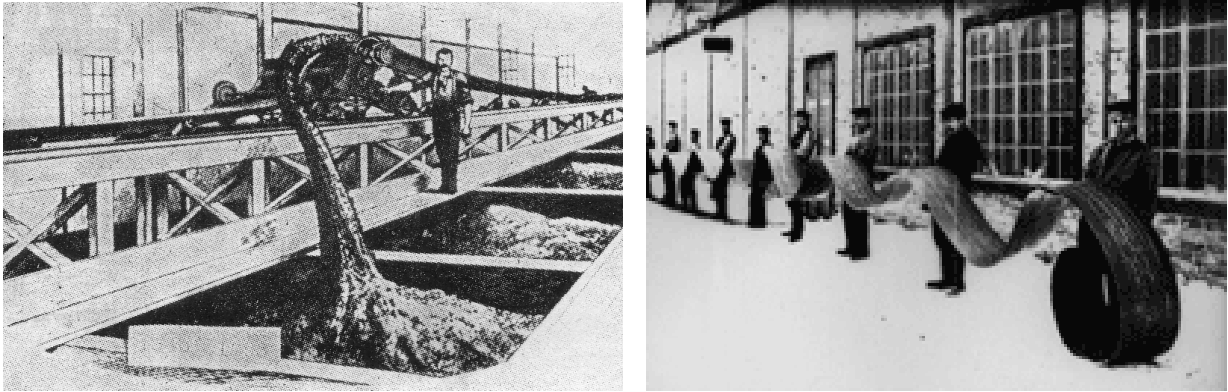
Zahvaljujući razvoju tehnologije umjesto drva počeo se koristiti metal, posebice čelik, za upotrebu na višim temperaturama i u svrhu povećanja trajnosti. U tvrtki Sandvik 1901. godine izumljena je i počela se proizvoditi čelična transportna traka (Slika 2. desno). Otada se istražuju novi, lakši i jeftiniji materijali pa su stoga mnogi dijelovi danas izrađeni od plastike. Međutim upotreba plastike nije uvijek moguća, npr. kod visokih temperatura i kod transporterera s teškim uvjetima rada, pa se i dalje koristi čelik.

## 2. HISTORY OF BELT CONVEYORS

The history of belt conveyors began in the latter half of the 17th century. The first belt conveyors were very primitive and consisted of a leather or a canvas belt traveling over a flat wooden bed or over wooden rollers. Since then, belt conveyors have become an inevitable and integral part of material transportation. The first use of belt conveyors in the United States was described in the book "A Millers Guide" by the inventor Oliver Evans, published in Philadelphia in 1795 [2]. The first use of cast iron idlers was recorded as being in 1891 in Edison's plant of the New Jersey and Pennsylvania Concentrating Company.

In the beginning, belt conveyors were used only for moving grain sacks along short distances, but the design slowly moved forward. In the 19th century, belt conveyors were becoming more and more reliable and their applications became more diverse (Fig. 2. left) [1]. Belt conveyors started to be applied to heavier materials.

Thanks to technological advancement, a switch was made to metal instead of wood, especially in the form of stainless steel to withstand heat and provide durability. In 1901, the Sandvik Company invented and started the production of the steel conveyor belt (Fig. 2. right). Since then, designers have been looking for even cheaper, lighter materials, and today many parts are made of plastic. However, there are instances when plastic is not adequate, such as under high temperatures and heavy-duty applications, in which steel continues to be used.



Slika 2. Trakasti transporter iz 1840. godine (lijevo) i Sandvikova čelična transportna traka iz 1901. g. (desno)  
 Figure 2. Belt conveyor dated 1840 (left) and Sandvik's steel conveyor belt dated 1901 (right)

Henry Ford je 1913. godine u svojem pogonu *Rouge* u Dearborneu u Michiganu uveo montažnu liniju na osnovi transportne trake, za montažu svojega vrlo popularnog automobila Model-T, što je omogućilo veliko povećanje proizvodnje (Slika 3.) [3]. Vrijeme potrebno za sklapanje šasije smanjeno je s 12 sati i 30 minuta na 2 sata i 40 minuta, a od 1914. godine na 1 sat i 30 minuta. U idućih deset godina svi proizvođači automobila počeli su koristiti montažne transportne trake. Tako su one postale popularan način transporta teške i velike robe unutar tvornica.

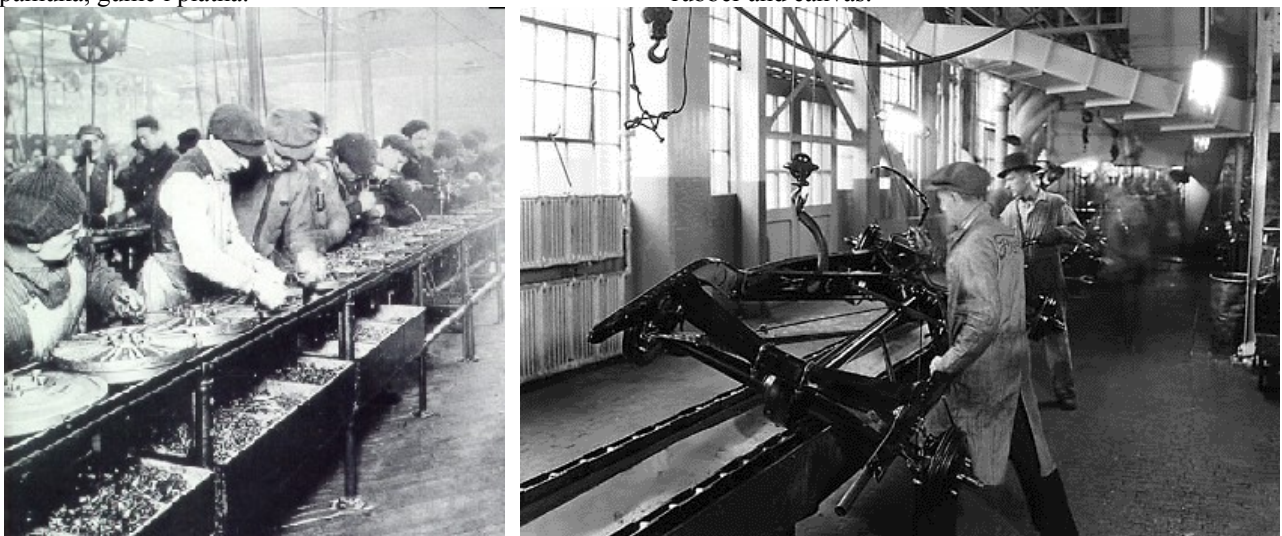
U prvoj polovici 20. stoljeća trakasti transporteri postali su uobičajena transportna sredstva i njihova je konstrukcija neprestano poboljšavana. Trakasti transporteri velike duljine koriste se danas u rudnicima i u lukama za transport ugljena i raznih ruda (Slika 4.).

Jedna od prekretnica u povijesti razvoja trakastih transportera bila je uvođenje sintetičkih transportnih traka. To je počelo tijekom Drugoga svjetskog rata, ponajviše zbog nestašice prirodnih materijala poput pamuka, gume i platna.

In 1913, Henry Ford introduced the conveyor belt-based assembly line into his plant *Rouge* in Dearborne Michigan, for his very popular Model-T car's assembly, which enabled an enormous increase in production (Fig. 3.) [3]. The time required to assemble the chassis fell from 12 hours and 30 minutes to 2 hours and 40 minutes, and then by 1914 to 1 1/2 hours. Within a decade, all automobile manufacturers were using the assembly conveyor belts. Thus, conveyor belts became popular tools for conveying heavy and large goods within factories.

During the first half of the 20th century, belt conveyors became a common means of transport, and their design was constantly improved. Very long belt conveyors are today used in mines and ports to transport coal and various ore. (Fig. 4.).

One of the turning points in the history of belt conveyors was the introduction of synthetic conveyor belts. They were introduced during the Second World War, mainly because of the scarcity of natural materials such as cotton, rubber and canvas.



Slika 3. Montažna transportna traka Fordova automobila Model-T (lijevo i desno)  
 Figure 3. Ford's Model-T car assembly conveyor belt (left and right)



Slika 4. *Suvremeni trakasti transporter ugljena u luci Immingham u Velikoj Britaniji*  
 Figure 4. *Modern belt conveyor for coal in the port of Immingham - Great Britain*

Danas se u proizvodnji transportnih traka uobičajeno koriste: pamuk, platno, koža, neopren, najlon, poliester, poliuretan, uretan, PVC, guma, silikon i čelik. Izbor materijala uvjetovan je konkretnom primjenom transportne trake [4].

Najduži trakasti transporter na svijetu nalazi se u Zapadnoj Sahari (Slika 5.). Dug je 100 km, od rudnika fosfata u Bu Craau do obale Atlantskoga oceana u El-Aaiunu. Najduži pojedinačni trakasti transporter prevozi vapnenac i škriljevac od Meghalaya u Indiji do Sylheta u Bangladešu i dug je 17 km.

Today, cotton, canvas, leather, neoprene, nylon, polyester, polyurethane, urethane, PVC, rubber, silicone and steel are commonly used in the production of conveyor belts. Nowadays, the material used for making a conveyor belt is determined by its application [4].

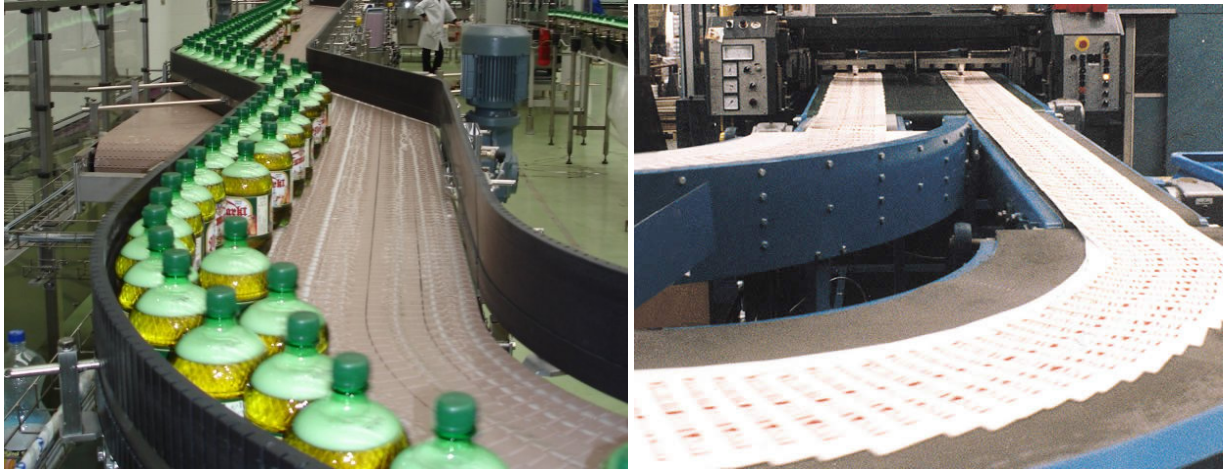
The longest belt conveyor in the world is in the Western Sahara (Fig. 5.). It is 100 km long, from the phosphate mines of Bu Craa to the coast south of El-Aaiun. The longest single conveyor runs from Meghalaya in India to Sylhet in Bangladesh. It is 17 km long and conveys limestone and shale.



Slika 5. *Najduži trakasti transporter na svijetu, dug 100 km, u Zapadnoj Sahari*  
 Figure 5. *The longest belt conveyor in the world, 100 km long, in Western Sahara*

Trakasti transporteri koriste se u mnogim industrijama: automobilske, računalne i elektroničke industriji, poljoprivredi, proizvodnji hrane i pića (Slika 6. lijevo), avionske, farmaceutskoj i kemijske industriji te za tisak novina (Slika 6. desno) i pakiranje.

Belt conveyors are commonly used in many industries, including the automotive, agricultural, computer, electronic, food and beverage processing (Fig. 6. left), aerospace, pharmaceutical, chemical, print finishing (Fig. 6. right) and packaging industries.



Slika 6. Trakasti transporter u punionici boca (lijevo) i u pogonu za tisak novina (desno)  
Figure 6. Beverage's belt conveyor (left) and belt conveyor at a newspaper's print plant (right)

Vrlo zanimljiva, praktična i zabavna primjena trakastog transportera vidljiva je u *sushi* restoranu (Slika 7.), gdje se tanjuri sa *sushijem* (raznolikom sirovom ribom) nalaze na rotirajućoj transportnoj traci, koja putuje kroz restoran i prolazi pokraj svakog stola, tj. gosta, brzinom od 8 cm u sekundi. Gosti mogu naručiti jelo ili pak jednostavno uzeti što žele od svježe pripremljenog sushija s putujuće transportne trake. Transportnu traku za takav tip restorana u Japanu je izumio Yoshiaki Shiraishi 1958. godine, jer je imao problema s osobljem u svojem malom restoranu i poteškoće pri njegovu samostalnom vođenju.

A very interesting, funny and practical application of a belt conveyor is applied in Sushi restaurants (Fig. 7.), where the plates with the sushi (various raw fish) are placed on a rotating conveyor belt that winds through the restaurant and moves past every table i.e. guest with a speed of 8 cm per second. Guests may place special orders, or simply pick their selections from a steady stream of fresh sushi moving along the conveyor belt. Conveyor belt sushi was invented in Japan by Yoshiaki Shiraishi in 1958, who had problems staffing and managing his small sushi restaurant.



Slika 7. Sushi restoran s transportnom trakom "Yo! Sushi" u londonskoj podzemnoj željezničkoj postaji Paddington  
Figure 7. Sushi restaurant with conveyor belt, Yo! Sushi, at London Paddington Railway Station

### 3. BUDUĆI RAZVOJ

Budući razvoj trakastih transportera sigurno će voditi ka smanjenju cijene i buke, smanjenom opsegu održavanja i njihovoj većoj trajnosti. Također, transportne će trake u budućnosti biti lakše i tanje, boljšeg omjera čvrstoća/težina pa će se time pridonijeti uštedi energije. Posebno će se svratiti pozornost na visoku čvrstoću i malu rastezljivost, na antistatičnu otpornost te otpornost na habanje i na štetni utjecaj ulja, masti i drugih kemikalija. Transportne trake u budućnosti bit će uzdužno vrlo fleksibilne, a poprečno adekvatno krute. Radnicima na montažnim transportnim trakama svakako će se poboljšati i ergonomski uvjeti.

Modularni sustav trakastoga transportera novi je koncept u manipulaciji materijalom (Slika 8.) [5]. On se razvija vrlo brzo zahvaljujući svojim prednostima: standardiziranim dijelovima i dimenzijama, lakoj montaži i popravku te mogućnostima fleksibilnog razmještaja i načina upotrebe. On postaje neizbježan dio automatske proizvodnje i montažnih linija u mnogim industrijskim granama [6].

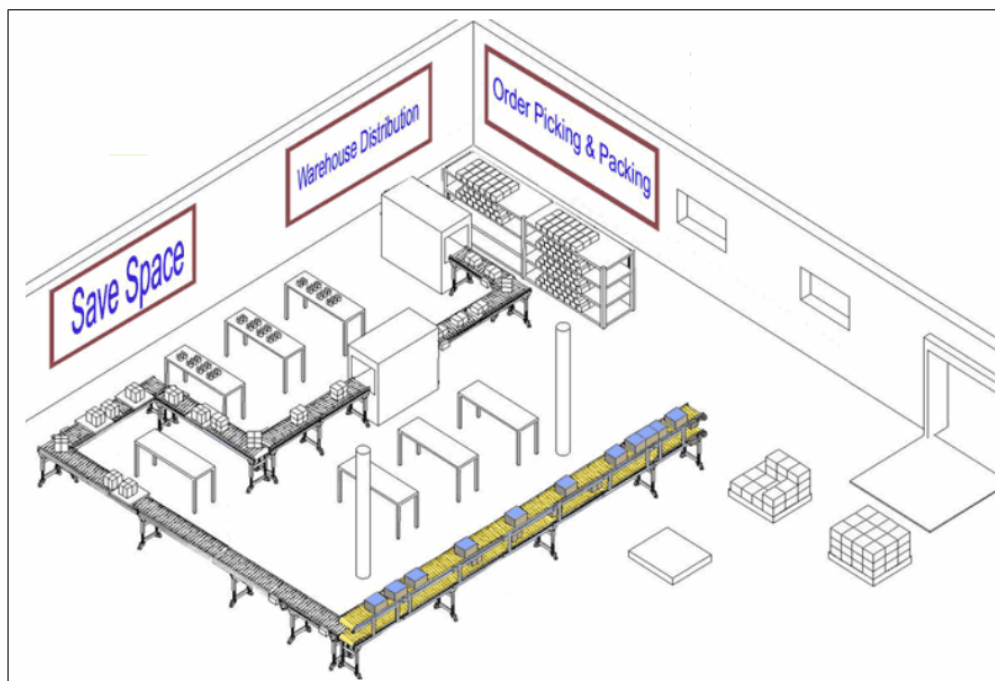
Temeljna je prednost modularnoga sustava trakastoga transportera mogućnost promjene njegova oblika prema želji, čime se mijenja i putanja toka materijala. Budući da je sastavljen od spojnih jedinki (modula), koje uključuju trake, stranice, postolja, motore i pomoćnu opremu, taj se sustav može graditi u blokovima, da bi udovoljio traženim putovima toka materijala u bilo kojoj okolini, gdje se inače koriste mali i srednje veliki trakasti transporteri.

### 3. FUTURE DEVELOPMENT

Future development of belt conveyors will surely lead to their low operating noise and costs, reduced maintenance and added durability. In the future, conveyor belts will be lighter and thinner with a better strength/weight ratio thus saving energy. Special attention will be focused on high strength and low stretch characteristics, antistatic and abrasion resistance and general imperviousness to oils, greases and others chemicals. Conveyor belts in the future will be longitudinally very flexible and laterally adequately stiff. Ergonomic considerations in the process of designing assembly conveyor belt workstations are another very important area for continuing improvement.

The modular conveyor belt system is a new concept in material handling (Fig. 8.) [5]. The modular conveyor belt is developing very rapidly because of its advantages, some of which include: standardized units and dimensions, easy assembly and repair, and flexible arrangement and variety of use. It is becoming an inevitable part of automated production and assembly lines in many industry branches [6].

The fundamental thing that a modular belt conveyor system does is change shape, and it does so very quickly. Composed of interlocking units (modules), including belts, sides, legs, motors and accessories, these conveyors are self-contained systems that can be configured like "building blocks" to meet a changing production flow in any environment where light- to medium-duty belt conveyors are used.



Slika 8. Modularni sustav trakastoga transportera  
Figure 8. Modular belt conveyor's system

Transportne trake također su objekt istraživanja u nanotehnologiji. Istraživači iz laboratorija *Lawrence Berkeley National* preinačili su karbonske nanocijevi u transportne trake koje mogu prenositi čestice veličine atoma ka mikroskopskim radnim mjestima (Slika 9.) [7].

Djelovanje male električne struje na karbonsku nanocijevu pomiče čestice indija uzduž cijevi, poput transportne trake. To kretanje rješava pitanje učinkovite montaže nanostrukture, što je trenutno najveći problem istraživačima.

Transportne trake nanovelikine mogu dostaviti atom za atomom konstrukcije nanostrukture.

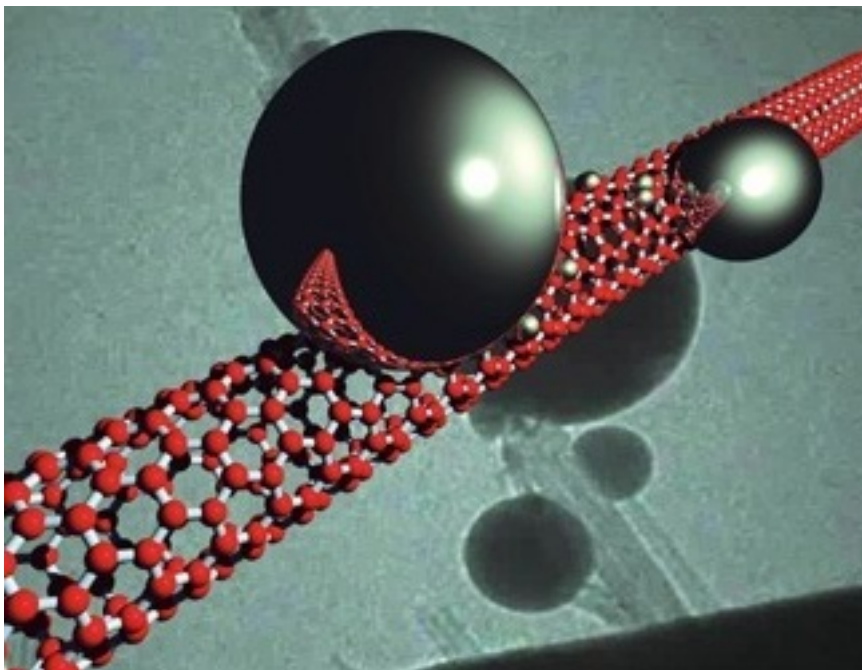
U budućnosti transportnu traku nanovelikine istraživači mogu koristiti za dostavu mnoštva atoma za atomom bilo kamo. Ona se može koristiti kod nanoproizvodnje, npr. kod nanolemljenja i kod nanoelektromehaničkih uređaja.

Conveyor belts are also an object of research in nanotechnology. Lawrence Berkeley National Laboratory scientists have transformed carbon nanotubes into conveyor belts capable of ferrying atom-sized particles to microscopic worksites (Fig 9.) [7].

Applying a small electrical current to a carbon nanotube moves indium particles along the tube like a conveyor belt. This movement solves the issue of efficient assembly of nanostructures currently plaguing researchers.

Nanoscale conveyor belts may expedite atom-by-atom construction of nanostructures.

In the future, this nano-sized conveyor belt could be used in any application where researchers want to deliver mass, atom by atom. It can be used for nanofabrication, for instance, nanosoldering, and in nanoelectromechanical devices.



Slika 9. Transportna traka nanovelikine  
Figure 9. Nanosized conveyor belt

#### 4. ZAKLJUČAK

Trakasti transporteri sastavni su dio rukovanja materijalom već više od 200 godina zbog svoje pouzdanosti, univerzalnosti i velikog raspona kapaciteta. Oni omogućavaju brz i učinkovit transport raznih vrsta materijala, od fine prašine do kamenih gromada, što ih čini vrlo popularnima u rukovanju materijalom, u proizvodnji, u teškoj industriji, u preradi hrane i u industriji pakiranja proizvoda.

Trakasti transporteri koriste se kao sastavni dijelovi u automatskoj distribuciji i skladištenju, u kombinaciji s računalno upravljivim sustavima paleta.

Trakasti transporteri smatraju se sustavima koji štede radnu snagu jer omogućavaju da se velike količine

#### 4. CONCLUSION

Belt conveyors have been an integral part of material handling for over 200 years due to their reliability, versatility, and range of capacities. They allow quick and efficient transportation for a wide variety of materials, from fine powders to large, lumpy stones, which make them very popular in material handling, in manufacturing, in heavy industries, in food processing, and in packaging industries.

Belt conveyors are used as components in automated distribution and warehousing in combination with computer controlled pallet-handling equipment.

They are considered a labor saving system that allows large volumes of materials to move rapidly through a

materijala brzo pomiču kroz proces, što omogućuje da tvrtke otpremaju ili dobivaju veće količine materijala uz manji skladišni prostor i niže troškove rada.

Budući razvoj trakastih transportera ide ka povećanju njihove trajnosti, ka nižoj cijeni i razini buke, smanjenom održavanju te ka optimalnoj težini i dimenzijama. Zaštita okoline također će se sve više uzimati u obzir pri konstrukciji trakastih transportera, posebno kod transporta žita, ugljena i raznih ruda.

Modularni sustavi trakastih transportera, kao novi koncept u rukovanju materijalom, postaju neizbježni dio automatske proizvodnje i automatskih montažnih linija u mnogim industrijskim granama.

Trakasti transporteri također su objekt istraživanja u nanotehnologiji. U budućnosti će transportne trake nanoveličine moći prenositi čestice veličine atoma ka mikroskopskim radnim mjestima.

process, allowing companies to ship or receive higher volumes with smaller storage space and with less labor expense.

Future development of belt conveyors leads towards their improved durability, low cost and operating noise, reduced maintenance, optimized weight and dimensions. Environmental protection will be more and more emphasized during the process of the belt conveyor's design, especially for the transport of grain, coal and various ore.

Modular belt conveyor systems as a new concept in material handling are becoming an inevitable part of automated production and assembly lines in many industry branches.

Belt conveyors are also an object of research in nanotechnology. In the future, nanosized conveyor belts will be capable of ferrying atomsized particles to microscopic worksites.

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