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Recycling tannery solid wastes and post-consumer leather products as an alternative carbon resource for steelmaking: an environmentally sustainable approach

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Introduction

The environment is facing adverse anthropogenic and natural challenges over the past several decades. Anthropogenic pollution is a worldwide problem. Industrial production and post-consumer product wastes are one of the most potentially significant environmental risks (Desenfant et al. 2004).

Tanneries are well-known to have serious negative impacts on the environment and public health. Survival of tanneries has become a great challenge. In tannery, putrescible raw animal hides/skins are converted into imputrescible leather by means of a series of chemical and mechanical operations which produce significant amounts of solid and liquid wastes as well as gaseous emissions (Covington 2009). It is reported that every ton of raw hides/skins processing converts only 200 kg of raw materials into leather and more than 600 kg is produced as solid wastes (Hashem and Nur-A-Tomal 2017). Globally, every year 6 million tonne solid waste is generated from leather processing (Masilamani et al. 2017). Moreover, considerable amounts of leather wastes are generated during manufacturing of leather products. In developing countries like Bangladesh and India, most of the solid wastes are discharged to nearby landfill sites without proper treatment which poses environmental problems (Ravindranath et al. 2015, Ahmed et al. 2017).

In addition, the disposal of post-consumer leather products, for example, footwear, garment, bag, glove, belt, watch strap, vehicle upholstery, furniture upholstery, and book-cover, etc. is a challenging issue. The global consumption of leather footwear is estimated to be 4621.2 million pairs per year and consumption in Australia is 42.6 million pairs per year (FAO 2016). Besides leather, leather products are made up with some other materials e.g. polymeric sole, foam, rexine, and textile, etc. that make it difficult to separate and reclaim completely in economically sustainable manner. The wastes are usually landfilled or incinerated which create environmental pollution.

On the other hand, over 70% of total global steel production directly depends on the inputs of coal. Globally, above 1.2 billion tons of coal is used in steelmaking (World Coal Association 2014). As the reserve of fossil fuel coal is limited that may be unavailable in the near future. Therefore, exploring alternative carbon resources to replace coal for steelmaking is urgent.

Most of the tannery solid wastes and post-consumer leather products are neither collected nor disposed of appropriately to avoid its adverse effect on the environment and human health. To date, several technologies (e.g. biological, chemical, physical, and thermal, etc.) have been developed, but there are still deficiencies in the complete management of the wastes. It is crucial to develop novel environmentally sustainable technologies that would utilise these wastes.

The characteristics of different tannery and post-consumer leather products wastes are represented in Table 1. The leather and polymeric materials could be potential resources for steelmaking.

Table 1: Carbon content and calorific value of wastes (Abajihad 2012, Bahillo et al. 2004)

Type of wastes	Carbon content (%)	Calorific value (MJ/Kg)
Raw trimmings	53.10	7.85
Fleshings	53.86	8.99
Chrome shavings	51.78	7.66
Crust trimmings	50.78	17.55
Leather trimmings	54.06	18.77
Footwear waste leather	54.90	18.95
Polyurethane foam	Not analysed	27.63
Ethylene vinyl acetate sole	Not analysed	16.57

Objectives

This study will evaluate the applicability of tannery solid wastes and post-consumer leather products in steelmaking as a source of reducing agent and heat.

Methods

The tannery solid wastes and post-consumer leather products will be collected from tanneries and/or landfill sites. The wastes will be cleaned, sun-dried, and cut into small pieces. The prepared wastes will be analysed for elements and energy content.

The wastes will be pyrolysed at different temperature in the absence of oxygen to produce char. Structural evolution of the wastes during pyrolysis will be observed. The pyrolysis process will be optimised.

The chars will be used in steelmaking (sintering, palletising, and direct reduction process) as a source of carbon and energy. Analyses will be performed to determine the level of iron reduction in steelmaking. The steelmaking process with the produced chars will be optimised.

Hypothesis/Expected Results

The chars produced from tannery solid wastes and post-consumer leather products would replace coal in steelmaking. Thus, the present attempt would i) reduce environmental pollution and also ii) make a valuable material which will cut the consumption of non-renewable fossil fuel.

Research benefit for the local or global leather industry

This research has the potential to minimize leather wastes by utilization which could abate the negative image of the leather industry in the society with respect to pollution.

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