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Baseline Scenario of Carbon Footprint of Polyester T-Shirt

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Abstract

Environmental sustainability is a vital issue in the clothing industry due to a large percentage of greenhouse gas (GHG) emissions from clothing manufacturing to consumption. The main GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Carbon dioxide is considered as the most significant greenhouse gas. The carbon footprint (CFP) of clothing supply chain reflects the GHG emissions throughout the life cycle of a product or activity, and CFP assessment is an important approach to assess GHG emissions. Polyester is one of the most widely used synthetic fibres in the world, but it is produced from non-renewable resources. In this study, a life cycle assessment (LCA) of a polyester T-shirt imported to Australia from China has been undertaken to examine the processes which cause GHG emissions across the life cycle. The results of the baseline model showed that consumer use phase contributes the highest CFP 30.35%, and second highest contributor is polyester fibre production process. Within the production phase, spinning is the highest contributor of CFP due to high electric energy demand. Within the consumer use phase, CFP is dominated by the washing process. The results of the model can be considered reliable comparing with other related studies.

Keywords: Sustainability; Greenhouse Gas Emission; Carbon Footprint; Life Cycle Assessment

1 Introduction

Environmental sustainability is a vital issue in the textile and clothing industry because buyers are more concerned about the sustainability of their clothing products, especially when purchasing imported apparel. Now the fashion industry is willing to develop their policies for sustainable environmental practice by giving attention to the carbon footprint (CFP) and energy used in the whole supply chain [1]. Sustainability can be maintained by several ways such as reducing energy consumption, improving productivity, reducing waste generation, recycling waste and using less

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material in production. According to North American magazine, Textile World, North Americans are the largest consumer of new textile products and Australians are the second largest consumer of new textile products based on average use per person [2]. Each Australian buys an average of 27 kg new textile product annually and after a certain time they dispose of 23 kg of the textile products. It is assumed that remaining 4 kg textile products are stored for reuse in their wardrobe. Each North American consumer buys 37 kg and each Western European consumer buys 22 kg textile products annually. Textile and clothing consumption rate in Africa, Middle East and India is about 5 kg per capita (Fig. 1) [2].

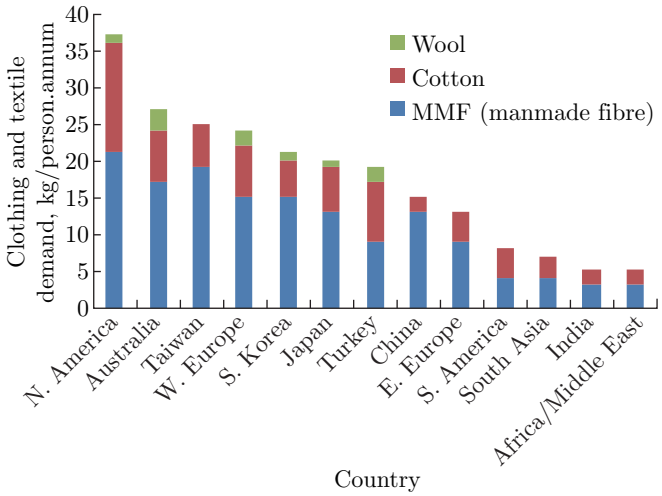

Fig. 1: Global consumer demand for clothing and textile, kg per person, per annum [2]

In 1980, 2000 and 2014, global polyester demand was 5.2, 19.2 and 46.1 million tonnes, respectively [2]. According to a study by Lenzing group on global fibre market in 2016, manmade fibres of synthetic origin (oil based synthetic fibre) occupied 62.7% and cellulosic and protein-based natural fibre occupied 24.3% share of the global fibre market [3]. Polyester is the main manmade fibre of synthetic origin then followed by nylon and acrylic [4]. Therefore, the demand for polyester fibre is growing. According to the Textile World report dated on February 3, 2015, a large part (approximately 69%) of global polyester is produced in China [2]. Textile World also stated that most of the new textile and clothing purchased by Australians are derived from manmade fibres [2].

Life cycle assessment (LCA) is a technique to access the environmental sustainability of a product or process. It involves the environmental impacts associated with the product or process, raw material acquisition, energy, resources, waste, and emissions to air, water and soil, etc. The main aim of this study is to assess the carbon footprint (CFP) throughout the life cycle of a basic polyester apparel item imported in Australia. This was done by developing a model of supply chain of the selected apparel from raw material extraction to use stage and end of life stage in Australia. A generic polyester knit T-shirt has been chosen as a basic apparel item. System boundary of this study is fibre production to disposal. Production stages include fibre production, yarn spinning, knitting, wet processing and apparel manufacturing. Consumer stages include apparel washing and drying behaviour of the purchased apparel. The carbon footprint (CFP) assessment of apparel supply chain helps to evaluate the basic conditions associated with the emission of greenhouse gas (GHG) during their production and use stages [5].