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The role of thermo-catalytic reforming for energy recovery from food and drink supply chain wastes

Marie E. Kirby[a*], Andreas Hornung[b], Miloud Ouadi[b], Michael K. Theodorou[a]

[a]*Harper Adams University, Newport, Shropshire, TF10 8NB, England*
[b]*Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT, Institute Branch Sulzbach-Rosenberg, An der Maxhütte 1, Sulzbach-Rosenberg, 92237, Germany*

Abstract

Disposal of food and drink wastes, including packaging wastes, has a significant cost and environmental impact. All carbon containing wastes have an energy potential and the food industry should focus on recovering that energy to offset their reliance on fossil-fuel derived energy sources. This paper focuses on the novel use of intermediate pyrolysis for decarbonizing the food chain, through the treatment of food and packaging waste, to recover energy. The TCR is a versatile technology which overcomes many of the traditional problems associated with fast pyrolysis and can thermo-chemically convert a range of different feedstocks, including inaccessible lignin and some inorganic, recalcitrant materials. The feedstocks are converted into new fuel sources; char, bio-oil (thermally stable) and permanent gases, for further electrical and heat generation. Ultimately with the use of the TCR technology, the food production industry could look to using decentralized power generation located on-site of large food processing facilities to optimize their energy efficiencies.

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Keywords: Food chain waste; Intermediate pyrolysis: Thermo-catalytic reforming; Decarbonisation

* Corresponding author. Tel.: +44-1952-815-489.
E-mail address: mkirby@harper-adams.ac.uk

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Nomenclature

CHP	Combined heat and power
GHG	Greenhouse gas
HHV	Higher heating value
LHV	Lower heating value
OFMSW	Organic fraction of municipal solid waste
TCR	Thermo-Catalytic Reforming

1. Introduction

The food and drink supply chain produces a vast quantity of wastes as both food and packaging wastes. If the waste can be recovered and used for energy generation, using the most appropriate technology, this will be of considerable benefit to the industry. Unfortunately there isn't a single technology which can effectively recover energy from both wet food and packaging wastes. For example, food waste contaminated with plastic packaging is not an ideal feedstock for anaerobic digestion due to its high content of biogenic and non-organic (rubble) components which cannot be degraded by microorganisms and can fill and clog the digester. However the high moisture content of this type of waste does not make it ideal for pyrolysis or incineration; therefore it is typically landfilled. This paper introduces the concept of intermediate pyrolysis of a similar feedstock to food and plastic wastes generated by the food supply chain and the role intermediate pyrolysis could play in decarbonizing the food supply chain.

2. Food supply chain

The food and drink industry is a significant global industry, with a turnover of $8 trillion US in 2016 [1]. Within the EU, the food and drink sector represents 8% of employment and almost 6% of EU gross domestic product, equating to €715 billion per year [2]. The average household expenditure on food and drink equates to 13% for EU residents and over 20% for UK residents [3].

Food supply chain wastes includes both waste food and drink and packaging wastes, and is very similar in composition to the residual organic fraction of municipal solid waste (OFMSW). These waste streams represent inefficiency within the industry and a valuable loss of resources (for example energy, nutrients and production costs) [4]. The European Sustainable Development Strategy plans to reduce wastes through reuse and recycling of materials. Wastage of food through the supply chain is a global problem and is estimated to account for one third (approximately 1.6 billion tonnes per annum) of all food produced [5]. The quantity of food waste per person per year varies depending on geographical region from 95-115kg in Europe and North America to 6-11kg in Sub-Saharan Africa, South and South-Eastern Asia [6]. In developed countries, waste food typically enters landfill, where it decomposes and releases greenhouse gases (GHG). If food waste is source-separated from other materials prior to collection, it can be used in animal feed, composting or anaerobic digestion (depending on the food type and technology availability). The majority of packaging wastes are generated from the initial production stage on-farm through to the retail stage, with limited addition waste generated from households and the consumer [6]. Of all packaging wastes produced (to include food waste packaging), the EU produces a total of 82.5 million tonnes per year, with the UK producing 11.4 million tonnes [4]. In 2013, the UK recycled approximately 64% of all packaging wastes and incinerated a further 8% of waste. However of the waste incinerated, the UK did not participate in incineration with energy recovery, missing this opportunity to decarbonize the food supply chain by recovering heat and electricity from incineration. The remaining packaging waste, 3.19 million tonnes, were sent for landfill [4].

Finding alternative methods to reduce, reuse and recycle waste are essential to reduce the quantity of waste and GHG emissions generated from the food and drink supply chain. Wastes generated from the food and drink supply chain account for 20% of the UK GHG emissions, although these GHG emissions would increase to 30% if the required land use change for food production was also considered [7]. The GHG emissions from the food supply chain can be reduced if food waste is source-separated and sent to anaerobic digestion and packaging wastes are