Workshop Structure Design of Frozen Drinks Factory

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Abstract According to the announcement of General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, the risk of microbial items in frozen drinks is very high, and it is difficult to improve. For example, a recent spot check showed that 42 kinds of frozen drinks had microbial indicators exceeding the standard. Part of the reason is that the design of the production workshop is not conducive to the rapid removal of production water, resulting in continuous moisture throughout the workshop, which provides a breeding bed for microorganisms to breed and then contaminates the product. Therefore, research is carried out from the design point of view to fundamentally reduce the moisture in the workshop and build a dry workshop for frozen drinks production, so as to effectively reduce the risk of microbial contamination of frozen drinks.

Key words Frozen drinks, Microorganisms, Structural design

0 Introduction

The main risks of frozen drinks are protein, total number of bacterial colonies and coliform bacteria. And unqualified protein can be controlled by formula adjustment and detection of samples taken when the device is started or stopped. However, microbial items are invisible, scattered, and the results are not representative. Therefore, the risk of microorganisms has always been a long-term risk that many frozen drinks factories have been dealing with. Especially after *Listeria monocytogenes* was listed in the national standard, the requirements of microbial control in cold drink factories were further enhanced[1].

Water is the key factor for the breeding and reproduction of microorganisms. Because of the characteristics of production process, the cold drink factory has a large amount of water in the workshop, which is easy to breed microorganisms, thus limiting the effect of daily cleaning and disinfection. The main difficulty in microbial control of frozen drinks is that the whole workshop is humid, which easily leads to microbial reproduction and growth. Therefore, when designing a frozen drinks factory, it is necessary to pay attention to the control of water in the environment. It is necessary to quickly remove demoulding water and cleaning water in the workshop, and strengthen roof waterproofing and anti-seepage measures to avoid microbial risks caused by rain leakage and humidity. When the factory is producing, the water vapor in the shop floor will cause condensation, which is a challenge for microbial control[2-4].

This paper combines the particularity of cold drink factory with the factory design, waterproof performance of and building materials, aiming to reduce the influence of water in the environment of cold drink factory, and eliminate the water in the production process and external environment as soon as possible, which can reduce the microbial risk[5].

1 Requirements for the floor of the production workshop

1.1 Safety and sanitation The floor should ensure that it does not volatilize substances that contaminate food, has anti-slip, moisture-proof, and mildew-proof properties, is easy to clean and maintain, and has no gaps to prevent dirt and filth. The interior of the workshop is required to be terrazzo or emery mixed ground or self-leveling ground, and the ground is required to be flat and without obvious low-lying areas. Since the clean workshop area is cleaned with water during production, the workshop floor must be smooth and flat.

1.2 Load-bearing, wear-resistant and corrosion-resistant The floor must be able to withstand traffic loads, such as equipment, forklifts, to prevent damage due to weakness and low wear resistance. It is necessary to resist the erosion of chemicals in food processing technology, such as lactic acid, fruit acid, caustic soda and bleaching powder used for cleaning and disinfection. To ensure that it can withstand the weight of the production line, the thickness of the floor concrete layer is required to be no less than 30 mm. The concrete floor should not have quality problems such as damage, cracks, bulges, and subsidence. Strong and wear-resistant porcelain tiles should be used for floor paving, and the gaps between porcelain tiles should be carefully smoothed with C30 concrete (or higher strength).

1.3 Conducive to drainage The inclination is set according to the drainage requirements of the area, so that sewage can be discharged smoothly. The longitudinal inclination angle in the production workshop is 3 -6°, and the transverse inclination angle is 1 -3°, which can ensure that the water sequentially flows to the drainage ditch along the inclination angle. The joint between the ground and the corner must be treated well, smooth and crack-free, set in an arc shape, and the radius of curvature is not less

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than 3 cm, which is conducive to cleaning and is not easy to breed microorganisms or pathogenic bacteria[6].

2 Requirements for production workshop walls

2.1 Material selection The wall of the workshop should be laid with wainscot with a height of at least 2 m, and it should be made of corrosion-resistant, easy-to-clean-and-disinfect, durable and impermeable materials. At the same time, it should be coated with light-colored, non-toxic, waterproof, mildew-proof, and easy-to-clean materials. Wall materials must have excellent waterproofing properties to prevent moisture penetration leading to mold growth. Due to possible contact with chemicals such as cleaning agents and disinfectants during production, the material should be resistant to acid and alkali corrosion.

2.2 Anti-mildew and anti-microbial The surface of the wall should be free of cracks, convexity and concavity, and easy to clean. The wall material should be resistant to high-pressure washing and high-temperature steam cleaning. Microbial contamination can be reduced by strengthening cleaning. It has antibacterial and mildew-proof properties, which can effectively prevent the growth of bacteria and mold and avoid contamination to food.

2.3 Durability The selected materials must have good acid, alkali and salt corrosion resistance, ultraviolet radiation resistance, and long service life. For the selection of wall materials in the workshop of frozen drinks factories, special emphasis is placed on the requirements of acid, alkali and salt corrosion resistance, ultraviolet radiation resistance and long life. This is particularly important in the face of high-frequency cleaning and long-term lighting conditions, and is the key to improving material performance.

2.4 Partition If insulation board is used for isolation, rock wool board with flame retardant effect must be used. Rock wool boards must comply with national fire safety standards, reaching B1 or higher to ensure that they have good flame retardancy properties in high temperature or fire situations and will not support combustion. The fire-resistant coating of the sheets must be certified and will not peel or age after long-term use. Some doors require the installation of limit switches and automatic return devices[7], in order to achieve the precise positioning of the door and prevent the door from opening too wide or too narrow due to external force, which affects the temperature control or airflow stability of the production area. The connection between the insulation board and the ground and the top is set in an arc shape, which can prevent dust accumulation and facilitate daily maintenance and overhaul.

3 Requirements for sewer pipes in production workshops

The drainage ditch of the workshop should be paved with smooth surface and impermeable materials. There should be no unevenness and cracks during construction, and an inclination of 3% should be formed to ensure the smooth drainage of the workshop. The direction of drainage is also from the clean area to the non-clean area. Movable grates made of rust-free materials should be added to the drainage ditch.

It is recommended to avoid using cement drainage ditches, because during use, the accumulation of grease and impurities, coupled with the corrosion of products, can easily lead to cracking and rotting of cement drainage ditches, which will affect the drainage effect and produce peculiar smell. You can lay tiles, or buy a large-diameter PVC pipe, plane it from the middle and lay it inside the sewer.

Reasonable design of sewers is the key to ensuring smooth drainage and preventing dirt accumulation. The semi-circular and arc design can significantly improve the drainage efficiency and reduce the difficulty of cleaning and maintenance. There is no right-angle inflection point at the bottom of the sewer, and the water flow pressure is evenly distributed, making it difficult for sewage backflow or water accumulation to occur. Solid residue, which is common in food factories, can be discharged faster, effectively avoiding long-term accumulation causing pipe blockage or odor problems. In the workshop of frozen drinks factory, the drainage system is an important facility to ensure environmental sanitation and smooth production. Due to the frequent use of water cleaning equipment, floor washing and food residue treatment in the workshop, the design of the drainage system should not only meet the needs of efficient drainage, but also have protective measures to avoid problems such as pipe blockage and sewage backflow. Installing check valve to prevent sewage backflow is a key design point, and it is necessary to comprehensively consider the layout, material selection, maintenance convenience and operation efficiency of the drainage system[8].

4 Floor system waterproofing and thermal insulation

4.1 Floor system waterproofing The floor system of pretreatment workshop, production workshop and aging pipe workshop is very important. In areas where the annual precipitation is less than 1 100 mm/m, a waterproof roll can be used; in areas where the annual precipitation exceeds 1 100 mm/m, floor system waterproofing measures must be strengthened. Waterproof roll and waterproof coating can be used for waterproofing. At the same time, the roof uses reinforced concrete material made of anti-seepage cement, which itself has waterproof properties. With two waterproofing layers, it can effectively ensure that water will not leak into the workshop. The drainage pipeline on the roof of the floor system also needs to be strengthened, organized drainage should be adopted, and the number of drainage pipelines should be calculated in accordance with the floor area to avoid water accumulation on the floor surface. For areas with annual precipitation exceeding 2 000 mm/m and summer rainfall exceeding 1 000 mm/m, it is recommended to use inverted siphon drainage pipeline to quickly remove floor water and effectively prevent roof water leakage caused by

short-term heavy rainfall during heavy rain or typhoon.

The inner side of the roof facing the workshop needs to be flat and smooth, and no shorter than 5 m. It must maintain a certain distance from the production line, and at the same time have a certain arc to prevent condensation from the top layer from dripping on the products due to its own weight[9].

4.2 Floor system insulation The insulation layer of the floor system can be inverted. First, an air barrier layer is made to prevent the water vapor in the house from entering, then a waterproof layer is made, and finally an insulation layer is made. The internal air barrier layer can prevent indoor water vapor from entering the waterproof layer and insulation layer, while the external insulation layer can prevent temperature and sunlight from damaging the waterproof layer. This can not only effectively control the temperature in the workshop, save energy, but also prevent water vapor from entering the waterproof layer and thermal insulation layer, breeding microorganisms and then polluting the workshop environment. Good insulation helps to avoid indoor and outdoor thermal bridges, thereby reducing the possibility of microbial growth[10].

5 Workshop ventilation

5.1 Setting clear ventilation objectives According to the standard of sterile workshop for food production, the ventilation volume should be set to ensure that the air quality meets ISO Class 7 or higher requirements and regular inspection and maintenance of air filters should be carried out to meet food production standards.

It is necessary to comprehensively consider factors such as workshop area, height and number of employees, and reasonably determine the ventilation volume to ensure uniform air circulation in each area and completely eliminate ventilation blind spots. It is necessary to ensure employee health and work comfort based on fresh air demand per person (typically 30 – 50 m^3/h per person). Additional exhaust requirements are designed for heat and moisture generated by refrigeration equipment, refrigeration units, *etc.*

5.2 Setting air quality standards Air quality standards include parameters such as air cleanliness, temperature and humidity. With reference to the national food production hygiene standards, the concentration of suspended particulate matter (PM_{10}) in the air should be controlled within a reasonable range to avoid food contamination. It is necessary to configure air filtration equipment, such as HEPA high efficiency filters, to remove more than 99.97% of particulates from the air. Through reasonable airflow distribution design, clean air is kept entering from the work area, and exhaust gas and hot air are discharged from the position far away from the production line.

5.3 Reasonable design of ventilation system Choosing ventilation equipment and methods: it is necessary to choose exhaust fans or ventilators with stable performance and low noise, and reasonably arrange air supply and exhaust outlets. It is necessary to choose exhaust fans or axial flow fans with stable performance and low noise (< 65 dB), and give priority to equipment with frequency conversion function, which is energy-saving and efficient. It is necessary to adopt a combination of air supply by central air-conditioning or natural ventilation, and adjust the air supply volume according to the needs of workshop zoning.

5.4 Design of air duct and air outlet The air duct is smooth and corrosion-resistant, and the number and size of air outlets are reasonably configured. It is necessary to ensure smooth airflow in the air duct, and avoid increasing airflow resistance due to excessive bending of the pipe or sudden change of the cross section. It is necessary to add sound insulation materials on the inner wall of the air duct to reduce the impact of airflow noise on the workshop environment. All air outlets should be equipped with detachable protective nets to prevent foreign objects from entering the air duct and facilitate daily cleaning[11].

5.5 Following airflow organization principles The principle of ventilation is always to flow from high cleanliness areas to low cleanliness areas, and backflow is absolutely prohibited to prevent external polluted air from entering the workshop. The high-efficiency filtration is used in production workshops and aging pipe areas, and the medium-efficiency filtration is used in semi-clean areas. It is necessary to pay attention to the pressure control in each area, and control the air flow direction through pressure difference. At the same time, an automatic pressure difference monitoring and alarm device can be installed. Once the pressure difference is abnormal, it can alarm to remind managers to take measures to correct the deviation. Ventilation and exhaust facilities connected to the outdoor should have dustproof nets and protective nets to prevent foreign objects and flies from entering[12].

6 Workshop ceiling

If the ceiling design is adopted, corrosion-resistant materials such as stainless steel should be selected as the ceiling structure. With their excellent corrosion resistance, these materials can effectively resist the erosion of moisture and chemicals, thus ensuring the lasting stability and safety of the ceiling structure. These materials have smooth surfaces, are not easy to accumulate dust, and are convenient for daily cleaning and disinfection; in addition, they are strong and durable, can withstand heavy loads, reduce the need for maintenance and replacement, and do not release harmful substances, fully meeting international food safety standards.

It is forbidden to use wooden structures or gypsum boards or similar water-absorbing boards, which may absorb water and become moisture, thus breeding microorganisms. Many international standards and specifications also stipulate that it is strictly forbidden to use wood as building or decorative materials for cold drink factories[13].

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(iii) Through precise control and operation, the new device can improve the quality stability of the experiment, reduce the error of manual operation, and further guarantee the safety of operators and the ecological environment.

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7 Workshop doors and windows

It is necessary to set up one-way doors in the production workshop as much as possible, so as to ensure that personnel can only flow from high cleanliness area to low cleanliness area. People, like air, cannot flow against the current. Non-toxic, corrosion-resistant and easy-to-clean materials, such as aluminum alloy and tempered glass, should be selected to ensure food safety and easy maintenance. Windows should be fitted with easy-to-clean insect screens to prevent pests from entering the workshop and contaminating food. At the same time, the edges of doors and windows should be well sealed to avoid dust entry[14].

The microbial control of frozen drinks is very important, especially after *L. monocytogenes* is listed in the national standard. Enterprises should be the first responsible person for food safety and strictly control the quality. Therefore, it is necessary to consider how to reduce food safety risks in project design. This paper focuses on the main controlling factors of microorganisms, water and air. Microbial control needs to be considered from many aspects, not only involving quality, supply, research and development, and procurement, but also closely related to project management. Only by doing well in every link can the microbial risks in frozen drinks be effectively controlled[15-16].

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