

Introduction of impact of GHG emissions concerning food machinery in food supply chain

Food Industry Research and Development Institute Huang Shih Rong

1. Introduction

Global warming exacerbates the costs of climate disasters due to carbon emissions affects the weather change, therefore, it is necessary to achieve net zero carbon emissions (Net Zero) and curb the amount of carbon dioxide emissions from every enterprise. Among the 198 countries, 133 countries claimed net-zero targets for 2050, meanwhile, kinds of international policies also inevitably affect the strategy of business strategies. The EU has agreed to the world' s first Carbon Border Adjustment Mechanism (CBAM), a measure aimed at preventing "carbon leakage" which claims to reduce greenhouse gas. (GHG) emissions by at least 55% compared to 1990 levels by 2030 and to achieve climate neutrality by 2060. The Financial Supervisory Commission (FSC) has also implemented green finance action plans 2.0 to promote the net-zero policy as well. Besides, Company can choose to take voluntary online survey - carbon disclosure (CDP), a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts, which provide ranking results from online questionnaires.

Companies may put efforts such as capital and investment of financing decision – green infrastructure or increasing carbon transparency enhancing climate resilience, assisting banking system to support the industry with cost/carbon emissions balance abroad. So far, world' s most popular brands such as Apple, Dell, Nike, P&G also commit to net-zero or carbon neutrality goals which requiring supply chains to make climate commitments. It means that the product carbon footprint and carbon neutrality progress of suppliers will be considered in the company' s procurement. Therefore, enterprises must take actions to plan carbon neutrality strategy with monthly meeting to review carbon emissions & energy use, meanwhile, suppliers are invited to jointly set carbon reduction targets, and obtain greenhouse gas inventory certificates as well. Taiwan government, for example, the Environmental Protection Department, the Energy Bureau and the Industrial Bureau of the Ministry of Economic Affairs, have also provided many resources, such as online carbon inventory calculators, various training courses, and experts from different sub-industries to provide simple carbon inventory and product carbon footprint calculation practices that helps process optimization and energy management. (Source: <https://zerotracker.net/>, January 31, 2023).

2. Roadmaps of net zero in food supply chain

To completely understand the source of GHG emissions, it is necessary to quantify and report it at the organization level. Then, enterprise can set up effective GHG management or GHG emissions reduction strategy for the supply chain and manufacturing. At present, there are more than 7,500 food companies in Taiwan, including about 28 large enterprises are classified to monitor and report its emissions. Due to the influence of policies,

regulations, and global market trends, food manufacturers may gradually introduce energy usage management, GHG inventory, green recipe development, and other total solutions concerning about the corporate sustainability. Most SMEs thought that GHG emissions management has nothing to do with their own business, and keep distance or cold attitude for these issues, greenhouse gases or energy conservation so that the carbon footprint of the food supply chain on is less transparent. It hinders the promotion of GHG reduction measures and increases the difficulty to reach the "net zero" target.

Roadmaps of net zero in food industries and supply chain are categorized as follows :

- a. Low carbon footprint products development: Danone developed varied plant-based food, such as soy milk, ice-cream, ...etc. that replace dairy product with higher carbon footprint. Premier provides kinds of planted-based proteins for foo manufacturers. General Mills invest Gethered Foods to expand plant-based markets by developing the seafood analogue.
- b. Cooperated with supply chain: Nestlé develops low-carbon coffee varieties using non-GMO cultivation technology, which increase the average yield by 50% and reduce CO2 emissions per cup of coffee by 30% compared to the original Robusta coffee. Pepsi cooperated with CCm UK to take the potato skins as fertilizer, reducing the carbon emissions by 70% during the planting process; McCain Foods 2030 replace the 100% potatoes with the ones from regenerative agriculture while reducing carbon emissions by 25% (growing, storing and transporting).
- c. Green packaging: Coca-Cola uses recycled PET bottles to make bottles (rPET) and uses cardboard to replace plastic shrink film; PG Tips develops 100% biodegradable corn tea bags and removes the plastic film from the outer box of the tea leaves products; Macphie cooperated with Tetra Pak to change the package of sauce & desserts to 87% plant-based materials, reducing its carbon footprint by 11%.
- d. Optimizing the Manufacturing: Suntory invests £13 million to set up a high-speed filling line to reduce water and energy consumption by 40%; Mondelēz' s operate it six plants in UK by using 100% renewable energy; Unilever replaces the cooling plant refrigerant (trifluoro methane) with alternative materials such as ammonia or carbon dioxide.
- e. Net-zero transportation: Mars cooperated with DHL by setting up smart logistics warehouses to increase storage capacity by 50% and reduce the GHG emissions by 7.7%. Campbell optimizes the transportation routes through digital tools with lower GHG emissions.

3. The role of food equipment for GHG analysis and reduction.

a. Digitalization: It is clear that the key to effectively lower GHG emissions in the food manufacturing supply chain concerning the product recipe design that takes into account the source of raw materials, the manufacturing process, and the transportation. Replacing the recipe components with local markets may drastically change food quality, flavor and cost. It reduces distance of transportation, thereby reducing GHG emissions due to leakage of refrigerant from refrigeration, as well as fuel consumption from various mileages. Another key point is that amount of energy usage resulting from manufacturing. In order to identify and quantify the energy usage and validate the corresponding GHG emissions reduction measures, a common way to install sensors for electricity monitoring which often be the highest carbon footprint in many food factories. Some measures to reduce energy consumption, such as turning off lights and machines when not in use. The others may identify the direct combustion or fugitive emission sources by means of gas flow meters or indirect sensing. Alternative environmentally friendly measures is green energy such as wind, solar, and biomass. Water used to be regarded as a finite resource that helps manufacturing processes such as cooling or cleaning require large amounts of industrial water. Although the carbon footprint of water resource is relatively small, however, people lives in southern Taiwan usually have water shortages in the winter.

b. Recyclable package design and precise filling: From the user' s point of view, it can be found that the easiest way to understand and practice should be packaging material in food supply chain. However, the way to recycle them from kinds of life cycle and its condition may have different recycling difficulties due to packaging types and materials. In 2019, the production and incineration of plastics creates 800 million tons of greenhouse gases. Many manufacturers are eager to study eco-friendly packaging materials or recyclable packaging materials. For example, the famous beverage package manufacturer, HON CHUAN which produce many packages that its PET can be 100% recycled and remade into new PET bottles. Recently, they also successfully developed 30% rPET shrink film labeled products and continue to develop more sustainable green packages such as bioplastic lids, rHDPE, Flexo printing, rPET labels, tethered cap and lightweight materials. Next, the GHG emissions hotspot or cost related to packaging process is the accuracy and stability. Precise filling or packaging depends on the design of the filling machine and its operating parameters inside or around the filling station including the temperature, moisture, moving speed, and the quality of packaging materials. To avoid waste, manufacturers introduce the flexible production management or quality sorting/inspection module with advanced automating tools in order to optimizing the performance of sealing, high yields, and label conformity. For example, over filling or splashing of products lead to the loss of sealing and equipment contamination. To optimize the bottle structure, some company cannot reduce the thickness of PET bottle which twice the material weight and GHG emissions. Sidel adjust its PET blow molding machine by controlling blowing parameters involving different bottle types, temperature, compressed air pressure, and packaging materials. This allows the pressure and flow of the gas to be adjusted to optimize the compressor' s power consumption.

c. Innovative design of food equipment: To reshape the product manufacturing chain, it is necessary to redesign equipment and process with low-carbon emission concepts. Furthermore, to integrate them with digital tools which provides intelligent management and GHG emissions war room. Followed by the integration of lean manufacturing and production scheduling management system, and optimize the performance of food equipment to achieve zero waste production. TECO and its associated cooperates provide many solutions with energy-efficient products to help suppliers reduce emissions, waste, and cost. For example, the IE3 high-efficiency nine-slot motor was designed for water wheels and oxygenation units in aquaculture and fisheries, which are made of stainless steel with excellent weather and corrosion resistance. With extended lifetime of the motor, it saves up to 7% cost within a year. Smart logistics technology provides excellent temperature control to keeps foods from spoilage. Tsung Hsing (TSHS) is a manufacturer specialized in frying equipment. The continuous microwave hybrid fryer uses microwave mixed frying heating to overcome the problem of traditional fried foods, which are cooked on the surface but not well inside. For Large pieces of food such as chicken legs and pork blocks, the heating time can be shortened by 70 - 75%, the weight loss is reduced by 30 - 40% compared with the traditional frying process, the oil absorption rate is reduced by 40%. In order to save more energy and frying oil, the design of energy recovery and secondary heating on the heating furnace has been obtained, and patents have been obtained in Europe, America, Taiwan, Chinese mainland and other countries. ANKO has introduced many low GWP Food Machines that use "R1234ze" HFO-based refrigerant to replace "R134a" . These machines were tested and proved to have only 1/10 the GWP compared to the original models as well as comply with the EU and US F-gas standards. The biggest challenge many machine manufacturers face when introducing new eco-friendly models using "R1234ze" refrigerant to replace "R134a" is the cooling effect does not compare with older models that use "R134a" . ANKO invested in the research and development to improve these new machines' mechanical design. Finally, ANKO's new machine models were tested using "R1234ze" eco-friendly refrigerants and they achieved cooling effects equivalent to older equipment using "R134a" . Since 2022, ANKO has upgraded all our appliances with an eco-friendly design that uses "R1234ze" for cooling (Source: ANKO.com.tw). Quickly Food Machinery Co., Ltd. has more than 40 years of experience in the food machinery market and is recognized internationally as the 'No. 1 Steamer Brand in Asia' . Its best-selling product 'Super Energy-Saving Steamer' can boil water from room temperature in just 3 minutes. In addition to the characteristics of fast heating, business scale steam volume and even heat distribution with no dead corner, it never leaks. It has been recognized by international customers and is the designated brand for many food processing, catering, and snack companies (Source: www.yuanjaan.com). CHIN YING FA MECHANICAL develops a hybrid type of overpressure water retort which can save energy, shorten the sterilization process time, and no more water enters the kettle during the heating, sterilization and cooling process, the product will not have the problem of re-contamination, and the cooling water can be 100% recycled and reused.

4. Summary

So far, most food manufactures have no ideas how to reduce GHG emissions which lack of the ability to collect the data of all factory sites. There are three solutions which can be considered in the future. First, the fuel substitution: To replace the fuel coal with gas or renewable fuel/biomass; Second, energy efficiency improvement: To introduce the energy management system and integrate with high-efficiency energy-saving equipment. Final, the process improvement: To optimize the process: to improve the equipment design with minor modification or replacing the old with innovative of low-emissions design. Many food equipment suppliers has begun to design high-efficiency and energy-saving equipment, which integrate heat recovery and new eco-friendly refrigerants. However, it is still necessary to consider whether the system construction is cost-effective. Then, to consider the introduction of ICT techniques such as monitor and control module that helps operate at ideal conditions.

5. Reference

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