IMPACT OF CO_2 EMISSIONS REGULATIVE ON TEXTILE INDUSTRY

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ABSTRACT: *Textile industry produces serious environmental impact through land, water and energy use. To lower CO_2 emissions very sophisticated obligatory mechanisms are imposed in many countries. In European Union this is EUETS based on trading with CO_2 emissions. Among covered activities there is no textile industry. Observing life cycle of various textile products significant carbon footprint of textile industry can be seen. Analysis of selected dying process is presented in order to illustrate how indirect carbon dioxide emission is generated. Interaction between textile industry, resulting waste from used textile products and our habits is discussed.*

Keywords: *Textile industry, CO_2 emission, EUETS, recycling of textile.*

UTICAJ REGULATIVE O EMISIJAMA CO_2 NA TEKSTILNU INDUSTRIJU

APSTRAKT: *Tekstilna industrija ima snažan uticaj na okolinu zbog upotrebe različitih resursa poput vode, sirovina i energije. Kako bi se smanjile emisije CO_2, mnoge svetske države su uvele obavezujuće zaštitne mehanizme. U Evropskoj Uniji, ovaj mehanizam se naziva EUETS i bazira se na trgovini emisijama CO_2. Među aktivnostima obuhvaćenim tim sistemom nije i tekstilna industrija. Prilikom sagledavanja životnog ciklusa tekstilnih proizvoda primećuje se značajan ekološki trag uzrokovan emisijom ugljenika u ovoj industriji. Na primeru konkretnog procesa bojenja tekstila, prikazano je kako nastaju indirektne emisije ugljen-dioksida. Razmatrana je interakcija između tekstilne industrije, nastanka otpada od korišćenja tekstilnih proizvoda i naših životnih navika.*

Ključne reči: *Tekstilna industrija, emisije CO_2, EUETS, recikliranje tekstila.*

1. INTRODUCTION

Textile industry produces serious environmental impact. Some amazing facts, as experienced by author, came up through this citation from reference [1]: “Per average person in the EU, in 2020, textile consumption required nine cubic metres of water, 400 square metres of land, 391 kilogrammes of raw materials**,** and caused a carbon footprint of about 270 kg. Most of the resource use and emissions took place outside of Europe.” From polluter’s point of view textile is the third highest source of pressure on water and land use in European Union (EU), the fifth highest use of raw materials and greenhouse gas (GHG) emissions and the third largest employer worldwide after food and housing [2]. And for the end of this devastating and concerning statistics, less than 1% of used textile is recycled worldwide into new products and from total amount of 16 kg of textiles consumed per person in EU 4,4 kg was collected separately to be reused and recycled while the rest of 11,6 kg ended in mixed household waste [2]. This is statistics of developed countries of EU that tripled its export of used textiles to third countries in last decade as stated in the same source.

2. CO_2 EMISSIONS REGULATION

GHG emissions are detected as global environmental issue for long time ago. Very wide range of measures for mitigation of emissions is set worldwide. European Commission brought more directives to arrange obligatory activities to reach goals of climatic policies. One of most important measures is introduction of European Union Emission Trading System (EUETS) based on allocation of free CO_2 emissions to emitters and trading with them as defined by Directive 2003/87/EC and following Directives brought by European Parliament and Council. Other GHG gases are included through equivalent emissions. Directives and activities covered by EU ETS defined by European Commission are implemented in national legislative of EU member countries [3]. Among them is heat energy production in thermal plants over thermal 20MW of thermal power that is closest to textile industry as great consumer of heat energy. Other categories are connected to other energy intensive branches such as pulp and paper, cement, ammonia, nitric acid production etc. Any branch of textile industry is not among them but let us keep in mind facts about its environmental impact mentioned in introduction. It is worth of mentioning that EUETS is not the only one system that regulates CO_2 emissions, other countries all over the World imposed their own rules more or less strict.

2.1. Sources of GHG emissions in textile industry

To determine or better to say to reckon CO_2 emissions from textile industry life cycle of products has to be observed. Textile industry is great consumer of electricity for fabric production and further treatment of textile and heat energy in form of process steam especially in dying process [4]. It is obvious from available facts that any part of textile industry is not subject of CO_2 emissions regulative that seems strange at first glance and at the same time textile industry is marked as fifth source of GHG emissions. Life cycle of textile industry products is very complex as described in reference [4]. Activities that serves to wide range of textile industry products are subject of this regulative, especially transport and heat energy and electricity production. Production of raw materials, for instance cotton, as part of agriculture is not yet covered by EUETS but is under consideration. EUETS is based on trading with CO_2 emissions that generally results in additional cost to final price of product.

2.2. Emission of CO_2 from selected process in textile industry

In order to become more familiar with problem of CO_2 emission, dying process will be analysed from heat energy and electricity consumption point of view. Data and calculation are taken from [5] while origin of data is from facility "VIS tkanine" from Varaždin (Croatia) that does not exist for long time as result of transition trend of Croatian textile industry, similar to trends in Serbian textile industry as analysed in reference [6].

Simplified scheme of all phases of dying process is shown in Figure 1. In mentioned facility it was possible to conduct following processes using appropriate dying machines; process 1: dyeing of polyamide with acid dyestuff on small jigger, process 2: dyeing of cotton with reactive dyestuff on small jigger, process 3: dyeing of cotton with reactive dyestuff on large jigger, process 4: dyeing of viscose with direct dyestuff on small jigger, process 5: dyeing of polyester part of cotton/polyester mixture with disperse dyestuff on high temperature machine, process 6: dyeing of cotton part of cotton/polyester mixture on large jigger, process 7: dyeing of cotton part of cotton/polyester mixture on small jigger, process 8: washing of viscose on jet machine, process 9: dyeing of viscose with reactive dyes on jet machine.

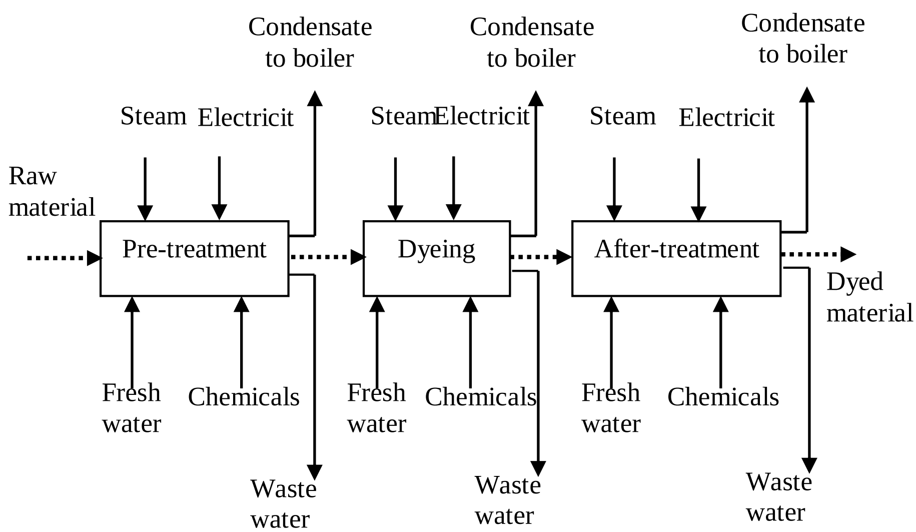

Figure 1: Scheme of dying process

Consumption of heat energy and electricity can be calculated based on data for annual capacity of facility such as mass and length of processed material and duration of processes (see Table 1.). CHP plant is not part of facility which is important for allocation of CO_2 emissions to CHP plant, not to dying facility. Natural gas is taken as primary fuel with assumed composition of 95% of methane CH_4 while rest up to 100% is neglected. Inserting this value to combustion equations [7] lower heating value and volume of CO_2 per $1m^3$ of natural gas can be calculated.

$$H_d = r_{CH_4} \cdot H_{dCH_4} = 0,95 \cdot 35,93 = 34130 \frac{kJ}{m^3_{natural\,gas}} \quad (1)$$

$$V_{CO_2} = CH_4 = 0,95 \frac{m^3}{m^3_{natural\,gas}} \quad (2)$$

This calculation is approximate, but accurate enough for purpose of further discussion. Assuming overall efficiency of cogeneration plant (CHP) of 60% that supplies facility with heat energy and electricity in total amount given in last row of Table 1., natural gas consumption $V_{natural\ ga}$ can be calculated by dividing sum of these values by lower heating value from Equation 1. and CHP plant efficiency.

$$V_{natural\,gas} = \frac{1687037 + 795480}{9,482 \cdot 0,6} = 436384 m^3_{natural\,gas} / year \quad (3)$$

Table 1: Annual heat energy and electricity consumption in dying process

Process	Energy consumption, kWh/year		Length of died material, m/year
	Heat	Electricity	
1	51015	10320	430000
2	46369	14600	200000
3	55089	4400	200000
4	36417	4500	300000
5	772667	222400	800000
6	92333	29200	400000
7	110011	8800	400000
8	35997	36900	150000
9	487139	464360	760000
Total	1687037	795480	$3,64 \cdot 10^6$

When volume of natural gas from Equation 3. is multiplied by volume of CO_2 from Equation (3) and carbon dioxide density ρ_{CO_2}=1,96kg/m^3 annual CO_2 emission in tons is derived.

$$Emission_{CO_2} = 436384 \cdot 0,95 \cdot 1,96 = 812547 kg_{CO_2} \quad (4)$$

This emission is result of spent heat energy and electricity for dying of 3,64 million meters of textile material. From author's point of view this is respectable quantity, but still that makes minor share of total world textile industry.

Further illustration of this value could be given as follows: it equals emission of one car with average emission of 110gramsCO_2/km that passed 8 million kilometres, or emission of 430 average households (flat with area of 80m^2 in building) in continental region of SE Europe that spent 1000m^3 of natural gas for space and water heating.

This emission is, as already mentioned, allocated to CHP plant that supplies heat energy and electricity to dying facility. So, all issues connected to CO_2 emission is concern of CHP plant, not of facility. Of course, any additional cost of CO_2 emission is incorporated in price of heat energy and electricity and finally in end product of dying facility. Additional cost will occur if emitter, in this case CHP plant has to buy CO_2 emissions at the stock exchange in case when emitted quantities exceed allocated free emissions, as imposed by described directives.

3. CONCLUSION

Previous calculation has shown how CO_2 emission indirectly affects one of many technological processes in textile industry which is not subject of CO_2 regulative. This could lead to wrong conclusion of carbon neutrality of textile industry. Introductory notes deny such thinking. Observing life cycle of all textile products it becomes clear that textile industry is serious emitter of carbon dioxide. Further problem is huge amount of textile products, especially clothes that ends in mixed solid waste after being used and much worse, the significant amount of completely new clothes whether not sold or bought and not worn experience the same destiny ending in landfills. Only one percent of textile worldwide is recycled. Statistics is not promising even in developed countries including EU. Especially if seen from point of clothes production, fashion dictates trends that change seasonally and together with products of lower quality results in immense quantity of disposed textile. Most of population doesn’t understand or care that this is not only textile, but energy, water and row material incorporated in final product. If endpoint of any sort of textile life cycle is landfill then all previously mentioned items are irreversibly lost. And suddenly, carbon footprint and rest environmental impacts of textile industry moves from technology field to field of our bad habits, comfort and irresponsibility, from technology to waste. Do we recognize similar pattern in our behaviour using many other products in our everyday life? Solution of problem is not only to press textile or any other industry to be more efficient but also to change our behaviour and increase our consciousness. But, are we ready for that?

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