Energy use in food processing industry

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Abstract

There are many opportunities for improving energy efficiency in the food industry through evaluation, addition and effective governmental energy policies and voluntary process analysis and improvement. Future directions for energy efficiency studies should focus on improving existing plants, developing energy-efficient process technology, improving and expanding demand, side management programs, creating informed and reasonable energy policies, and further research in the possibilities of zero-discharge plants.

Introduction

The production of food, which sustains the human energy balance, requires a considerable and continuous supply of energy delivered from natural resources, principally in the form of Fossil fuel, such as coal, oil and natural gas. For example, a typical energy requirement for the delivery of(1 J) in the form of food consumes almost (10 J)from natural resources. In the production of food for human consumption, the processing of food and drink requires a considerable part of this .The steady increase in the human population of the planet and its growing nutritional demands has produced an annual increase in the energy demand [1].

Energy consumption of food and drink industries isup to 40% in the last decade. The accelerating development of many countries with large populations, such as China and India, has resulted in a large increase in energy demands and a steady increase in energy cost. The growing demand for energy from the increase in world population has also resulted in unpredictable environmental conditions in many areas because of increased emissions of CO_2, NOx, SOx, dust, black carbon and combustion processes waste [2].As the developing world increases its food production, at the same time it is becoming increasingly important to ensure that the production/processing industry takes advantage of recent developments in energy efficiency and minimizes the amount of waste that is produced.

The food and drink industry has many processes that consume energy. The energy and related environmental cost, and imposed emission and effluent limits, charges and taxation, contribute substantially to the cost of production.

A potential solution to the problem is the optimization of energy consumption, increasing the efficiency of processing and decreasingthe emissions and effluents [2].

However, there are some specific features in food processing that make optimization for energy efficiency and total cost reduction more difficult when compared with other processing industries; for example in the oil refining industry, there is a continuous mass production concentrated in a few locations which offers an obvious potential for large energy savings [3].

Food processing is distributed over very large areas and is often producing during specific and limited time periods, for example in the case of campaigns in the sugar industry. In addition, the industry is frequently extremely diverse and relies heavily on small producers and processors.

These particular features of the food production/processing industry have resulted in less intense activity with regard to energy optimization than has been the case in other comparably sized industries. This has also been the case in targeting for energy savings where the main purpose of such analysis has always been centered on economic performance.

The pressure on demand of energy is increasing hence energy costs andthis calls forconcerns about environmental degradation, even previously economically less attractive and energy-consuming food processing plants - such as those producing sugar, ethanol, glucose, dry milk, tomato paste, vegetable oil, fruit juice. -have become strong candidates for retrofits to reduce energy costs and environmental impact. In addition, the food processing industry has the potential for integrating the use of energy in food industries.

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Renewable energy

Sources in order to reduce pollution and waste generation, and so reduce overall costs. A typical example is the use of bagasse

Biofuel

For generating the energy needed for processing in a cane sugar plant and exporting any
surplus electricity into the distribution network.

Clean energy

From the sun light requiring no cost except generation and maintenance.There are a number of well-established methodologies available to optimize the use of energy, and consequently reduce operating costs. Many of these methods only require good management practice, good housekeeping, Objective analysis based on optimum measurement policy and planning.

There is also an increasing role in waste management and co-product recovery for life-cycle assessment (LCA), not only in the production chain, but within the complete life span of production, processing, consumption and waste disposal [4,5].

An advanced methodology for the improvement of energy efficiency -which has been widely applied in the chemical, power generating and oil refining industry - is process integration [3]. This methodology has also been referred to as 'pinch technology' [3]. and the area of the technology mainly associated with heating reduction costs is often referred to as 'heat integration'. This methodology has a large potential in the food processing industry.This a novel methodology to reduce energy demand and emissions on a site comprising of individual processing units and an integrated utility system, and at the same time maximizing the production of cogeneration shaft

This methodology is based on the analysis and understanding of the heat exchange between process streams through the use of a temperature-enthalpy diagram. The methodology first identifies sources of heat (termed 'hot streams') and sinks of heat (termed 'cold streams') in the process flow sheet.

Sources of heat can be combined together to construct the composite hot stream (Figure 1) and sinks of heat can likewise be combined together to construct the composite cold stream (Figure 2). The relative location of these curves on the temperature-enthalpy diagram is dependent on the allowable temperature difference for heat exchange. The next step is therefore to select a minimum permissible temperature approach between the hot and cold streams, allowable minimum heating requirement (ATmin). The selection of the most appropriate or optimum allowable heating requirement (ATmin) is a result of an economical assessment and trade-off between the capitals and operating

costs (which are mainly costs for energy use of the process being analyzed. A large allowable heating requirement implies higher energy use and costs and lower capital costs. Consequently for increasing energy cost (for example the price of gas) the optimum allowable heating requirement is reduced, meaning the heat exchanger system is allowed to recover more energy, but at the expense of more capital to pay for the greater heat transfer area (Figure 3) This issue has been discussed in greater detail elsewhere [1].

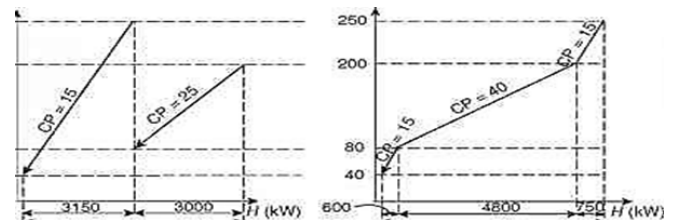**Figure 1.** Amalgamating hot streams to create a hot composite curve

Figure 2. Amalgamatingcoldstreams to create a cold composite curve (after
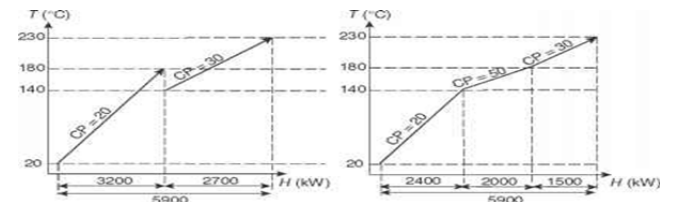
CPI 2004a and 2005a).

Figure 3. Plotting the hot and cold composite curves

Opportunities for energy efficiency improvements

Direct use: Recycling part of the grain drying air or using heat exchangers to
increase the temperature of the incoming drying air would result in a 25%
savings in energy used in the dryers.

Boiler use: Economically practicable savings in the industry of 30% would be
possible with the installation of economizers to reduce boiler losses. Figure (4) below

Purchased electricity: Proper sizing and improvement on the power factor of
motors have a potential savings in electricity of 14% while conversion to
florescent lighting and improvements in overall management practices can save about 15%.

Energy use in dairy Industry

The number of dairy plants has decreased, and the value added has increased in recent years.Processing of dairy products requires large amounts of energy,with concomitant production of large amounts of high BOD and TSS waste. To reduce energy and costs associated with water and waste, measures such as optimizing and reusing concentrated waste streams as ingredients should be taken. In addition, dairy

processes require large amounts of energy for refrigeration and pasteurization processes. Efficient equipment, using "waste energy" from one stream as usable energy for another, and on-site energy generation are some methods of reducing energy costs. Figure4 . The dairy industry also creates a significant amount of waste per year. The most energy consuming process in this industry is the production of dried milk using drum.

Conclusion

The food industry sector is the fifth largest energy consumer in the manufacturing industry sector. Process heating, cooling/refrigeration, and boiler losses were the most energy consuming processes in the industry accounting for range of energy inputs respectively. Application of energy reducing techniques such as recovery and reuse of hot and cold streams, heat recovery from compressors and more efficient boiler operations can lead to increases in efficiency.

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