Techniques for On-Site Audit of Quality Management System in Food Production Enterprises

Min Gao

Yunnan Light and Textile Industry Vocational College, Kunming, 650000,China

Email: 674592474@qq.com

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Abstract: The cleaner production audit is the premise of promoting cleaner production and an important means for enterprises to achieve sustainable development. A dairy enterprise in Yunnan Province implemented no / low cost scheme and medium / high cost scheme for cleaner production, and achieved water saving by 299,000 t/a , a reduction in waste water discharge by 40,971 t/a, a benefit of ¥1.703 million/a, and significant economic and environmental benefits. This article introduces the audit of cleaner production according to the characteristics of the dairy industry and expounds the characteristics of cleaner production of dairy enterprises and the relevant policy requirements of the industry. It argues that, to achieve sustainable development, dairy enterprises should comprehensively carry out cleaner production starting from themselves, which includes energy saving, consumption reduction, pollution reduction, and efficiency improvement.[4]

1 Introduction

Under the increasingly fierce market competition, the questions of how to save energy, reduce consumption, reduce pollution and increase efficiency have become the keys to the sustainable development of enterprises. Cleaner production is an effective approach for the construction of ecological civilization, and the transformation of end control into source control. In the Cleaner Production Promotion Law, Cleaner production refers to taking continuous measures, such as improving design, using clean energy and raw materials, adopting advanced technology, using advanced equipment, and improving management, to realize comprehensive utilization, to reduce pollution from the source, to reduceor avoid the generation and discharge of pollutants during the production, services and the usage of products. The aim is to reduce or eliminate the negative effect on human health and the environment.

2 Characteristics of the cleaner production audit in dairy enterprises

The development of the cleaner production audit not only equips staff with a new understanding of the concept of cleaner production, but also promotes the improvement of enterprise management. This requires enterprises to gradually and continuously run cleaner production through daily work to achieve the goal of saving energy, reducing material consumption, reducing pollution, and improving the comprehensive utilization rate of resources. As a result, the whole process unifies enterprises' economic growth, resource conservation and environmental protection, and helps enterprises achieve the harmony and simultaneous prosperity of quantity, quality, and efficiency.

The idea of cleaner production audit of dairy enterprises revolves around facts including high energy consumption, high water consumption, large amount of wastewater discharge, etc. Cleaner production opportunities are discovered and the corresponding plans are formed from eight aspects: products, employees, management, process control, equipment, technology, raw and auxiliary materials, and energy & wastes. Furthermore, to achieve the goal of cleaner production, priorities should be highlighted in each of the seven-stage audit process, planning and organization, pre-audit, audit, generation and selection of the scheme, feasibility analysis, implementation of the scheme, and continuous cleaner production [1].

2.1 Obstacles to cleaner production audits in the dairy industry

This section analyzes and predicts various obstacles that may be encountered in the development of cleaner production. Table 1 presents the corresponding countermeasures.

Table 1 Obstacle analysis and solutions

Obstacle type	Manifestations of obstacles	Solutions
Ideological obstacles	Ideas that cleaner production and cleaner production audits are extremely difficult	To master cleaner production methods through publicity and training
Technical obstacles	Lack of analyzing, testing methods and experience; difficulty in obtaining accurate data on material consumption, energy consumption and waste emissions during the production process	To seek help from consulting organizations, who can provide technical guidance to assist enterprises in completing analysis and testing
Financial material obstacles	Lack of capital support for cleaner production	To gather potential funds within the enterprise by flexibly utilizing capital resources

2.2 The importance of finding and replacing obsolete equipment, facilities, and technology, etc

Guidance Catalogue for Industrial Structure Adjustment (2019 Version) clearly states the production process and equipment that are restricted, and thus should be eliminated. According to the second batch (2012), the third batch (2014), and the fourth batch (2016) of the *Phase-out Catalogue of Mechanical and Electrical Equipment (products) with High Energy Consumption*, the production equipment, the equipped motors, and transformers should be tested on the spot. The appropriate energy-saving motors should be selected with reference to the *Recommended Catalog of Energy-saving Mechanical and Electrical Equipment (products)* (Batch 7).[5]

2.3 Cleaner production analysis of energy consumption in dairy enterprises

Equipment in factories are mainly used for refrigeration, sterilization, homogenization, and drying. In recent years, natural gas has replaced coal as the fuel in the boiler,[10] and steam generated is used for preheating, sterilization, drying and other processes in production. At the same time, natural gas boilers have replaced coal-fired boilers [2].

2.4 Cleaner production analysis of water consumption in dairy enterprises

The cleaning process in factories consumes the majority of water supply. This includes floor cleaning, bottle boxes cleaning, as well as CIP cleaning. Besides, boiler systems also consume a certain amount of water. Furthermore, liquid waste is generated from domestic sewage, CIP cleaning of workshop equipment pipes, etc.,[7] and solid waste comes from production, such as packaging materials and domestic garbage.

2.5 Analysis on the causes of waste and solutions

Based on the investigation of the production status and product situation of different enterprises, this section analyses the causes of waste in the production process and proposes solutions.

(1) Raw and auxiliary materials and energy. The raw and auxiliary materials used are mainly fresh milk, whey protein, white sugar, auxiliary materials, etc., which are edible, non-toxic and harmless. In the production process, these are unlikely to generate waste. Thus, the goal here is to control the amount of raw and auxiliary materials, as well as packaging materials used, and to improve utilization.

(2) Technical process. During the production, the main process water is softened water and internal washing water, the second one is usually contained in the equipment and the milk tanks of milk carts. In order to meet industry standards, the wastewater can only be discharged after treated at the sewage treatment station, and such water can be used for greening. Similarly, the cooling water of the equipment should be recycled after treatment and used for greening as well.[7]

(3) Equipment. Gas boilers can emit a certain amount of pollutants, which include sulfur dioxide, nitrogen oxides and so on. However, as natural gas is a clean energy, the amount of waste generated is much lower than the concentration limits set by *Boiler Air Pollutant Emission Standards* (GB13271-2014).

(4) Process control. Technological process control has an impact on product output and quality, which will indirectly affect the company's energy consumption and the amount of pollutants generated.[9]

(5) Products. Changes in product structure and in production processes can also indirectly affect corporate energy consumption and the generation of pollutants.

(6) Wastes. Some enterprises analyzed by the author have built their own sewage treatment station, applying hydrolytic acidification + anaerobic + good nutrition treatment process, with a processing capacity of 2,500m^3 / d. The anaerobic tank can produce a great amount of methane in large manufacture scale. Methane is combustible and thus should be recycled, otherwise can result in huge waste.

(7) Management system. Improper management can lead to inappropriate use of raw materials in the production process; obsolete monitoring system and a lack of monitoring plan will increase pollutant emissions. Similarly, improper equipment maintenance leads to equipment failure and efficiency decline, generating more waste as a result.

(8) Employees. Employees in enterprises analyzed by the author have mixed understandings of cleaner production, some of them do not even know this concept. A combination of the lack of cleaner production training, limited awareness, and obsolete working habits contributs to greater waste.

3. Cleaner production standards for dairy enterprises

At present, government has issued relevant policies for the dairy industry, these include the *Guidance Catalog for Industrial Structure Adjustment* issued by the National Development and Reform Commission (NDRC), the *Catalogue for the Phase-out of Mechanical and Electrical Equipment with High Energy Consumption and Backwardness* issued by the Ministry of Industry and Information Technology (MIIT), and the *Dairy Industry Policy* promulgated by the MIIT and the NDRC. The third document clearly lists the consumption standard of unit output of pasteurized milk and yoghurt, as well as the quota requirements of water consumption per unit product [3].

According to *Cleaner Production Standard—Dairy Products Manufacture (Pure Milk and Whole Milk Powder)*, cleaner production of sterilized milk is divided into five categories: production process and equipment requirements, resource and energy utilization index, product index, pollutant production index (before end treatment), and environmental management requirements. The first-level index of resource and energy utilization requires that those parts that can be cleaned by CIP must all be cleaned by CIP, the loss rate of raw milk be less than 0.5%, the water consumption be less than 1 m^3/t, and that the comprehensive energy consumption be less than 1 GJ/t.

4. An Example of cleaner production audits in dairy enterprises

Dairy enterprises with different products have different key points and objectives in cleaner production audit, but the common point is to focus on the links in the consumption of water, material and energy, to compare the current situation of the enterprise with cleaner production standards,[6] and to find the reasons for high energy consumption from 7 stages and in 35 steps. Finally, the enterprise can adopt the methodological principle of cleaner production, look for cleaner production opportunities, and conceive cleaner production schemes.

For example, the establishment of a large-scale professional dairy breeding base at the source of materials can reduce material consumption; the technical upgrade of production equipment can reduce power and personnel consumption; by making use of Yunnan's unique solar energy, the inlet water temperature of the boiler can be increased, thereby decreasing natural gas consumption of boiler (a reduction of energy consumption); similarly, the utilization of the biogas produced by the

sewage treatment station and the external biogas stove can achieve the same effect; the recycle of condensate and bottle-washing wastewater from bottled milk can decrease water consumption; and finally the photovoltaic power generation in the factory can decrease power consumption.

This section analyzes an example on the cleaner production audit of a dairy enterprise in Yunnan. Through the investigation of its current situation, the audit team found that its industrial wastewater comes from CIP cleaning and softening water production, and that industrial wastewater is concentrated in the sewage treatment station, and then is discharged according to the standard of biochemical treatment.

Table 2 shows the consumption of water resources and energy in the past three years, with a comparison from first-level indicators of cleaner production standards.

Table 2 Comparison of energy consumption and standards in the past three years (before cleaner production)

Items	Units	2017	2018	2019	First-level indicators of cleaner production standards
Water consumption	t	263868	332859	519895	—
	t / t	4.46	4.41	5.86	≤1m3/t
Total energy consumption (equivalent value)	tce	1868.98	2060.16	3110.05	—
	GJ/t	0.92	0.80	1.03	≤1

The audit team firstly compared the production status of the enterprise with the cleaner production standards and domestic counterparts, and then identified those indicators that show large gaps as the goal for cleaner production, and then looked for cleaner production opportunities from 8 aspects. After technical, economic and environmental feasibility analyses, the team produced a medium / high cost transformation scheme. The details are as follows.

(1) Transformation of frequency control of the air compressor. As there had been empty power consumption when the air compressor was working, the audit team suggested the company to use frequency converter to adjust the speed of the air compressor and form a closed-loop feedback system, and to adjust the air supply of the air compressor according to the actual needs. By doing so, the company saved power up to 20% of power.

(2) Modification of cooling water pipe in evaporative condenser. Originally, the cooling water of the refrigeration workshop had consumed a lot of electricity. This can be improved by connecting the evaporative condenser water tank in series, connecting the evaporative condenser water tank with the water pipe near the circulating pool, and connecting the water supply pipes in parallel. Then the water supply flow of three evaporators can be controlled, and the power saving rate is up to 30%.

(3) To increase the inlet water temperature with biogas furnace. As the boiler consumed a large amount of natural gas, the methane generated by the anaerobic reactor UASB of the sewage treatment station can be used to preheat and heat up the inlet water, leading to 70% reduction of natural gas consumption.[8]

(4) Water recycle for greening. The water treated by the sewage treatment station was originally discharged, but actually 50% of this water can be recycled for greening.

(5) Internal recycle of water in CIP section. In the original process, the water in the three cleaning sections of CIP was directly discharged. The audit team proposed that the last flushing water can be used for the first flushing, which will save 146,600 tons of water every year.

The enterprise has cumulatively invested about 2.472 million *yuan* in the cleaner production program. As a result, it realized a total water saving of 299,900 t / a, a reduction of wastewater discharge of 40,971 t / a, and a benefit of 1.7039 million *yuan* / a.

Apparently, after the cleaner production audit and the implementation of the cleaner production

plan, costs have significantly dropped, and the goals of reducing energy consumption and pollution, increasing efficiency. Furthermore, unite economic and social benefits is realized.

Conclusion

Overall, strategies for the cleaner production audit are to make use of the principles of cleaner production, to find cleaner production opportunities through scientific audit methods and systematic analysis, and to implement a series of operable cleaner production schemes. The aim is to save energy, reduce consumption, decrease pollution, and improve efficiency. Therefore, as an opportunity and the start, the study of cleaner production in dairy enterprises is of great importance to the sustainable development of dairy enterprises.

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