

DESIGN AND TECHNICAL FEATURES INCREASING FOOD SAFETY OF AN IQF FREEZER

Svetlana Plotean^{1*}

OctoFrost AB, Volframgatan 3, 213 64 Malmö, Sweden

*e-mail: svetlana.plotean@octofrost.com

Abstract

This paper comes at a moment when food safety became a serious concern on the market of frozen foods, with major frozen food recalls which took place in 2016 only due to food contamination. The focus on Individual Quick Freezing (IQF) technologies specifically, is equally relevant in an era when the consumption of frozen products is steadily shifting towards frozen products of higher quality and increasing convenience. This work can be of significant value for food processors due to the lack of an explicit guideline on the matter in the existing legislation and literature. The main objective of this paper is to highlight those specific design and technical features which have a positive impact on a reliable food safety of an IQF freezer. This paper can be used as an orientation guideline by food processors when choosing a food safe IQF freezer.

After almost a decade of experience in the designing and building of IQF freezers, we can surely state that the voice of food processors is the most reliable method to gather realistic feedback on design and technical features which contribute to a reliable food safety. This paper is a result of years of testing, trials and customer feedback. We have found that features such as short cleaning time, elevated housing, limited number of moving parts, easy to clean product-transportation plates, coil-cleaning system, accessible design, and mono-block housing are the main features of an IQF freezer increasing dramatically the food safety standards during freezing process.

We want the reader to be aware, however, that it is up to each food processor to put in efforts and energy to take advantage of these features in order to achieve reliable food safety, as the mere presence of these features does not guarantee results in itself.

Key words: Food safety, IQF freezer, Food safe design, IQF freezing.

1. Introduction

Individual Quick Freezing (IQF) technologies are becoming increasingly more popular due to complex socio-cultural lifestyle changes in today's society. IQF means that the relatively small pieces of product are frozen separated from each other, while moving freely and relatively continuously (fluidized) through the freezing tunnel, surrounded by low-temperature airflows which leads to a high temperature transfer coefficients and therefore results in short freezing time [1].

The demand for IQF frozen products is growing as these products are typically of higher quality and are much more convenient when defrosting as the exact needed amount can be used without thawing a block of frozen product which leads to unnecessary waste. In addition, uneven distribution of food production together with increase in number of one-person households are influencing the growing preference for IQF frozen products.

As the customer's expectations and tastes become more and more sophisticated, there is also a growing pressure on a more reliable food safety of the frozen products. Food safety has become a non-compromising aspect for each food processor. Not only that processors need to keep the freezing equipment bacteria-free, but new kind of expectations are emerging on the frozen food market today. Food safety trends of a more religious nature, such as the continuous increase in the demand of frozen Halal meat, for example, is creating the need to ensure cleaning on a micro level, so there is no trace of pork meat in the production of Halal meat. Similar pressure is put on the companies processing meat for Hindu consumers, where no trace of beef meat is allowed. In addition to these types of cultural trends, the chain of major frozen food recalls due to *Listeria* spp. contaminations which took place in 2016 only, are increasing the pressure and the concerns for a more reliable food safety in the freezing process of food products.

Nonetheless, today's regulations on food safety in the IQF freezing equipment are often perceived to be insufficient to ensuring a truly reliable food safety. Lack of clear regulations defining optimal design features or recommended cleaning time is currently lacking in the legislation.

We have observed over years of experience in the freezing industry that there are specific design features of IQF freezers which improve the food safety during freezing process. This paper is an empirical research and has the goal of highlighting those features and explain our reasoning behind this selection. This work can also be seen as a start in creating useful recommendations which should be taken in account today, when looking at the design of a food safe freezing equipment. We have found that features such as: optimal cleaning time, elevated housing, limited amount of moving parts, easy-to-clean product transportation plates, coil cleaning system in place, general easy access and mono-block housing are some of the determining features of an IQF freezer which can increase dramatically the food safety standards during the freezing process. We will continue by describing the methods used in our empirical research and further on explaining in detail each feature and how it plays an important role in ensuring a reliable food safety. Some conclusions and reflections will close our paper.

2. Design and technical features increasing food safety of an IQF freezer

2.1 Methods of data collecting and reasoning for mentioned collection

After almost a decade of experience in the designing and building of IQF freezers, we can surely state that the voice of food processors is the most reliable method to gather realistic feedback on design and technical features which can contribute to a reliable food safety.

This paper is a result of years of testing, trials and customers' feedback. The method used in gathering the findings presented in this paper is of purely empirical nature as it is a continuous collection of feedback and expertise from over 200 food processors on the market during the past decade.

We believe that in this matter, this is a highly reliable method, as the food processors are the ones clashing with the food safety challenges on a regular basis and in the most practical way, therefore their observations and experiences are of highest value in such an analysis.

In the EHEDG guidelines the cleanliness of the equipment is described as a very important aspect especially in the case of difficult-to-clean equipment which need additional and more severe cleaning procedures, more

aggressive chemicals and longer cleaning cycles, which leads to higher costs and lower profitability on a long term [2]. We have focused our study on a number of design and technical features which have proven to dramatically increase the reliability of food safety in the IQF freezing equipment.

Based on food processors' feedback and observations, we have identified 7 main technical and design features which proved to play an important role in insuring high standards for food safety: optimal cleaning time, elevated housing, limited amount of moving parts, easy-to-clean product transportation plates, coil cleaning system in place, general easy access, and mono-block housing. We will further explain the reasoning behind the above mentioned selection.

2.2 Optimal cleaning time

Cleaning time is a crucial factor when it comes to profitability especially during high production season. When choosing the right IQF freezer, a closer attention should be paid to the freezers with a shorter but still optimal cleaning time. The cleaning cycle should not only be fast, but more importantly - as ample as possible. All walls, floors, ceiling, product transportation bed, fans - should go through a thorough cleaning. A cleaning performed with both water and sanitizing solutions should be aimed for.

As cleaning time is crucial during peak production, in order to insure a reliable food safety without compromising the production capacity, equipment with best ratio cleaning time vs. cleaning results should be aimed for. Any inefficient cleaning systems will threaten the food safety of all production as fans will keep circulating bacteria contamination over and over through the different product batches. The following (Figure 1) has been drafted based on feedback from food processors and it can be considered as a reference point of an optimal ratio time vs. efficiency when looking at different cleaning cycles in IQF freezers:

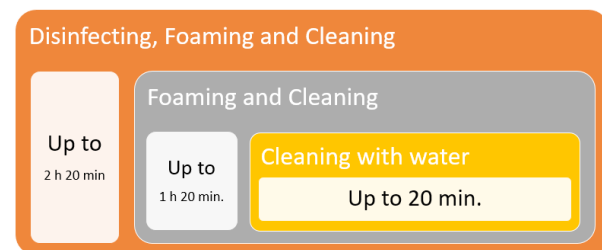


Figure 1. Optimal cleaning time for different cleaning cycles

As illustrated in Figure 1, an optimal time for cleaning with water only, has been concluded to be up to 20 minutes. When it comes to cleaning cycle with both water and foaming, the optimal time is considered to

be up to 1 h and 20 min., while in the case of cleaning with water, foaming and disinfecting, the optimal time is up to 2 h and 20 min. These estimations are taking in consideration the already existing cleaning systems in IQF freezers and are considered optimal even in pick production when down-time must be kept to minimum.

2.3 Elevated housing

Another important aspect which was observed by food processors is that an elevated housing of the IQF freezer can avoid the accumulation of water under the equipment, water created through condensation due to high temperature changes in-between production and defrost. The water accumulated under the freezer can become a contamination hazard therefore an IQF freezing equipment with an elevated housing should be something to aim for (Figure 2).

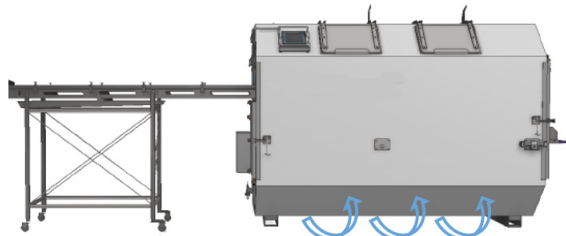


Figure 2. Circulating air under an elevated housing of an IQF unit

Another benefit of a freestanding body of the IQF freezer has proved to be the possibility of air circulation under the IQF unit, which eliminates the need of heating the floor/concrete fundament and facilitates future movement of the unit in the production facility. The feet of the IQF freezer can be placed directly on the floor or lifted on a steel structure to fit the other processing equipment like presented in Figure 2.

2.4 Limited amount of moving parts inside the freezer

Many freezing technologies still present designs where electrical cables and electrical boxes are installed inside the freezer. All these parts, together with transportation trays can become sources of bacterial contamination. Food processors claim that there is almost no cleaning cycle which can achieve acceptable results when so many parts are in the production zone. As a solution to this, there is the option of choosing IQF freezing equipment which is designed with a minimum of moving parts inside the freezer. For a reliable food safety, electrical boxes and cables should be placed outside the freezer.

Another design feature reported by food processors as being threatening to food safety is the presence of reusable trays for product transportation. This type of

transportation is used together with a mesh belt which transports the trays carrying the product through the IQF tunnel. These trays enter in direct contact with the product and can facilitate bacteria contamination as they are difficult to clean, and many times not convenient to clean after each transported batch of product. Food processors find exchangeable bedplates as a good alternative to mesh belt or trays for product transportation. We will treat this option in the next sub-topic, in more detail.

2.5 Easy-to-clean product transportation bedplates

An often problem reported by food processors, is a thorough cleaning of the transportation belts, especially when it comes to mesh belts. It is seen as almost impossible to clean a mesh belt at high food safety standards, without stopping the production for many hours.

An advisable alternative to this challenge is the use of IQF freezers which have exchangeable bed plates made from food grade plastic which are illustrated in Figure 3.



Figure 3. Easy-to-clean and exchangeable product transportation bedplates

The removable bedplates are easy and fast to exchange with another set of bedplates in the middle of production, with a downtime of less than 5 minutes for the exchange itself - an extremely important aspect noted by food processors especially in high season when multiple types of products can be frozen during one shift. This way, the bedplates can be washed outside the freezer with high-pressure water, insuring an excellent level of food safety on the transportation bed while the freezing process can continue. In addition to a reliable food safety in place, fast product change and close to zero downtime in pick production periods is possible when using exchangeable bedplates instead of mesh belt.

This specific feature has been recognised by food processors to bring a few more important benefits such as better product appearance (no freeze burns or cracks which usually occur when using metallic mesh belt) and minimal amount of lumps and blocks.

2.6 Coil cleaning system in place

The coil inside a freezer can obviously become a hazardous part of the freezer, due to all product particles circulated by the fans and which can get stuck in the coil. It is however possible to increase the food safety by choosing a freezing equipment with a coil cleaning system in place. Such systems are rinsing the coil during the cleaning cycle, removing all the product pieces and residues stuck in the coil. In the Figure 4 such a system is presented where can be seen the mechanism which is using high pressure water jets to clean the coil from debris after production.

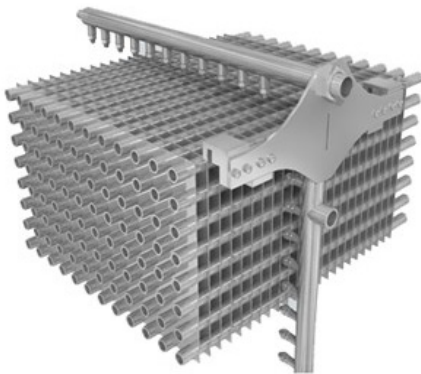


Figure 4. Coil cleaning system of an IQF unit

In addition, food processors are reporting that some IQF freezers are designed with a fence which protects the coil from the flying product residues which is a good addition to a coil cleaning system, further strengthening food safety levels in the IQF freezer.

2.7 General easy access

Food processors have expressed their preferences for IQF freezers which have a generally easy accessible design. This can be achieved by choosing an IQF unit with inspection hatches, mobile structures which can be opened when needed, lateral doors, etc. This is very



Figure 5. An IQF unit with a mobile lateral door

important not only for easy cleaning purposes, but also for reliable food safety inspections.

In the Figure 5, a mobile lateral door of an IQF unit is presented. This kind of feature facilitates access to the back side of the coil and can be used for throughout cleaning or sanitary inspections.

2.8 Mono-block housing

By mono-block housing we are referring to the casing of an IQF unit which is built in one piece (Figure 6). Such structures represent the main structural element of the unit.



Figure 6. An IQF unit with a mono-block casing

It has been noted by food processors that designs which feature a hermetic mono-block unit like the one shown in the Figure 6, are much more favourable for an enhanced food safety. Joints are the areas which present a great risk for bacteria accumulation, and by eliminating these risk areas, cleaning can be done with better results and cleaning time can be optimized as well.

Acknowledgement

This paper was created with the significant input and help of Ruben Larsson who shared his vast, life-time knowledge and experience of building and designing IQF freezers.

3. Conclusions

- Food safety during freezing process is a critical aspect to all food processors and there is a real need for guidelines in terms of design features which can increase and strengthen food safety standards. Over 200 IQF processors across the world have shared their opinions and experiences with us about the best design and technical features of an IQF freezer which significantly improve food safety during freezing.

- Optimal cleaning time is a very important factor when it comes to keeping profitability high and contamination risks low. As an orientation of optimal time ranges for different types of cleaning routines without compromising the quality of the cleaning and the production capacity, we have found to be: water cleaning in up to 20 minutes, water and foaming - in up to 1h 20 minutes and water, foaming and disinfection in up to 2h 20 minutes. IQF units which present cleaning systems and design features able to achieve such cleaning time are considered of preference for a better food safety.

- An elevated housing has shown to be an important design feature which avoids water accumulation under the IQF unit, facilitating cleaning under the freezer. This feature even presents other technical benefits such as eliminating the need of floor heating.

- The amount of moving parts inside the freezer is an important design criteria as it is directly linked to the food safety in the IQF freezer. The more moving parts the more challenging it is to achieve a throughout cleaning. Elements such as metal mesh belts, product transportation trays, electrical cables and boxes inside the freezer - all can compromise the quality of the cleaning process, therefore IQF units with limited amount of moving parts inside the freezer should be aimed for. As a good alternative to metal mesh belts and trays can be used IQF units featuring exchangeable bedplates made from food grade plastic.

- Food processors report excellent results in terms of food safety when using such bedplates as they can be thoroughly washed outside the freezer without stopping the production. This design feature must be considered as an important aspect in insuring a high food safety inside the production zone of the IQF freezer.

- A coil cleaning system has proved to be an important addition to a food safe environment as it helps to better clean the product residues which might enter the coil during freezing process. Such systems are using high pressure water jets and significantly contribute to better food safety.

- IQF units with general easy access are considered to be more food safe as the food processors can perform better cleaning while also having access for reliable food safety inspections.

- And finally, food processors consider mono-block housing to be a positive feature of an IQF unit as it minimizes the risk of bacteria accumulation in joints, which are usually hard to clean.

- The goal of this paper was to present a guideline for food processors who are interested in finding a food safe IQF freezer. We believe that this list of technical and design features could be a solid support for food processors when evaluating the right IQF technology.

It is well known that such features are of course facilitating achievement of high food safety however it is up to each food processor to put in efforts and energy to take advantage of these features in order to achieve reliable food safety, as the mere presence of these features does not guarantee results in itself. We believe that this paper could initiate a discussion around the present and future regulations regarding IQF design which could guide and harmonize the practices of the food processors for a more secure product of the tomorrow's consumer.

4. References

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