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A discussion paper on challenges and limitations to water reuse and hygiene in the food industry

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Abstract

Drinking water is becoming a scarce resource in many areas and both use of water and wastewater outlet are of major ecological and economical importance in many countries. Consumption and discharge may be considerably minimized by means of water reuse. The food industry has a large consumption of water, but until now very limited reuse has taken place due to legislations constraints and hygienic concerns. Legal space for use of water of qualities other than drinking water has been opened with the current legislation. This will, however, in many cases require careful analyses of individual cases based on a thorough understanding of the hazards involved in order to avoid compromising the safety of the food product and thereby the health of consumers. Implementation of water reuse practices in the food industry presents a great challenge for both companies and public health authorities regarding knowledge, technical expertise and documentation. Regulatory, technological, monitoring, verification and ethical aspects associated with microbiologically safe reuse of water in the food industry are discussed and some examples of the challenges ahead and possible approaches are given.

Keywords: Water reuse; Food industry; HACCP; Microbiology; Regulations

1. Introduction

The concept of water being a never-ending resource with a limitless renewable capacity belongs to the past (Beekman, 1998). Water reuse is increasingly regarded as a necessary tool for substantial reduction in water supply needs and savings in related costs (Dean and Lund, 1981; Pagella et al., 2000). Severe water shortages and dry periods are the main driving forces behind water reuse for some countries, whereas others have been motivated by the increasing environmental constraints and the fact that water quality discharge regulations have become stricter. Water reuse practices have also become more technically feasible due to the development of better purification processes. The implementation of actual reuse for industrial purposes depends, to a large extent, on economic incentives. As water prices rise, there will come a point when existing or developing technologies will make water recycling and reuse a viable commercial operation (Hancock, 1999). For many

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countries, however, agricultural irrigation still remains the main reuse application for industrial wastewater (Angelakis et al., 1999).

Water is extensively used in the food industry (Poretti, 1990). At present, water recycling and reuse practices in the food industry take place in order to supply cooling water, wash water or even process water, especially after reconditioning, but other water reuse practices are limited when compared to the potential (Palumbo et al., 1997). The potential for recycling and reuse in the food industry has been shown in several studies. For example, a study carried out in the Netherlands concluded that a definitive potential for recycling and water cycle closure exists in the food industry, and depending on the food sector, it seemed possible to reduce the use of water by 20–50% (Hiddink et al., 1999).

According to Pagella et al. (2000), a strategic approach to water reuse must be based on a systematic analysis and on the principle that water users must not use more water of a higher quality than strictly needed. The statement may seem bombastic but there is no doubt that appropriate quality and quantity as well as point-of-use availability need to be balanced. Reuse in the food industry has been limited for many years due to strict regulations. We now have a situation where current guidelines and regulations regarding use and reuse of water in the food industry acknowledge the use of other water qualities than that of potable water (Council Directive 98/83/EC, 1998; Codex Alimentarius, 2001). This provides flexibility but at the same time requires a high degree of multidisciplinary knowledge and substantial documentation from industry and regulatory authorities. Unfortunately, research and development have been somewhat hampered in this area due to the fear of lowering hygienic standards. While this hesitation may be understandable since health risks associated to reuse are difficult to assess, the challenges need to be faced in order to avoid future problems.

The drivers to improving water efficiency in industry can be roughly classified into three types: economic, environmental and technological (Terrell and Holmes, 1994), whereas the barriers also include elements dealing with safety, legislation, perception, collaboration and communication. This paper presents the status, including drivers and barriers, as well as the challenges that may arise when implementing water reuse practices in the food industry with particular focus on the microbial aspects. It also describes some approaches for reuse in food manufacturing plants. It should be mentioned that in this paper the term ''reuse'' refers to the recovery of water from a processing step and its subsequent use in a food manufacturing operation, ''recycling'' refers to reuse within the same food manufacturing operation, and ''reconditioning'' refers to the treatment of water intended for reuse (Codex Alimentarius, 1999).

2. Water in the food industry

2.1. Water consumption

Water is involved in many food processing methods and unit operations, e.g., soaking, washing, rinsing, fluming, blanching, scalding, heating, pasteurising, chilling, cooling, steam production, as an ingredient, and for general cleaning, sanitation and disinfection purposes. The food industry is characterised by high water consumption per ton of food product as exemplified by some figures from Germany, e.g., 30 m^3 wastewater per ton of frozen carrot produced, 1.2 m^3 for apple juice, 4.15 m^3 for beer production, and 1.7 m^3 for chiller showers during meat processing (Chmiel et al., 2000). The annual total water consumption for the food industry was 347.2 million m^3 in Canada in 1991 (Dupont and Renzetti, 1998), 455 million m^3 in Germany in 1995 (Fähnrich et al., 1998) and 247 million m^3 in the Netherlands in 1996 (Statistics Netherlands, 1998). The consumption of tap water, ground water and surface water for the food industry compared with other industries in the Netherlands in 1996 is shown in Table 1 (modified from Statistics Netherlands, 1998). In this table, the use of water for cooling is separated from the total use and it may have been fed back to the source after use. The term sweet water use refers to total tap water, sweet groundwater and the part of sweet surface water that is specifically used in food production and processes, i.e., not cooling. Here, the chemical and food industries are the major sweet water users. Approximately 50% of the total water used in the food industry is sweet water, whereas this is significantly lower for the chemical industry. Sweet water requires effort and cost to obtain, i.e., purification, pumping and license costs, and it is considered scarce.

The principal water quality parameters are of sensory, chemical and microbiological nature. The microbiological quality parameters are described in Section 4.3. Water supplied to the factory may differ in quality according to its different routes through the environment. In most cases, the source water for the food industry is the potable supply from the water main. Depending on the quality of the water and the technical requirements for use, this water may be further adjusted to suit different needs (Griffiths, 1998) such as removal of colour, softening or the addition of chlorine to minimise the count of potential spoilage microorganisms or the use of UV radiation, e.g., to disinfect stored water directly before use as an ingredient (Dawson, 1998). Deterioration in the quality of water prior to use may