ASSESMENT OF ECO-CRITERIA IN TERMS OF SUSTAINABILITY APPROACH IN TEXTILE SECTOR

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ABSTRACT

In this study, an integrated textile mill located in Turkey was investigated in terms of tests for product and environmental safety conducted to eco-criteria limits. 29 synthetic/cellulosic blended woven finished fabric tested acccording to the Oeko-tex test standards and 3 discharged treated wastewater samples were tested acccording to the Zero Discharge of Hazardous Chemicals (ZDHC) test standards. To widen the assesment on wastewater test results and to investigate the current situation of the similar production mills in textile industry, the Institute of Public & Environmental Affairs (IPE) database was examined and data has been compared with investigated mill's test result.

Key Words: Sustainable Production, Eco-Criteria, Hazardous Substances, Product and Environmental Safety

1. INTRODUCTION

The textile and apparel industry is one of the world's largest industrial sectors, both in terms of production and labor. With the increasing population, developing technology and changing life standards, textile production has increased significantly in recent years and it has a share of 28.2% from global trade. The woven fabric sector is one of the most important sub-sectors of the textile industry and has a share of approximately 25% in the total textile production [1]. Turkish apparel industry is in the second place within Turkey's highest five export sector with its 10% share of the 17.6 billion US Dollars trade volume in 2018 [2]. The major countries that produce synthetic/regenerated cellulose blended woven fabrics investigated in this study are China, India and Turkey (Harmonise System Product Code: 55.11.15) and this sector has 8,1% share in Turkey's export [3]. Turkey is a major supplier of global brands with its significant export share. Increased production, pressure on sustainable use of natural resources poses considerable impact on environment [4]. Producers based on sustainable-clean production methods need to certify that their products and processes are suitable for human and environmental health. Because dyestuffs and chemicals used in wet finishing processes and petroleum-derived synthetic fibers in the structure of raw fabric cause organic and inorganic pollution both in fabric and treated wastewater. For many years in textile sector scientific studies have revealed that a significant proportion of these substances, that remain in the fabric and discharged to the wasterwater are toxic. Common conventional treatment systems are generally unadequate for the treatment of industrial wastwater so the discharged treated wastewater creates a permanent, toxic and biological effect on human and environmental health.

The awareness of human health, product and environmental safety increased in 1990s and the first studies started in 1992 with STANDARD 100 by OEKO-TEX® and Responsible Care® Standard; Bluesign® in 2000; Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) directive in 2007; The Ecolabel in 2009 and followed by ZDHC wastewater standards that emerged together with the 2011 Detox campaign were among the eco-criteria to be complied with by manufacturers in the sector [5]. The change of parameters and limit values in years within the scope of eco-criteria in fabric/garment and wastewater are examined and summarized in Figure 1.

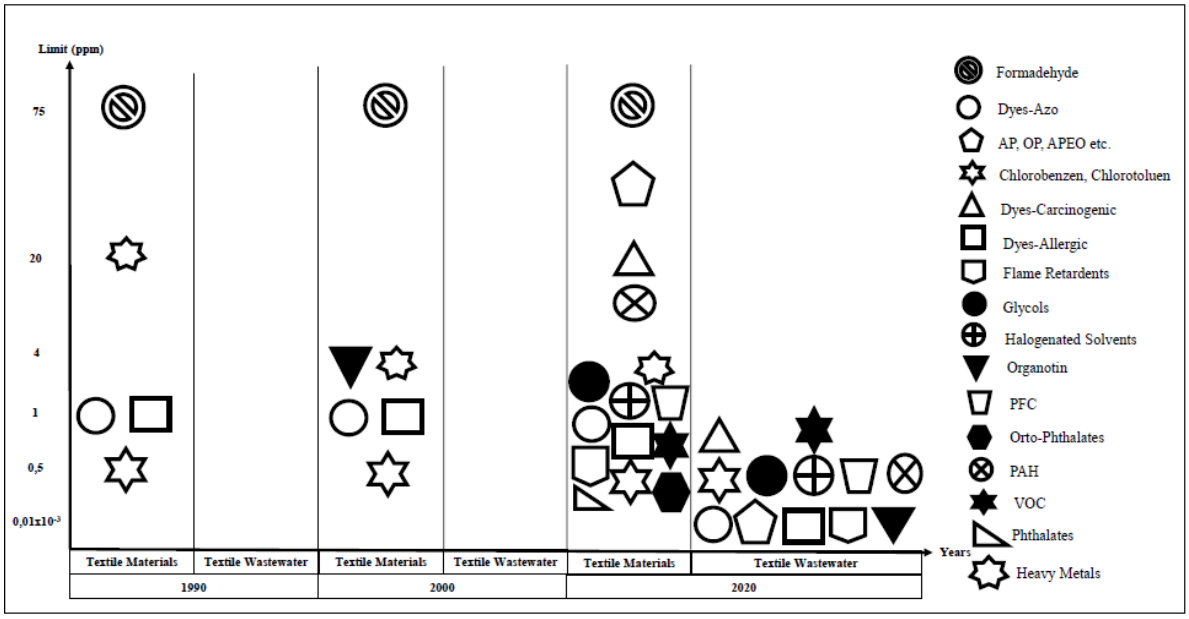

Figure 1. Change of eco-criteria in years

In this study, fabric and discharged treated wastewater test results of Can Tekstil has been investigated with the scope of eco-criteria. It has an annual 12 million meters of woven fabric production capacity and exports 70% of its production to Europe and the United States. The mill has a significant position within the woven fabric manufacturers in Turkey and targeting sustainable production and environmentally friendly technologies. With this awareness the mill was one of the first companies certified by STANDARD 100 by OEKO-TEX® in 1996. Till today the mill had an important role in national and international projects aiming sustainable and clean production. In 2018 the mill's project has been granted by TUBITAK (The Scientific and Technological Research Council of Turkey) and aiming the prevention, restriction, monitoring and zero discharge of hazardous substances at the source. In the first work package of the project, the outputs obtained from the current situation analysis and from the results of the hazardous substances assessment were examined within the scope of eco-criteria of this study.

2. APPROACH

Can Tekstil Integrated Mill has a ring-spinning, air-jet weaving, HT jet dyeing, wet&dry finishing technology and physical, biological wastewater treatment processes. Fabric production and wastewater plant flow diagrams are shown respectively in Figure 2 and 3. The mill uses groundwater for wet processing and treats the process wastewater in physical and biological wastewater treatment plant.

In this study, in 2017- 2018 approximately 2-3 meters of randomly selected samples from totally 29 synthetic/cellulosic blended woven fabrics; grab and 6-hour composite samples 2 of which represents incoming water and 3 of which represents discharged treated wastewater were tested with advanced analytical methods in an international accredited laboratory. Oeko-tex test standards in fabric advanced analytical tests and ZDHC limit values in wastewater advanced analytical tests were taken into consideration. Additionally, an open platform called IPE was established to create a water pollution database with governmental support in China in 2006 and datas from all over the World and Turkey's textile sector are investigated.

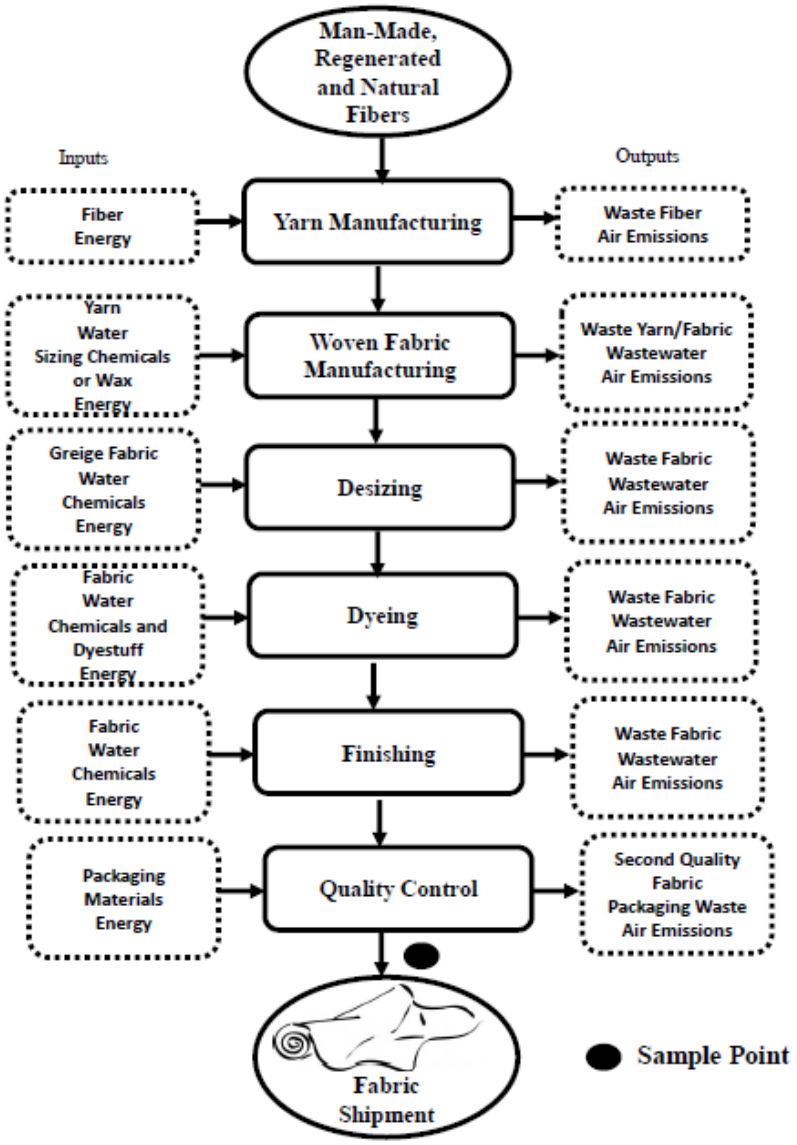

Figure 2. Flow diagram of investigated mill fabric production

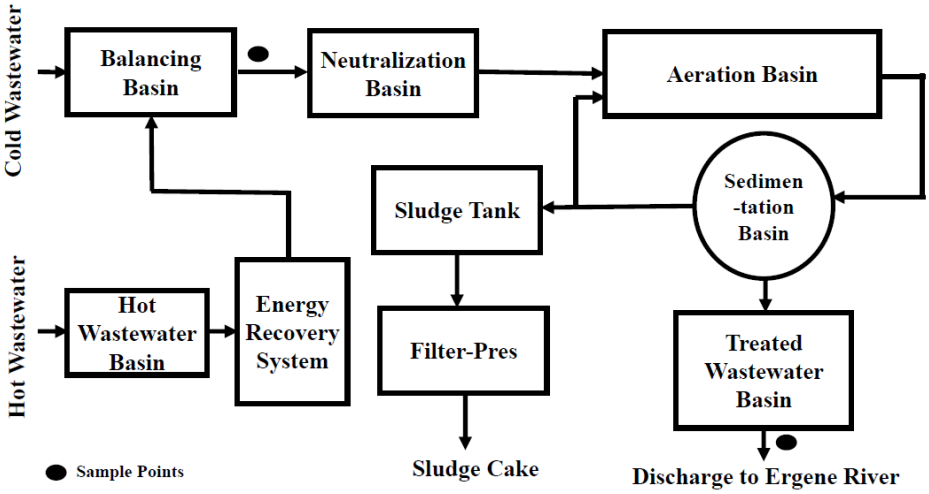

Figure 3. Flow diagram of investigated mill wastewater plant

3. RESULTS AND DISCUSSION

In this study, advanced analytical tests of 29 finished woven fabric with different compositions were carried out for 2017-2018, 21 of them were PES/CV/EA, 5 of them were PES/WO/CV/EA, 1 of them were CV/EA, 1 of them were CLY/CO and 1 of them CLY/PES. Among these samples, which were subjected to advanced analytical testing, hazardous substances "antimony" and "pentachlorobenzene" have been identified only in 19% of PES/CV/EA blended fabrics but measured values were below the Oeko-Tex Standard limit values [6].

Two hazardous substances were detected over the limit in the samples taken from 2 incoming and 3 discharged treated wastewater in year 2017-2018 according to the ZDHC 2020 aspirational limit values [7]. The value of "heavy metal-antimony" in all three samples; the value of "anilin" and "4-chloroaniline" were detected over the limit values in only one discharged treated wastewater sample.

For the textile sector in the IPE database of the same years, a total of 1101 units in the world; and a total 49 advanced analytical wastewater test results in Turkey. Within the investigated 19 wastewater test results, it highlights the presence of hazardous substances such as chlorinated aromatic hydrocarbons, chlorophenols, restricted sensitizing and carcinogenic dyes, brominated/chlorinated flame retardants, halogenated compounds, perfluorinated chemicals, phthalates, volatile organic compounds and heavy metals have been reported [8]. The test results comparison, found for investigated mill, with for other similiar mill's in the World and Turkey, declared in IPE, were given in Table 1.

Table 1. Test methods and comparison of the test results for fabric and discharged treated wastewater [6,7,8]

Hazardous and Restricted Substances	Test Methods for Fabric	Oeko-Tex Class- II Limits (ppm)	Test Results Investigated Mill (ppm)	Test Methods for Discharged Treated Wastewater	ZDHC Aspirational Limits (ppm)	Test Results Range for Discharged Treated Wastewater Investigated Mill (ppm)	Test Results for 19 Mill-Turkey (ppm)
Alkylphenol and Alkylphenol Etoxylates	ISO 18254	< 10-100	Not Detected	ASTM D7065, ISO 18857-2	0,005	Not Detected	Not Detected
Chlorinated Aromatic Hydrocarbons	DIN 54232	< 0,3	Pentachloro-benzene 0,2	EPA 8260 B, EPA 8270 D	0,0002	Not Detected	0,00004-0,022
Chlorophenols	ISO 17070	< 50	Not Detected	ISO 14154, EPA 8270 D	0,0005	Not Detected	0,000001-0,000002
Restricted, Sensitizing and Carcinogenic Dyes	ISO 14362-1	< 20	Not Detected	ISO 14362-1	0,0001-0,5	Anilin: 0,001; 4-Chloroanilin: 0,00037	0,0009-0,04
Brominated/Chlorinated Flame Retardants	Not Required	Not Required	Not Required	EPA 527, EPA 8321 B	0,005	Not Detected	0,01-0,45
Glycols	Not Required	Not Required	Not Required	LC-MS, GC-MS	0,05	Not Detected	Not Detected
Halogenated Compounds	Not Required	Not Required	Not Required	EPA 8260 B	0,001	Not Detected	0,000003-0,001
Organotin Compounds	Not Required	Not Required	Not Required	ISO 17353	0,00001	Not Detected	Not Detected
Perfluorinated/Polyfluorinated Chemicals	Not Required	Not Required	Not Required	DIN 38407-42	0,00001-0,01	Not Detected	0,00000002
Phthalates	Not Required	Not Required	Not Required	EPA 8270 D	0,01	Not Detected	0,001-16,2
Polycyclic Aromatic Hydrocarbons (PAHs)	Not Required	Not Required	Not Required	EPA 8270 D	0,001	Not Detected	Not Detected
Volatile Organic Compounds, Formaldehyde	ISO 14184-1	< 75	Not Detected	ISO 11423-1	0,001	Not Detected	0,0034-0,8
Heavy Metals	ISO 16711-1; ISO 16711-2	As < 1; Pb < 0,001; Cd < 0,1; Cr (VI) < 0,5; Co < 4; Cu < 0,005; Ni < 4.10^{3}; Sb < 30; Hg < 0,02	Sb: 11,5	EPA 3051A, EPA 6020A	Sb: 0,01 Cr Total: 0,05 Co: 0,01 Cu: 0,25 Ni: 0,05 Ag: 0,005 Zn: 0,5 As: 0,005 Cd: 0,01 Cr (VI):0,001 Pb: 0,01 Hg: 0,001	Sb: 0,01-0,09; Ni: 0,0021-0,0024; Cu: 0,014-0,016; Zn:0,04-0,4; Cr Total: 0,003-0,01; Cd: 0,001	Cu: 0,0000018-0,54 (for 11 mill) Pb:0,0000018-0,007 (for 7 mill) Zn:0,0000056-0,6 (for 13 mill) Cr: 0,000025-0,045 (for 13 mill) Sb: 0,0000028-0,024 (for 10 mill) As: 0,000005-0,009 (for 9 mill) Ni: 0,0000039-0,0083 (for 6 mill) Hg:0,0000001-0,00097 (for 5 mill)

According to this table; investigated mill has a good environmental performance in terms of eco-criteria according to the other mills located in Turkey. Against this, current performance of the mill is not sufficient for wastewater to provide ZDHC 2020 aspirational limits. The potential emission sources of hazardous substances cannot be clearly identified since there is currently no monitoring and prevention system for the hazardous substances detected both in finished fabric and in discharged treated wastewater. In the literature reviews, it was stated that "antimony" could only originate from polyester fibers, "chlorobenzenes and chlorotoluenes" could be caused by polyester fibers and/or dyestuffs [7,9].

4. CONCLUSION

When all these data are evaluated; in all studies which are carried out brand-oriented in order to determine the emission of hazardous substances both in the finished fabric and in the discharged treated wastewater, it shows that these samples taken at random, instant and in different dates are insufficient to represent the emission of hazardous substances and also to determine the source of emission. Despite strict restrictions specified by global brands it is clear that the emissions of hazardous substances still continue to be discharged to receiving water from textile mills both in Turkey and in the world. For this reason, it is important for production mills to develop measuring, monitoring and controlling models and systems simultaneously on production sites. The mill has a project supported by national fund, aiming zero discharge of hazardous substances and developing a monitoring system to prevent pollution. It is expected that the nationally funded project initiated in this mill will meet this need.

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