WP T2 – INNOVATION ON TEXTILE WASTE MANAGEMENT

ACTIVITY A.T2.3 PILOT CASES

D.T2.3.2 PILOT CASES

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ENTeR - Expert Network on Textile Recycling

ENTeR works in five central European countries that are involved in the textile business, to promote innovative solutions for waste management that will result in a circular economy approach to making textiles.

The project will help to accelerate collaboration among the involved textile territories, promoting a joint offer of innovative services by the main local research centres and business associations ("virtual centre"), involving also public stakeholders in defining a strategic agenda and related action plan, in order to link and drive the circular economy consideration and strategic actions.

The approach of the proposal and the cooperation between the partners is oriented to the management and optimization of waste, in a Life Cycle Design (or Ecodesign) perspective.

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1. Pilot case description – aim and scope

The Pilot case "Generation of waste from manufacturing of technical textiles"

In Czech textile industry, the highest share (about 2/3) of the value of economic indicators in 2016 had the manufacture of other textiles (CZ-NACE 13.9) - mainly manufacturing of non-woven and technical textiles. Technical textile manufacturing grew in recent years by an average of about 10% per year; today, technical textiles represent a significant majority (65%) of the outputs and revenues of textile production in Czech Republic. With respect to the long-term dominant position of the production of motor vehicles in Czech economy, there is also growth in the production of respective intermediates, including production of technical textiles used, inter alia, in automotive industry.

Whereas the recycling technologies for processing of textile waste such as the old clothing or home textiles are traditional and well available in Czech Republic (almost mechanical technologies as cutting and tearing), the processing and utilization of waste from technical textiles are often difficult or costly due to their technical nature (coatings, laminations, composites ...). This type of waste cannot be processed by these traditional mechanical technologies.

The three Czech companies producing the heavy coated textiles are looking for the processing and reuse opportunities for their waste. Two of them (Company 1 and Company 2) are producers of the technical textiles for abrasive, printing and bookbinding sector. The third company (Company 3) is the producer of bathmats. The generated waste consists of selvedges (edge strips), cuttings, pieces of yardage textiles with or without coatings, or yarns and fibers.

2. Theoretical part

2.1. Technical textiles

Technical textiles are the materials and products which are manufactured primarily for their technical and performance properties either than thein aesthetic or decorative characteristics (1), despite of their raw material or manufacturing process. They are usually, but not always, manufactured by special materials on special machines. (3)

Techtextil, Messe Frankfurt Exhibition GmbH developed the classification system of technical textiles depending on their end use (2). According to this, technical textiles are generally classified into 12 categories according to application areas: Mobiltech, Indutech, Medtech, Hometech, Clothtech, Agrotech, Buildtech, Packtech, Sporttech, Geotech, Protech, Ekotech. (3)

Many various materials are used for manufacturing of technical textiles based on the desired properties of the end product. The used natural fibres include cotton, jute, silk and coir. The most widely used manmade fibres are viscose, polyester, nylon, acrylic/modacrylic, polypropylene, high density polyethylene (HDPE), low density polyethylene (LDPE), polyvinylchloride (PVC). (1)

Mobiltech (textiles used in transport) is a term for textiles used in construction of automotive, railways, ships, aircrafts and spacecraft. these coated and reinforced materials are used for example as truck covers (PVC coated PES fabrics), car trunk coverings (needle felts), lashing belts for cargo, seat covers, seat belts, air filters, airbags, parachutes, boats, air balloons (high tensile polyester), air

ducts, timing belts, engine sound insulation (non-wovens), car interiors. In aeroplane parts are used carbon composites; for manufacturing of higher end tyres are used the carbon fibres. (2)

The automotive industry is the largest user of technical textiles – about 20 kg of these is used in a car, whereas world-wide is produced about 45 millions of car annually. (3)

Indutech (Industrial textiles) covers the textiles used for chemical and electrical applications and in mechanical engineering, for example for sil-screen printing, filtration, plasma screens, propulsion technology, filtration, sound-proofing materials, roller covers, insulations, lifting/conveying equipment (high tenacity polyester, nylon, HMPE (high modulus polyethylene) yarns). Also the advanced materials like nonwoven nanofiber textiles may be used (micro-filtration). (1,2)

Medtech (Medical textiles) means all medical textiles used in health and hygiene application in medical as well as in consumer markets. (1) They are also known as healthcare textiles. This type of textiles is one of the fastest growing sectors in the technical textiles market. The consumption of Medical Textiles worldwide was 1.5 million tons in 2000 and is growing at an annual rate of 4.6% (3); in 2018, the global medical textiles market was valued at almost 16,7 million USD and is predicted to grow of 4.9% by 2025 owing to the rising geriatric population, ongoing technological advancements and stringent legislative Framework (10). This fast development is associated with the today´s societal changes like growing and aging population, growing diabetic and society aging or hazards of activities like transport accidents, sports, chemicals, fire, cold, diseases. (3, 10)

This type of textiles covers wide range of various products from gauze and bandage to scaffolds for tissue culturing or prostheses for permanent body implants; from products used in human hygiene or medical practise. The areas of use include wound healing, controlled release, barrier material for infection control, bandaging and pressure garments, hygiene materials, implantable and medical devices, development of new intelligent textile products. (3)

The most important properties of materials for medical textiles are softness, lightness, flexibility, absorption or filtering. Materials used must be biocompatible; with good resistance to alkalis, acids and micro-organisms; with good dimensional stability, elasticity; absorption or repellence; air permeability. (3)

The present innovations in field of medical textiles are represented by nano-fibre based materials. Thanks to their unique properties as high surface area to volume ration, film thinness, nano scale fibre diameter porosity of structure or lighter weight they may be used for special medical applications including wound dressing, bone regeneration, carriers of various drugs to the specific sites etc. (3)

Hometech (Home textiles) are used in interior environment for decoration (curtains, table cloth) and furnishing fabrics, carpets, sun protection, cushion materials, pillows, fireproofing, floor and wall coverings, bathrooms textiles, mattress, components, stuff toys. The market includes also large area buildings, ships, caravans, buses. (2, 3, 12)

The commonly used fibres include both natural and synthetic as acrylic, viscose, wool, polyester, polypropylene, nylon and jute. (12)

The important required property of the materials is flame retardancy. This is achieved by use of inherent fire retardant fibres (e.g.modacryl) or through application of a coating with flame retardant additives (bromide of phosphorus compounds). (3)

Clothtech (Clothing components) include technical textiles for further processing to (intermediate) products in apparel and shoe industry like shoe fabrics, interlinings, lingerie, zip fasteners, elastic

tapes, labels, umbrella cloth, sewing threads. They are usually made from blends of polyester, modal, viscose and nylon. Multi-layer substrates are bonded by thermoplastic powders. (1, 2, 4)

Agrotech (Agrotextiles) are textiles used in agriculture – in horticulture, farming and other activities (3). The main target of thein use is to help with the growth and harvesting of crops and other foodstuffs. Some examples of use of agrotextiles are: preventing erosion; layer separation in fields; bets for plants, rootless plants, protecting grassy areas; sun screens and wind shields; packing materials and bags; shade for basins; anti-birds nets; grand and plant water management (2), insect repellent fabrics (to protect plants), temperature control fabrics (usually nonwoven fabrics designed to protect crops from cold, frost, insect and various environmental factors) (3).

In agrotextiles may be used synthetics as well as natural fibres – nylon, polyester, polyethylene, polyolefin, polypropylene, jute, and wool. Among them, the fibres extensively used are polyolefin together with jute and wool; jute and pool after some years degrade and act as the natural fertilizer.(3)

The essentials properties required for agrotextiles are strength, elongation, stiffness, bio-dedradation, resistance to sunlight and to toxic environment (2), resistance to microorganisms, lightweight.(3)

Buildtech (Construction textiles) segment comprises textiles or composite materials used in the construction of permanent and temporary buildings; structures such as architectural membranes, tarpaulins, awnings, scaffolding and nets sired; construction concrete reinforcement; facade foundation systems; interior construction; insulations; proofing materials; air conditioning; noise prevention; visual protection; sun protection; building safety; roof construction. The used materials include PVC of PTFE coated high tenacity PES, Teflon coated glass fibre fabrics, silicone coated PES, aramid, carbon and glass fibres, combined with cross-linking resin systems to form a composite. (2, 6)

They offer mechanical properties such as lightness, strength and resilience as well as resistance to many factors such as creep, degradation by chemicals and pollutants in the air or rain and other construction material as well as the effects of sunlight and acid. (5)

Packtech (Packaging textiles) include several flexible textile packing materials intended for to be used for packing of goods. The examples are the polymer based bags for industrial packing, jute based sacks used for packaging food grains, tea and coffee bags, nonwoven insert, knitted net packaging, silos, containers, lashing straps, canvas avers, marquee tents. (2, 3)

Packtech products can be made from spinning, weaving, knitting and non-woven processes. (12) Here are some examples of packing materials. Polyolefin (HDPE/PP) woven sacks are used in packing of cement, fertilizers, thermo plastic raw materials, food grains, salt or sugar etc.; the bags are made by sandwiching PP and HDPE. Flexible Intermediate Bulk Containers (FIBC, Jumbo Bags) can be made from polypropylene woven fabric which can be coated or uncoated. The Leno bags used for packing of fruit and vegetables like citrus fruits, potato, onion, cabbage etc. are made of netted fabric of virgin polypropylene with colour masterbatch. Wrapping fabrics are made from HDPE/PP, cotton canvas etc.; unlaminated PP/HDPE woven fabric is mainly used for wrapping of paper rolls, tyres, yarns cones etc. The jute sacks intended for packing of materials which do not need special protection are made of heavy jute fabrics. Tea bags sold to the end-consumers consist of a filter paper pouch with a thread, which holds the tea powder and a tag; tea bag filter paper is made with a blend of wood and vegetable fibres (bleached pulp abaca hemp). (7)

Sporttech (Sport textiles) are used for production of sportswear, swimming costumes and shoes; artificial turf used in sport surfaces; sleeping bags, ballooning and parachute fabrics. (3) Their

function may be e.g. to take moisture away from the body; to sense heart rate, temperature and other physiological data. Sports textiles fabrics have a very high electrical conductivity to permit the effectual dissipation of electrical charge; should be light as best as possible; must be highly effective in moisture management; should have good perspiration fastness, heat conductivity and be ultra-breathable. (8)

Geotech (Geotextiles) are any permeable textile material from woven, non-woven, knitted or stitch-bonded fibres or yarns used in civil engineering, construction work, earth and road construction, dam engineering, soil sealing, drainage systems etc. with the purpose to increase stability and decrease wind and water erosion. They are used with soils which have ability to separate, filter, protect or drain. The fabrics must have the following characteristics: good strength, durability, low moisture absorption, thickness. (2, 9, 12)

A geotextile has to be permeable to allow the flow of fluids through it or in it; may be made of synthetic or natural fibres. In contrast, a geomembrane is a continuous membrane-type liner or barrier which shall be able to control migration of fluid in a constructed project; it is designed to restrict the fluid flow. (9)

The used materials may be nonwoven and woven, from synthetic fibres like glass, polypropylene, acrylic fibres, polypropylene and polyester. (2) Natural fibre geotextiles (e.g. Loir, jute) degrade and form an organic mulch; thus help in quick establishment of vegetation. (9)

Protech (Protective Textiles) are the textiles designed to improve people safety in their workplace. They are mostly used for manufacturing of PPE (personal protective equipment). Textiles must comply with many standards and regulations (e.g. defined by ASTM and ISO) to be considered as a technical protective fabrics. This type of technical fabrics can protect of high temperatures, burns, electric arc flask discharge, molten metals, metal sparks, acids, bullets impact; it includes as well cut resistant clothing, astronaut´s suits. (1, 2) Protective textiles and protective clothing are classified in 15 types: high-temperature protective textiles, chemical protective textiles, mechanical protective textiles, flame-resistant protective textiles, UV protection finish, metalized fabrics, high visibility textiles, radiation protective textiles, protective health care garments, clean room technology, biological protective textiles, ballistic protective textiles, space suits, breathable fabrics, electrical protective textiles. (11)

Protech products can be manufactured from woven, knitted, non-woven, coated, laminated or composite materials. (12) The fibres used to manufacture this type of textiles include e.g. meta-para aramides, carbon, wool viscoses polyamide, glass fibres, modacrylic cotton or polyamide (Kevlar), PTFE, acrylic, nylon, polyester, polypropylene, polybenzimidazole, ultra-high modulus polyethylene, spandex, flame-resistant cotton/polyester/viscose, wool, cotton, hemp, linen etc.. (2, 11, 12). The special functional finishing may be provided to this textiles to achieve the required protective effect.

Ekotech (Ecological Protection Textiles) are used in environmental protection applications like floor sealing, erosion protection, air cleaning, prevention of water pollution, water cleaning, waste treatment/recycling, depositing area construction, product extraction, domestic water sewerage plants. (2) The primary segment is landfill waste management (use of geosynthetic fabrics to prevent leakage of municipal or hazardous waste from landfills. Other application area include secondary protection in chemical and oil industry (ground covers preventing of tanks leaks). (1)

This textiles shall comply with some material requirements as permeability, high strength and modulus, good dimensional stability, good abrasion resistance, resistance to fungal attack and rooting,

UV resistance or good durability. These textiles can be woven, knitted, non-woven. Both natural and synthetic fibres are used in manufacturing; some of the used fibres are acrylic, nylon, polyester, polypropylene, polyethylene, jute, hemp, flax, kenaf etc. (12)

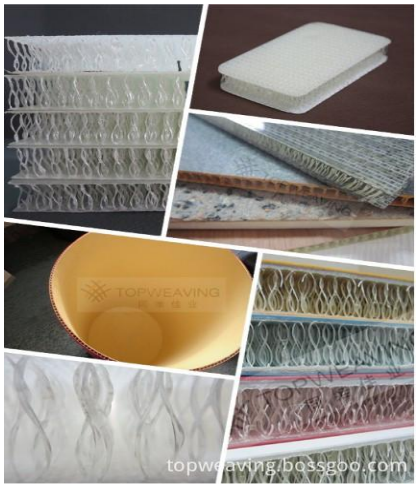

Fig. 1: 3D Fiberglass Sandwich Fabric (13)

Fig.2: Smart Electronic fabric (14)

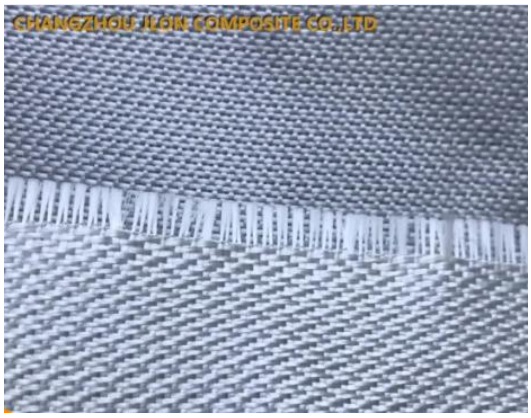

Fig.3 Fiberglass Textile for Insulation (15)

Fig.4 Technical textile for automotive (16)

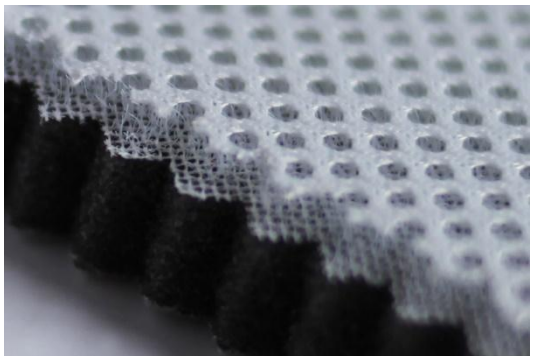

Fig.5 Technical textile (with PU foam) (16)

Fig.6 Silicone coated Fiberglass cloth (17)

2.2. Recycling of technical textiles

As described in the previous chapters, technical textiles are very complex and valuable products with special technical properties and characteristics, achieved thanks to the type of used fibre, fabric structure or chemistry applied on the textile substrate. Often the textile is consisting of various coatings, laminatings, sandwich structures with both textile and non-textile (metal, glass, plastics) materials, foams. Whereas the traditional mechanical recycling technologies as tearing or cutting are feasible for processing of "common" textiles as end-of-life clothing, in case of technical textiles the product specific recycling method may be needed for individual kinds of technical textile products.

There are many projects in the world focusing on innovative recycling of individual types of technical textiles. Some of them are described bellow:

The Slovak company PR Krajné has developed the patented technique called **STERED** for recycling of synthetic fabrics - carpets and upholstery from end-of-life vehicles, offcuts from new car production and of a pulp from recycled old tyres. The resulting STERED building blocks can be used as acoustic and thermal insulations and – thanks to its capability to retain water – as a base for "green roofs" allowing growth of grass and plants. These products are succesfully available on the market, between 2012 – 2017 the company processed more than 1 780 tonnes of automotive textiles and the demand is increasing. (18)

RECYCOAT project (2018 - 2020) funded by VLAIO (Flanders Innovation & Enterpreneurship) aims to study separation of the different layers in complex, coated or laminated materials by various technologies. Based on the results, the addressed companies involved in production and use of the chemicals (coating formulations, binders, adhesives, solvents etc.) and of coated textiles should gain understanding in various separation technologies, to be able to select the appropriate technology which should lead them to the development of coated or laminated products with layers which can be separated and thus become recyclable. The goal is the development of a good design of the coating or adhesive layer and its chemistry, to allow maximum separation of different layers. (19)

The new Horizon 2020 project **DeCOAT (**started in February 2019) addressing the recycling of coated and painted textile and plastic materials. The main goal is to enable recycling of textiles and plastics with "multilayer" coatings, which are typically not recyclable yet. These coatings include the fiuctional and performance coatings and paints and adhesion layers. The novel smart polymer material systems and the corresponding recycling processes will be developed. The solutions will be base on smart additives (microcapsules, microwave triggered additives) for the coating formulations which will be activated by a specific trigger (like heat, humidity, microwave or chemicals). (20)

The project **REMAKE (2015-2017)** was an australian project aiming to explore cost effective recycling of vinyl (PVC) coated PES fabrics, namelly advertising billboard skins. This type of coated fybric used as advertising billboards was used to be landfilled in Australia. Using the traditional mechanical separation techniques, the residual cross contamination of the two polymers are left which reduce usability of the polyester and PVC recyclates; the process also involves granulating the material which results in very short polyester fibre lengths, further reducing the reusability of the polyester. The project aims were: to study whether it would be feasible to reprocess the material as a composite (PES fibres would be a beneficial part of the recycled material) or whether the PVC and PES had to be separated; to find local manufacturers and products applications for use of large volumes of the resulting reprocessed material. Within the REMAKE project, several product design and reprocessing options were explored and developed, comprising the reprocessing the material as a composite (not separating PES form PVC), mechanically separated PVC to achieve PVC with < 3% of PES , chemical separation (through a mechanical and catalyst-initiated process), chemical engineering research (analysis and

characterisation of the recyclates , a number of product concepts and prototypes. One of the product concepts developad within this project – the recycling of vinyl coated fabrics into roof tiles – was further developed within the project called **VesrsTile.** (21, 22)

The project **Move4earth** (LIFE+, 2012 - 2017) aimed to design, implement and validate an innovative recycling process of the silicone-coated polyamide fabrics from airbag cushions into high-quality polyamide 6.6 grades and to explore possible applications for the silicone coating by-product separated from polyamide fabric. The technology for separating the airbag fabrics from the coating was developed by company Solvay, one of the project partners. (23, 24)

In Europe, an innovative solvent-based process founded by Solvay called **Vinyloop** was developed to recycle PVC coated fabrics in a scheme called Texyloop. The process was based on dissolution, filtration and separation of contamination in order to separate PVC from the other materials as wood, metal or textile. The VinyLoop process has been selected to recycle membranes of different temporary venues (rroofing covers) of the London Olympics 2012. The operation plant was launched in 2002 in Ferrara (Italy); since the process could not remove low molecular weight pthalate plasticizers during recycling, tightening EU regulations meant the recycling ceased the operations at plant in June 2018. (22, 25)

The serbian national project **IZORETEX** aimed to develop a new thermal and acoustic insulation building material based on recycled textile waste from automotive industry. The resulting composite insulation material called IZORETEX is a insulation material for light building structures. It combines three main features – thermal and acoustic insulation and vibration resistance; it is resistant to water vapor or moisture as the primary material is the high quality polyesterr and polyurethane used for seats and headrests for cars. IZORETEX is a granulate in form of flakes of textile leftovers that remain from tailoring car cover after cutting shapes for seats and headrests. The additives and flame retardants present in this fabric provide better durability and protection from insects and parasites. The insulation is applied by injecting into the holes and interstices of walls.(26)

2.3. Czech pilot companies

Company 1

The company produces the base abrasive-emery cloths. The cotton fabrics are coated with starch-glue coating or with synthetic coating based on polyvinylalcohol or resins. The company has own in house weaving capacity and and produces the materials for use in their cloth backing production. In addition to cloth backings for abrasives, they offer coated materials with waterproof and fireproof finishes for home and industrial applications.

The company faces problems with reuse of the pieces and cuts of selvedges of coated cloths (dyed and not dyed); with respect to the chemical composition of the coating pastes, reuse of this type of waste seems to be difficult.

Company 2

The production profile of the company covers dyeing, printing, coating and laminating of textiles. They produce include materials for printing (bookbinding cloths, layered papers amd fabrics adapted for printing and security documents, laminated fabrics and papers for production of passports, print media – printable canvas etc.), base fabrics for abrasive cloths or special projects according to the customers demands.

These textiles are dyed or printed fabrics with various types of coatings or laminated with other material (paper). The composition of the material (backing with other materials, heavy coating) makes the recovery and reuse of the textile waste difficult.

Company 3

The company focuses on production of the bathroom accessories. Their production covers all steps starting from the production of the input material – polyacrylic yarn through tufting of yarns into the PP textile to coating by latex or hot melt.

3. Catalogue of the waste covered by the pilot case

The general description is provided in the text bellow. The details are available in deliverables "D.T2.3.5. Pilot Cases – Milestone" and "D.T2.3.3. Pilot Cases Technical report_INOTEX technical textiles".

Company 1

The company produces several types of textile waste.

The waste of yarns from warping is currently reused: residues of yarns on warping bobbins are rewinded on another bobbin and further used as weft; in case of yarns where rewinding is not suitable, the residues are manually removed from the tube and sold for further processing. Other type of textile waste produced in a company are fabric pieces and cuts of selvedges of grey sized fabric coming from weaving; this waste is sold to producers of shredded rags.

The cuts of selvedges of grey sized fabrics coming from weaving are reused by third party.

The company faces problems with fabric pieces and cuttings of coated fabrics (dyed or not dyed); the coating is composed of starch or various polymers (resins, acrylics,...); they are seeking for a solution of this waste; in the past, the company sold for reuse cuttings of dyed cloths with starch coating (reused by external comany as a filling material for punching bags), but actually they don´t have market for this waste. Also they don´t have any solution for waste of textiles with polymeric coatings (resins,acrylics, ...). Company disposes annually 79 tonns of this waste of coated textiles by landfilling.

Company 2

Textile waste produced by the company are in a form of cuttings (selvedges of the fabrics and defective parts). This waste is composed from dyed or printed textile fabrics (cotton, viscose, polycotton) with various types of coatings or laminated with other material (paper). Chemical composition of the coating is variable, according to the technical specifications of the product (acrylic, styrene-butadiene, starch).

The company didn´t seek for a solution for their waste yet. They dispose annually about 500 tonnes of textile waste by landfilling.

Company 3

The produced textile waste include polyacrylic fibres; yarns (PA, PES); cuttings of the bathmats (PA, PES together with PP textile) with or without the SBR latex back coating.

Currently, the annual production of textile waste is about 2000- 3000 kg of waste of fibres; 6000 –

8000 kg of yarns; about 5000 kg of cuttings (yarns + PP textile) without the coating and approx. 20 000 kg of cuttings consisting of yarns, PP textile and SBR latex back coating. All waste is disposed to the landfill.

The company reported the urgent need to look for a solution for their waste, mainly in case of textiles containing the latex coating.

4. LCA of the textile waste covered by the pilot case

4.1. Environmental characteristics

The waste covered by this pilot case included the strips, cuttings and pieces of fabrics with various coatings. In all cases, the used coating chemicals were water-based systems based on starch, acrylic resins, polyurethane or SBR dispersions.

Poalyacrylates and polyurethanes belong to the polymers mainly used for coating of textiles. Polyacrylates usually consist of copolymers of acrylate and methacrylate esters with other unsaturated monomers (e.g. styrene); these resins are available in solid form, dissolved in organic solvents or as a dispersion in water. Choise of the monomers allows the wide variation of properties (physical, chemical) properties of the resulting polymers. Polyurethanes can be used in solutions or in dispersion form. (41)

In both pilot companies (Company 1 and Company 2), dyeing and coating (resp. backing) of the fabric is applied to the fabrics. From dyeing operations, the waste water is produced and discharged to be treated on municipal wastewater treatment plants. During coating, any wastewater is not produced.

The textile waste from coated textiles is not dangerous for environment on it´s own. The environmental burden is its landfilling or incineration and the lack of a solution for its recycling.

Both companies stated that the dispose their post-production textile waste by landfilling. Degradation of wastes in the landfill results in the production of leachate and gases. The landfill gas contains mainly methane and carbon dioxide, both important greenhouse gases, and can also contain many other gases at low concentrations, some of them are toxic. The environmental impacts of the landfill gas components include the contribution to such effects as global warming, acidification, depletion of the quality of ecosystem. Leachate can migrate to groundwater or surface water. There are also the substantial environmental burdens associated with waste transport and collection. (43)

4.2. Environmental impact assessment

Process:															
Environmental impact	Energy consumption			Waste generation			Air pollution			Water pollution			Soil contamination / usage			Total
Value of the stage	1 - Process or method with low energy consumption	2 - Average energy consumption	3 - Large consumption	1 - Little waste, no hazardous	2 - Average waste, no specially high volumes or risks	3 - High volumes, also hazardous waste	1 - No air pollution at this stage	2 - Some air pollution, but not considerably high	3 - Considerable air pollution	1 - No water pollution at the stage	2 - Some water pollution under control, (treated)	3 - The process often pollutes water, or high risk of that exists	1 - No potential to contaminate soil	2 - The process potentially pollutes the soil, but it is not likely	3 - Frequent occurance of normal or accidental soil contamination	Sum up the values in the row
Stages	Before/After			Before/After			Before/After			Before/After			Before/After			
Extraction of resources	3/3			3/3			2/2			2/2			1/1			11/11
Transport of resources	3/3			1/1			3/3			1/1			1/1			9/9
Storage of resources	1/1			1/1			1/1			1/1			1/1			5/5
Manufacturing, assembly	3/3			2/t.b.d.			2/2			2/2			1/1			10/ t.b.d.
Storage of finished products	1/1			1/1			1/1			1/1			1/1			5/5
Use, useful life	1/1			1/1			1/1			1/1			1/1			5/5
Waste transport	2/2			1/1			2/2			1/1			2/2			8/8
Waste disposal	1/1			2/t.b.d.			3/ t.b.d.			2/ t.b.d.			2/ t.b.d.			/ t.b.d.

4.3. Conclusions

The life cycle of the product from coated technical textiles can be split into certain main stages, as described in the table above. Comparing the two scenarios – production of the coated fabric without or with recycling / upcycling of textile residuals from manufacturing, the differences can be identified only for the end-of-life phase.

In general, the environmental impact of the end-of-life phase are small compared to the other life cycle phases (production, distribution, use). The environmental benefits of the post-production textile waste recycling / upcycling are connected to the fact that the environmental burdens associated with manufacture of a new product can be avoided. The benefits can be also due to the avoided disposal of wastes impacts of whose are higher than impacts of the recycling processes themselves. (42)

The end-of-life phase includes reuse, recycling and final disposal (incineration, landfilling) of textile post-production waste. Both pilot companies stated that they dispose their post-production textile waste by landfilling. Therefore, when upcyclig of a part of the waste would be applied, environmental impact of the landfilling would be decreased. The level of the impact depends on the achieved solution. However, as described in the deliverable "D.T2.3.3_Pilot Cases Technical Report_INOTEX technical textiles", the succesfull solution for the coated textile waste was not found within this pilot case; although some verification testing is still ongoing.

5. Identification of the companies in the partner region with similar waste streams

The highest share of the Czech textile industry production is represented by manufacturing of non-woven and technical textiles, mostly for automotive industry and various technical applications.

Together with the pilot companies mentioned in the chapter 2.3., following companies are leaders among producers technical textiles:

Adient Strakonice s.r.o., Strakonice - manufacture and supply of fabrics for the automotive industry (auto-textiles) including: car seat covers, automobile door panels, head restraints for cars, armrests for cars, rear plates of cars, rubber-textile car mats etc. (27)

Bentex Automotive a.s., Benešov nad Černou – production of fabrics for the automotive industry (auto-textiles): seat upholstery, armrests, head restraint covers (28)

HEDVA a.s., Moravská Třebová – the product portfolio includes polyester and polyamide fabrics for sports and leisure activities (parachutes, hot-air balloons, sportswear, tents, sleeping bags, motorcycle clothing, footwear, luggage, backpacks); work and protective clothing (high visibility, cleanrooms, antistatics, surgical gowns, antibacterial); fabrics for trade fair buildings, protection against the sun, parasols or garden furniture; fire-resistant PES fabrics. (29)

INTERCOLOR a.s., Červená Voda – the company operates its entire business in the form of wage labour; they offer to their customers production capacities in dyeing and treatment of fabrics, knitted fabrics orgarment, printing of knitted and woven fabrics and coating of textile materials. Concerning the coating capacities, the company provides to ist customers the application of water-based chemicals (acrylic, PUR, flame retardant, hydrophobic) in form of coating pastes or foams. (30)

Koutný spol. s r.o., Prostějov – manufacturer of the garment for men. Together with men´s fashion as suits, shirts or coats they also produce the field and walking uniforms, special intervention clothing, overalls, vests, suits, jackets, trousers and many other products; the textile materials for these products are the technical textiles with special characteristics as i.e. sofshell, knits with antistatic fibers, kevlar, 2 and 3 layers laminates with sealed seam technology or waterproof zippers. (31)

Nanomembrane s.r.o., Svitavy – the company developis unique membrane laminates with special properties such as extremely high vapor permeability, high water column resistance and 100% wind resistance. These special laminates with membrane are intended for manufacturing of sports and outdooror goods, fashion , shoes, gloves or protective clothing for armed forces, police, civil forces and others. (32)

SILK & PROGRESS spol. s.r.o., Moravská Chrastová – manufacturer of technical screens,home textiles, warp knitted fabric, parachute fabrics, antistatic fabrics with carbon and metal yarn, peel plies, fabrics for special purposes (camouflage fabrics, products for army, other armed force, uniformed services, rescues forces, PPE clothing), fabrics for technical purposes (bags, advertising, marquises, funerals,theatre decorations) etc. (33)

SINTEX a.s., Česká Třebová – producers of yarns, knitted fabrics, fabrics with special characteristics (i.e. antiabrasive, antistatic, chemically resistant or other technical fabrics for

protective clothing), filters and clothing (sportwear, functional undrewear, protective clothing). (34)

STAP a.s., Vilémov u Šluknova - the company is one of the largest European manufacturers of elastic, inelastic ribbons and zippers or straps. (35)

SVITAP J.H.J. spol. s r.o., Svitavy – the product portfolio includes home textiles; fabrics for tents, halls and shelters; foils and covers; packaging materials; artificial leathers and membranes; civilian and military fabrics. (36)

TOMATEX Otrokovice, a.s., Otrokovice – production of weft kntwear, textile materials for footwear, automotive and apparel, laminating door panels and armrests. (37)

Toray Textiles Central Europe s.r.o., Prostějov – fabrics for production of airbags. (38)

VEBA, textilní závody a.s., Broumov – their portfolio of technical textiles covers 2D, 3D and multiaxial woven structures of technical fibers for a wide range of applications in various industries.(39)

ZITEX s.r.o., Jičín – producer of filters (filter sheets and plates), technical and sport clothing and textile packaging products. (40)

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