UNION OF ENGINEERS AND TEXTILE TECHNICIANS OF SERBIA

V INTERNATIONAL SCIENTIFIC CONFERENCE

CONTEMPORARY TRENDS AND INNOVATIONS IN THE TEXTILE INDUSTRY

V MEĐUNARODNA NAUČNA KONFERENCIJA

SAVREMENI TRENDOVI I INOVACIJE U TEKSTILNOJ INDUSTRIJI

PROCEEDINGS

EDITOR:
Prof. dr SNEŽANA UROŠEVIĆ

Belgrade, 15-16th September, 2022.
Union of Engineers and Technicians of Serbia
Dom inženjera „Nikola Tesla“

PROCEEDINGS
V INTERNATIONAL SCIENTIFIC CONFERENCE
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UNION OF ENGINEERS AND TEXTILE TECHNICIANS OF SERBIA

AND

UNION OF ENGINEERS AND TECHNICIANS OF SERBIA
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PREFACE

The 5 th International conference "Contemporary Trends and Innovations in the Textile Industry" CT&ITI 2022, is co-organized by the Union of Engineers and Textile Technicians of Serbia, the Union of Engineers and Technicians of Serbia, the Faculty of Technology and Metallurgy in Belgrade, the University of Faculty of Technology, Shtip, North of Macedonia, Society for Robotics of Bosnia i Herzegovina and Balkan Society of Textile Engineering-BASTE of Greece.

The Ministry of Education, Science and Technological Development of the Republic of Serbia recognized the importance of this Conference, and thus, supported it.

The aim of this Conference is to consider current technical, technological, economic, ecological, R&D, legal and other issues related to the textile industry, then the application of contemporary achievements and the introduction of technical and technological innovations in the production process of fiber, textile, clothing and technical textile by applying scientific solutions in order to improve the business and increase the competitive advantages of the textile industry on the domestic and global market.

Leading scientists and experts from the Balkans and other countries, working at faculties, textile colleges and institutes, but also individuals who professionally deal with the issues at hand are taking part in this Conference.

The Conference program involves papers dedicated to the scientific and practical aspects of the following topics: Textile and Textile Technology, Textile Design, Management and Marketing in the Textile Industry and Ecology and Sustainable Development in the Textile Industry. The Conference program includes 48 papers, and a total of 116 participants from 14 countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, India, Latvia, North of Macedonia, Portugal, Romania, Russia, Serbia, Slovenia and Turkey.

Therefore, this Conference is an opportunity for establishing scientific, educational and economic cooperation of our country with other countries. Certain number of papers by domestic authors present the project results dealing with fundamental research and technological development, financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

I would like to thank all those who have made it possible to organize the conference Contemporary Trends and Innovations in the Textile Industry and make it a success. First, I would like to thank the Scientific and Organizing Committee for working hard, spending countless hours and finding the best solutions for numerous organizational aspects of our Conference. Also, I would like to express my gratitude to all sponsors who believed in the importance of this Conference and co-financed it. I also thank all the other institutions that supported the Conference in various ways, because without their support, the Conference could not have been organized. Last but not least, I would like to thank plenary lecturers, all authors and co-authors and guests for their participation in the Conference.

On behalf of the Organizing Committee
Prof. dr Snežana Urošević, president

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„Savremeni trendovi i inovacije u tekstilnoj industriji“
15-16. septembar 2022, Beograd, Srbija

ANALYSIS OF THE SITUATION WITH TEXTILE WASTE

Silvana Zhezhova[1], Sonja Jordeva[1], Sashka Golomeova Longurova[1], Vineta Srebrenkoska[1], Vanga Dimitrijeva Kuzmanoska[1]

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ABSTRACT: *As a result of global population growth and rising living standards, textile fiber production and consumption are projected to continue to grow and global fiber production is expected to reach 156 million tonnes by 2030. The increase in the production and consumption of textile products causes an increase in the amount of generated textile waste. The increasing quantities of textile waste is a significant problem, as 2 to 15 kilograms of waste per person are generated annually in Europe. The largest producers of textile waste in Europe are Belgium, Czech Republic, Portugal, Italy, Austria and Netherlands. Only 20% of clothing waste is collected globally for reuse or recycling. The remaining 80% is deposited or incinerated, resulting in a large loss of energy and raw materials.*

Keywords: *textile waste, recycling, landfilling, sustainability*

ANALIZA STANJA SA TEKSTILNIM OTPADOM

APSTRAKT: *Kao rezultat rasta globalne populacije i životnog standarda, predviđa se da će proizvodnja i potrošnja tekstilnih vlakana nastaviti da raste, a očekuje se da globalna proizvodnja vlakana dostigne 156 miliona tona do 2030. Povećanje proizvodnje i potrošnje tekstilnih proizvoda dovodi do povećanja količine nastalog tekstilnog otpada. Sve veće količine tekstilnog otpada predstavljaju značajan problem, jer se godišnje u Evropi generiše od 2 do 15 kilograma otpada po osobi. Najveći proizvođači tekstilnog otpada u Evropi su Belgija, Češka, Portugal, Italija, Austrija i Holandija. Samo 20% otpada od odeće se prikuplja na globalnom nivou za ponovnu upotrebu ili recikliranje. Preostalih 80% se deponuje ili spaljuje, što dovodi do velikog gubitka energije i sirovina.*

Ključne reči: *tekstilni otpad, reciklaža, deponovanje, održivost*

1. INTRODUCTION

Historically, the development of society has been closely related to the development of textiles and their use. Every segment of our daily life, in one way or another, influenced by the textile.Textiles are used in different segments of our lives, such as: clothing industry, interior design, agriculture, construction, transport, medicine, etc.. Textile industry is one of

the oldest, most important and most complicated production industries. The textile industry consists of a number of sub-sectors, which cover the entire production cycle: from production and preparation of raw materials (chemically produced fibers), to the production of linear and two-dimensional textile structures (yarns, woven, knitted and nonwovens materials with their finishing processes) and their processing into final products (clothes, home textiles, carpets and technical textiles).

World production of textile fibers has been growing steadily over the past few decades. In 1975, approximately 24 million tons of textile fibers were produced, 10.6 million tons of which were chemical fibers, while in 2010 the production of textile fibers increased 3 times (76 million tons, approximately 49.6 of which were chemical fibers). In the period of 2010-2020, the production of chemical textile fibers was steadily increasing and a total of 108.3 million tons of textile fibers were produced (Figure 1) [2].

As it can be seen from the data in 2020 (Figure 1), the amount of synthetic fibers is significantly higher and amounts to 80 million tons while the production of natural fibers is about 3 times lower and amounts to 27.4 million tons.

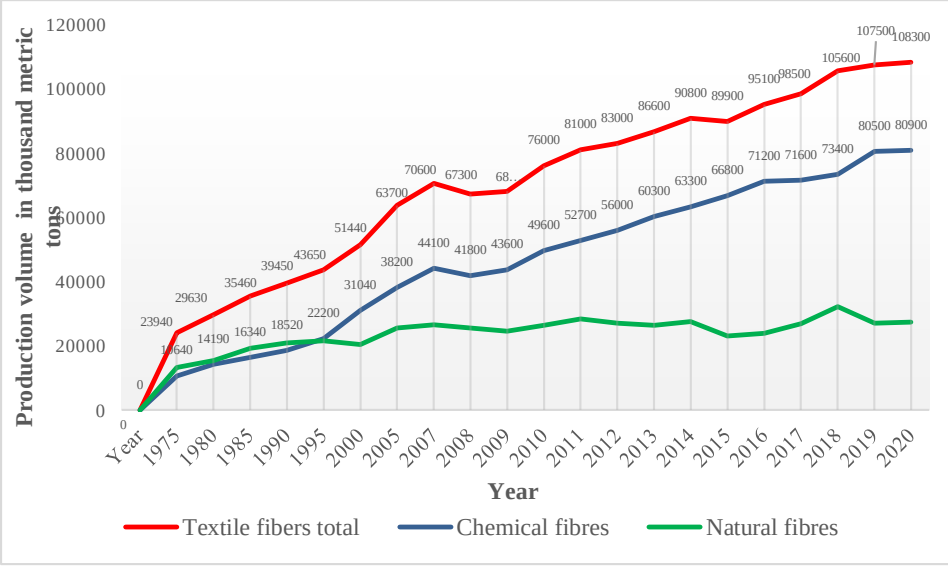

Figure 1: World production of chemical and textile fibers from 1975 to 2020 (in 1,000 metric tons) [2]

Natural fibers participate with about 30% (cotton - 24.2%, other natural cellulosic fibers - 6%, animal fibers – 2 %), while the remaining 70% are chemically produced fibers. Synthetic fibers make up 62.2% of world fiber production (polyester - 52%, polyamide - 5%, other

synthetic fibers - 5.2%). Artificially modified cellulose fibers (viscose) account for 6% (Figure 2) [3].

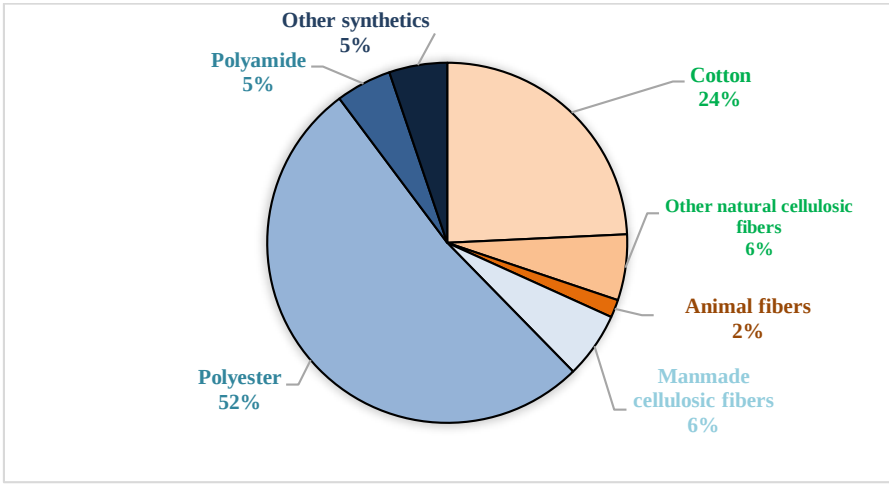

Figure 2: Distribution of world production of textile fibers in 2020, by type [3]

Increased demand and consumption of fiber is a result of global population growth and rising living standards. Textile fiber production and consumption are projected to continue to grow and global fiber production is expected to reach 156 million tonnes by 2030. In general, textile fibers are most widely used in the following three categories: clothing, household textiles and technical textiles. Most of the textile products have a short service life (for example, consumables) to textiles with an average shelf life (for example, clothes, carpets, car interiors, etc.).

The European region as a whole remains one of the world's leading manufacturers of textiles and clothing. The value of the production of textiles and clothing in 2018 amounted to 146.2 billion euros (production of textiles - 77.4 billion euros and production of clothing - 70.0 billion euros). The largest producers of textiles and clothing are Italy, Germany, France, Spain, Portugal, Great Britain, Belgium, Poland, Romania and Austria. Southern EU countries contribute more to total production of clothing. While northern countries such as Germany, Belgium, the Netherlands and Austria contribute more to the production of textiles, especially technical textiles.

Belgium is the main European manufacturer of carpets with more than 30%, while 24% of technical textiles in Europe are produced in Germany. Austria is a leader in the production of cellulose fibers. Italy is the leading European country in the production of clothing with about 45% [4].

Many of the processes and products associated with the modern way of life have negative effects on the environment, and have caused a rapid increase in the amount of generated textile waste.

Generally, textile waste can be classified into two groups: pre-consumer or post-consumer waste. Pre-consumption waste consists of by-products created by the fiber and textile industries, which are recycled and used again to produce yarn, clothing, mattresses, furniture, paper, technical textiles for the needs of automotive, furniture and other industries. Post-consumer waste is defined as any type of clothing or household textile that the owner no longer needs and has decided to dispose it. These products are discarded because they are old, worn, damaged or old fashioned. Old clothes are sometimes donated to charity organization [5, 6].

2. THE SITUATION WITH TEXTILE WASTE IN EUROPE

Textile waste is a significant problem, as 2 to 15 kilograms of waste per person are generated annually in Europe. In 2021, the total population of the European Union was approximately 447 million [7]. The constant increase in the number of inhabitants means higher consumption of textiles, and consequently larger quantities of textile waste.

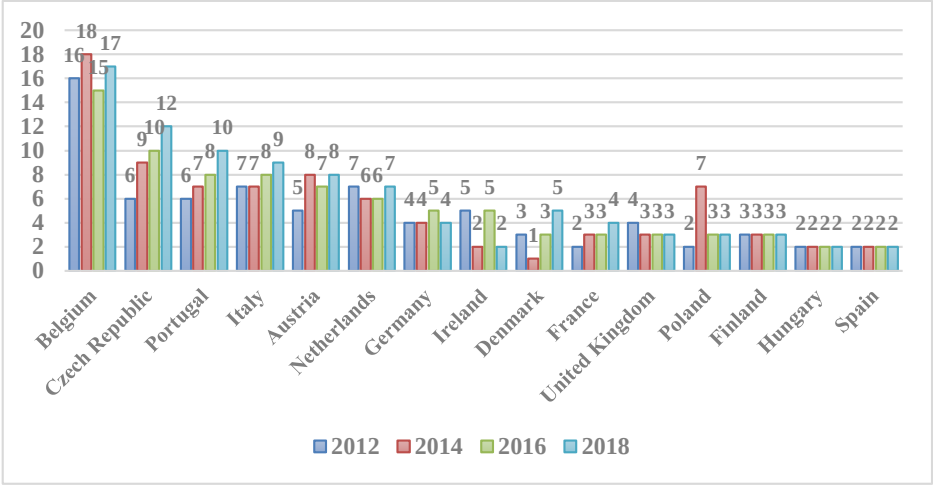

Figure 3: Total amount of textile waste per person in the European Union in 2012, 2014, 2016 and 2018, by country [9]

According to the data on waste generation in the countries of the European Union (EU), Italy is on the first place in the generation of textile waste (in 2016 the total amount of textile waste was close to 466 thousand tons). After Italy, Germany, France and the United Kingdom

are among the largest producers of textile waste in the EU, each with over 200 thousand tons of landfilled textile waste [8].

But if we take into account the number of inhabitants, then Belgium has the largest amount of textile waste per capita with 17 kilograms per person in 2018 year. Belgium is followed by the Czech Republic, Portugal, Italy, Austria and the Netherlands (Figure 3) [9]. In 2018 Germany and France had 4 kilograms of generated textile waste per person.

As it can be seen during the analyzed period (2012-2018) in some countries (Belgium, Czech Republic, Portugal, Italy, Austria, Denmark, France) there is an increase in the amount of generated textile waste.

On Figure 4 is presented the total amount of generated textile waste per person in other country in Europe for the same period from 2012-2018 year [9]. The largest increase in the amount of generated textile waste was observed in Kosovo from 4 to 16 kg per person. In the Republic of North Macedonia and Serbia the amount of generated textile waste in 2018 is 2 kg per person.

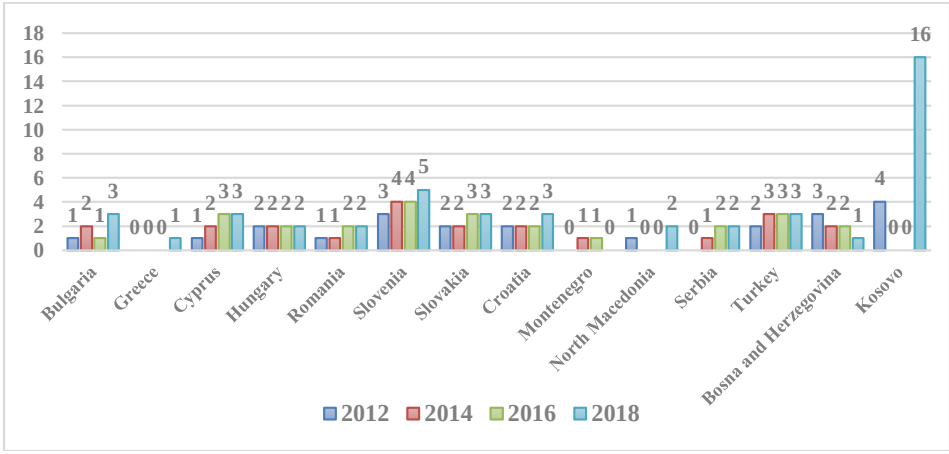

Figure 4: Total amount of textile waste per person in other country in Europe in 2012, 2014, 2016 and 2018 year [9]

The data clearly show that the largest producers of textile waste in Europe are Belgium, Czech Republic, Portugal, Italy, Austria and Netherlands. Only 20% of clothing waste is collected globally for reuse or recycling. The remaining 80% is deposited or incinerated, resulting in a large loss of energy and raw materials. On Figure 5 is presented the total quantity of landfilled textile waste per person in the European Union countries, in 2016 [10]. The data show that in 2016, the largest amounts of textile waste were landfilled in Belgium with an average of 8.4 kg per person. In Portugal, Italy and Austria the amount of landfilled textile waste was around 4 kg per person.

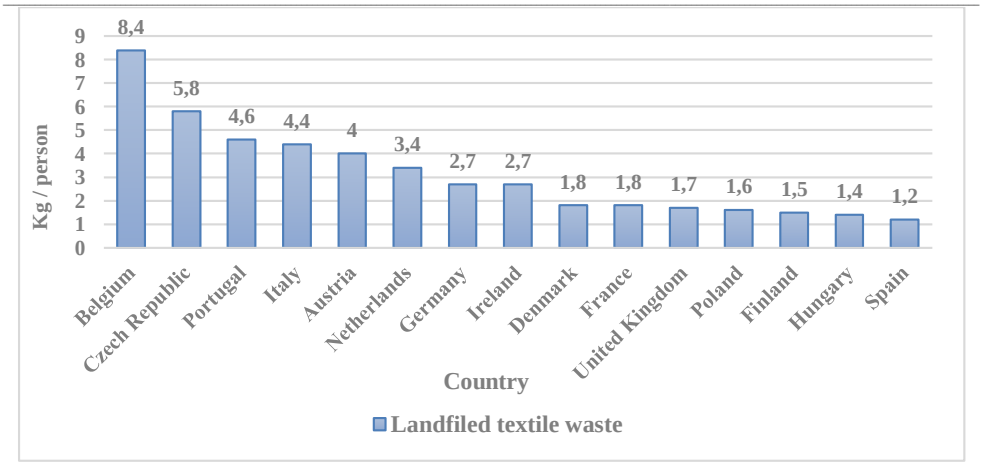

Figure 5: Total quantity of landfilled textile waste per person in the European Union (EU) countries, in 2016 [10]

According to the data on waste generation in the countries in European Union (EU) (Figure 6), Belgium has the highest percentage of textile waste utilization per person in 2016, with an average of 1.5 kg [11]. In Italy and Portugal, on the other hand, the amount of reusable textiles was 0.8 kilograms.

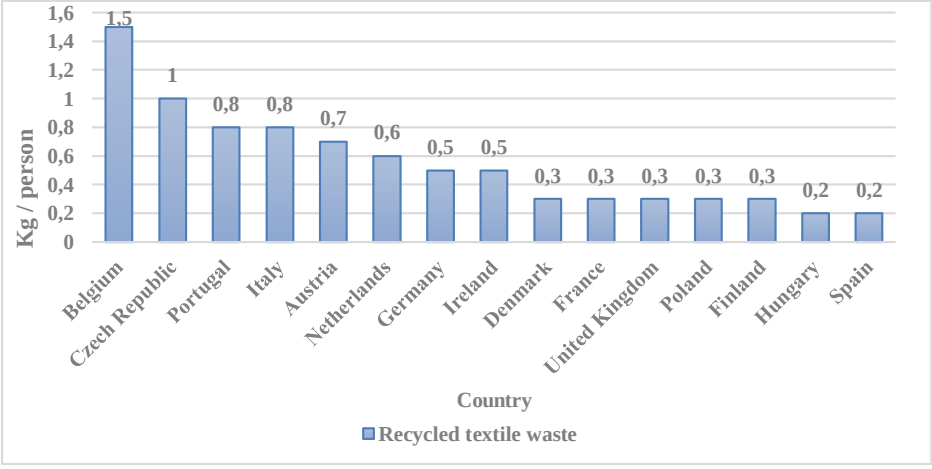

Figure 6: Total quantity of recycled textile waste per person in the European Union (EU) countries in 2016 [11]

3. POSSIBILITIES AND CHALANGES

The increasing quantities of textile waste, the pressure and energy in the processes of its disposal or incineration, performed properly or not, impose the need to introduce sustainable ways of textile waste management [12]. Sustainable ways of textile waste management will contribute to reduced waste generation, ie. more efficient use of raw materials and reuse of flows of production materials, reduction of disposal costs, which inevitably imposes the need to raise environmental awareness of waste generators.

Consumers should be aware that almost 100% of their used clothing can be recycled and that there are many different markets for used textiles and fiber production. By raising environmental awareness and environmental business ethics, steps can be taken to create a sustainable environment.

Restoring the flow of textile waste involves reusing products in their original form, common practice for clothing and recycling waste, and transforming it into a new product. Recycling technologies are generally divided into primary, secondary, tertiary and quaternary. Primary approaches involve recycling the product in its original form. Secondary recycling involves the processing of polymer products into new products that have lower physical, mechanical, and chemical properties. Tertiary recycling involves processes such as pyrolysis and hydrolysis, which convert polymer waste into basic chemicals or fuels. Quaternary recycling refers to the incineration of textile waste and the use of generated heat. All of the above approaches are used to recycle textile waste.

The dominant way to deal with textile waste is landfilling. There are several disadvantages associated with this practice: first, landfillis covers useful areas of land and requires payment of adequate fees, and second is leading to environmental pollution due to increased amounts of waste. Also, landfiling of textile waste creates material and energy losses.

Because textiles are almost 100% recyclable, nothing in the textile and garment industry should go to waste. However, the recycling process itself faces many challenges [12]. Unlike direct reuse, some recycling processes such as mechanical, chemical or biological processes involved in recycling waste to new products are associated with the consumption of a certain amount of energy, additional raw materials and the emission of waste materials into the air, water and soil. In reality, the recycling rate of textile waste is not very high [13, 14].

A common reason for this is the underdeveloped public awareness of consumers to participate in the recycling process as well as economic conditions. While legislation can easily upset the balance in favor of recycling, this coercive move can only have the opposite effect in terms of environmental protection. Given the heterogeneity of textile waste, the development of more energy efficient and less expensive recycling technologies requires cooperation with the textile and garment industry, legislation, adequate resources, labor and time.

The efforts of the textile recycling industry are aimed at recycling and reducing both types of waste: pre-consumer and post-consumer waste.

4. CONCLUSION

The constant increase in the number of inhabitants means higher consumption of textiles, and consequently larger quantities of textile waste. Textile waste is a significant problem, as 2 to 15 kilograms of waste per person are generated annually in Europe. Sustainable ways of textile waste management will contribute to reduced waste generation, ie. more efficient use of raw materials and reuse of flows of production materials, reduction of disposal costs, which inevitably imposes the need to raise environmental awareness of waste generators. Textile recycling and reuse are more sustainable than incineration and landfilling.
The textile recycling industry is a combination of different activities and numerous constituents (users and arbitrators of the textile recycling system) that operate within a socio-cultural system that influences the attitudes and behavior of citizens. Without an internal connection of the constituents the system does not work at full potential and may even cease to exist.The global economy, international trade laws, technological and engineering advances, cultural development, competitive conditions and infrastructure (including waste availability options) are also important factors.

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