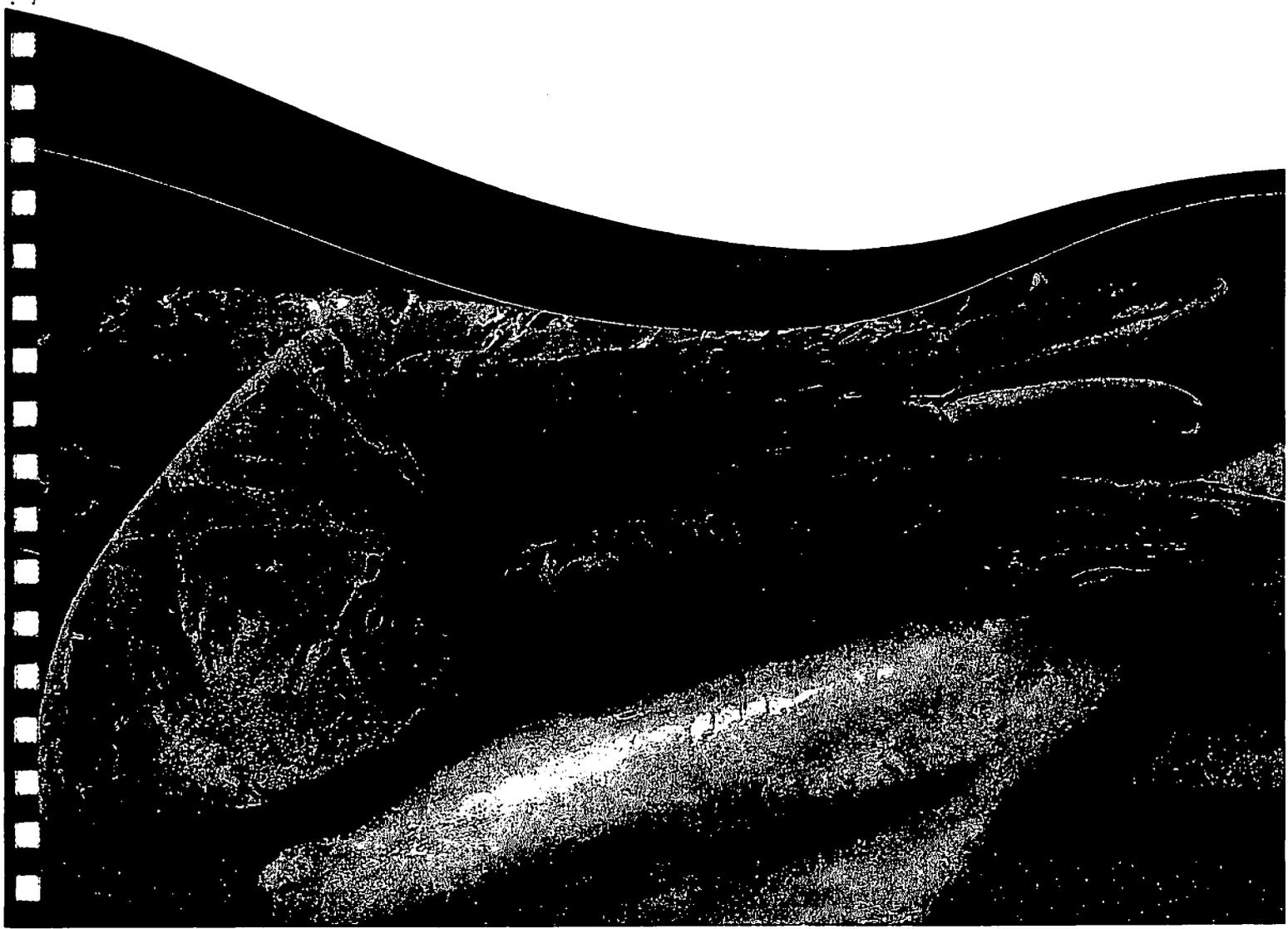


The Frozen Fish Chain



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The Frozen Fish Chain
An Open Learning Module for the
Seafish Open Tech Project.

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ISBN 1 85280 025 9

Contents	Page
THE AUTHOR	iii
Acknowledgements	iii
GENERAL GUIDE	v
INTRODUCTION	xi
Pre-Entry Requirements	xi
Equipment Required	xi
OBJECTIVES	xiii
SEGMENT ONE – BASICS OF FREEZING FISH	
Aims of the Segment	1
Why freeze fish	1
The need for quality	2
Freezing	5
Freezing rates	9
Summary	10
SEGMENT TWO – FREEZERS 1	
Aims of the Segment Two and Three	13
Basic Methods of Freezing	14
Plate (contact) freezers	14
Air blast freezers	18
Other types of freezer	22
Summary	23
SEGMENT THREE – FREEZERS 2	
Introduction	25
Fluidised bed freezers	25
Immersion freezers	26
Liquified gas freezers	28
Freezer operating temperatures	33
Loading/unloading space required	34
Summary	37

SEGMENT FOUR – GOOD FREEZING PRACTICES

Aims of the Segment	39
Buildings	40
Hygiene	42
Freezing time	46
Distortion of Uniform Blocks	52
Treatment after freezing	52
Summary	56

SEGMENT FIVE – STORAGE AND DISTRIBUTION

Aims of the Segment	57
Speed of transfer	58
The need for low temperature	58
The distribution chain	60
Cold storage warehouses	63
Handling and transfer of frozen fish products	69
Transport of frozen fish products	70
Summary	73

SEGMENT SIX – THE RETAIL OUTLET AND THAWING

Aims of the Segment	75
The retail freezer cabinet	75
Hints on the proper use of freezer cabinets	80
Thawing of frozen fish	80
Summary	84

RESPONSES TO SELF ASSESSMENT QUESTIONS 85

The Author

Tony Garthwaite is a Senior Lecturer in the School of Food Studies at the Humberside College of Higher Education. He has a special interest in fish processing and food engineering.

Prior to his present position Tony was employed for 17 years in the food processing industry. During that time he acquired considerable experience in product and process development including the freezing of fish and shellfish products.

ACKNOWLEDGEMENTS

We acknowledge permission from the Controller, Her Majesty's Stationery Office, to reproduce a diagram of a Batch Air Blast Thawer (our Fig. 9) from a publication on Fish Handling and Processing.

A Guide for Open Learners

This will help to explain what open learning is all about. It will help you to make the best use of your open learning module.

WHAT'S SO GOOD ABOUT OPEN LEARNING?

Open learning gives you freedom to choose.

You study:–

- What you like
- Where you like
- When you like
- At a pace to suit you.

You can pick the subjects you want. You don't have to be in a certain classroom at a certain time. You won't be bored because the teaching is too slow, or lost because it's too fast.

You seldom need any qualifications before you are allowed to study.

All this freedom lets you fit your studying into your daily routine.

The best thing about it for most people is that they can study without taking valuable time off work.

Modules are written in a way that allows you to study without help. However, it is expected that you will need assistance from time to time, this can normally be provided.

THINGS YOU SHOULD KNOW ABOUT YOUR MODULES

What is a module?

A module is the name we have given to a study package. It will have a printed text. In a few of them there will be audio or video tapes as well.

Each module will be divided into segments. You could think of each segment as a lesson.

Before you begin

Each module will have a short introduction. You will be given a list of things you will need. For some modules, special equipment will be needed. We can supply most of this. This section will also tell you if you need any knowledge or experience before you begin. Check that you have everything you need.

Objectives

Modules are based on objectives which tell you what you will be able to do when you have finished. These are clearly stated. You should check that the module objectives match your own reasons for studying. You will be told when you have achieved each one of the objectives. In this way you can easily keep track of your own progress.

S.A.Q.'s

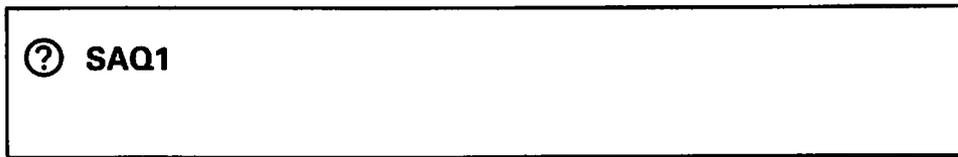
This is short for **self assessment questions**. These questions are carefully designed to help you. They let you know how you are getting on. They help you to find out any problems that you may be having with the material and help you to put them right.

Don't be tempted to skip these questions. Don't look at the answers before you try them! You will only be cheating yourself.

Where you are expected to write an answer, a space will be left in the text. Remember the module is your learning tool, not a textbook, so go ahead and write on it. **Don't try to keep an answer in your head until you have checked it. Always write down your answer first.** Writing the full answer down is very important, it makes you really think about what you are doing. The wide margins are also there for you to make notes in.

You will notice that the numbers given to the S.A.Q.'s are out of order. We did this on purpose. This is to stop you from accidentally seeing the answer to the second S.A.Q. when you are looking at the response to the first. The responses to the S.A.Q.'s are at the back printed on yellow paper. They are in the correct number order. I have called them responses because they are usually more than just answers. It is a good idea to read the whole response every time. It usually helps to know about common mistakes even though you got the right answer.

S.A.Q.'s are shown by a box with a question mark and the number of the question.



Important information

Other boxes are used to show different types of information. This box with the **i** in the top left corner contains important information.



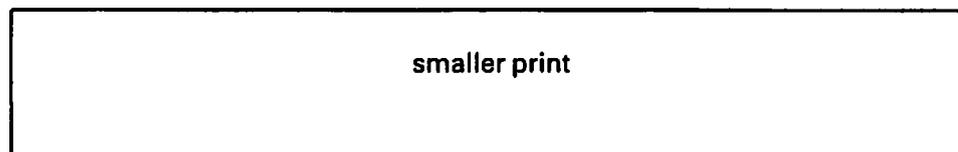
Warnings

This box with the warning sign gives information about possible dangers, health hazards, etc.



Definitions

A box with smaller print is used for definitions and extracts from documents.



Other emphasis

Shading like this is used to pick out important sentences and paragraphs.

Bold type is used to make important words or numbers stand out.

HELP IF YOU GET STUCK

At the time of obtaining your module you will be told of any support which can be arranged.

This might be through one of the following:

- Telephone
- Face to face meeting
- Letter
- Tutor marked assignment

Questionnaire

Some modules will be accompanied by questionnaires. The questionnaire is your chance to help us. Your answers are our way of finding out if any changes are needed. If there is one, please remember to fill it in and return it.

HINTS ON STUDYING

When?

Try to get into a regular study routine. Set aside times for study but be ready to give and take a bit. Miss one of your planned sessions if you must, but try to make it up later.

Set yourself realistic targets such as 'I will finish segments one and two by this weekend' and **stick to them!**

Grab the chance to study at odd moments. You'll be amazed how much you can learn in fifteen minutes. It's difficult for the average person to really concentrate for more than 20 minutes at a time anyway. A word of warning – don't think you can learn anywhere. You need to be able to concentrate, there are often distractions which prevent this.

- Time spent just **reading** a module is not the same as time spent **learning**.
- You must become involved, the best learning happens when you're active, e.g. answering questions and making notes.
- Don't study too long without a break.

This module will remind you of suitable places to stop for a while, but if you need a break earlier, take one. It's entirely up to you.

Where?

Try to find somewhere where you will not be distracted. Almost anywhere will do. It all depends on how you are placed at home and at work. Don't forget your local library. Fishermen might find their local mission is able to help, especially with video equipment.

The secret is, **be flexible**. If the kids are having a party, go to Auntie's. If she's not in, go to the library. All you need is somewhere where you can get on with it and not be disturbed.

Carry your module with you when you can. Try to find gaps in your normal routine when you could do some useful work.

Now that you've decided to have a go, **stick with it!** Don't give up. Most people find studying hard at times, this is quite natural. It is also quite natural to need help with parts that you find especially difficult. I'm sure you'll find it worthwhile.

Introduction

Welcome to this module on 'The Frozen Fish Chain'. The module deals with the more commonly used freezing processes and covers many of the benefits of freezing fish. The importance of temperature control is emphasised and the correct handling at all stages of the chain is discussed.

It is intended that this module should be of use to persons who are involved in the freezing, storage, transport or retailing of frozen fish or fish products.

PRE-ENTRY REQUIREMENTS

No formal qualifications are required but it is assumed that you will have some knowledge of the frozen fish industry.

EQUIPMENT REQUIRED

The only equipment you will need is a pen and lots of enthusiasm!

Objectives

After completing the module you should be able to:

1. State the reasons for freezing fish, the importance of temperature control and its effects on quality.
2. Describe the basic operation of the more commonly used types of freezing equipment and state the differences between them.
3. Describe a building suitable for having a freezing operation.
4. Describe how to maintain standards of quality and hygiene during a freezing operation.
5. Explain the means of keeping frozen fish in good condition during storage, transport and distribution.
6. Describe good practice in the end use of frozen fish including thawing and retailing of the product.

Segment One

Basics of Freezing Fish

Segment One – Basics of Freezing Fish

AIMS OF THE SEGMENT

Welcome to the first segment in which the main aim will be to achieve Objective 1 given on page xiii.

When you have finished this segment you should be able to:–

- Give reasons for freezing fish;
- State that freezing can not improve the quality of fish;
- State the importance of using only highest quality raw materials;
- Identify the various stages in the cooling cycle during freezing of fish;
- Identify reasons for poor quality in frozen fish;
- Know the recommended times for stages of the freezing process;
- State the store temperatures needed for frozen fish products.

WHY FREEZE FISH?

You may have learned from another module on chilling that, by using ice and other methods of chilling, fish can be kept in a fresh condition for extended periods.

Chilling should reduce the temperature of the fish to around 0°C. This slows down the rate of growth of bacteria and also the rate at which chemical reactions take place.

Remember, the temperatures used in chilling should **not** be low enough to freeze the fish.

The object of freezing the fish is to lower the temperature to a point where the spoilage described above almost stops. This means that when the product is thawed after being in cold storage, it is almost impossible to tell it from the fresh fish.

By reducing the temperature of the fish much further, to between minus 20°C and minus 30°C, the shelf life of the fish may be extended a lot. At these temperatures the fish is, of course, frozen. The shelf life may be counted in months rather than days.



In both chilling and freezing, the shelf life will depend on the species of the fish. Fatty fish, like herring, generally have a shorter shelf life.

An extended shelf life is useful in any perishable food industry. It is especially so in the fish industry.

Sudden change in levels of available supply are a real problem in the fresh fish industry. Landings can vary enormously due to season, weather and quota restrictions amongst other things.

These peaks and troughs in supply can be evened out by freezing and storing surplus fish when landings are good. This also keeps the price to the customer more stable.

THE NEED FOR QUALITY

Selecting Raw Materials

The most important point for you to remember when selecting raw materials is that freezing can **not** improve the quality of fish.

Nothing can reverse the process of spoilage in fish. If we put rubbish in we will get rubbish out. The best we can hope to do is to keep the quality of the fish very close to what it was before it was frozen.

The things which will affect the quality of the frozen fish product are:

- The quality of the fish when it was caught;
- How it was handled before freezing;
- How the fish is frozen, stored and distributed.

The quality of fish changes during the year depending on things such as spawning times, feeding available and parasites. If the fish is of poor quality when it is caught it will not be suitable for freezing no matter how it has been handled.

Even fish which is of good quality when it is caught can be made unsuitable for freezing by bad handling. It can be damaged by being squashed, kept for too long or at too high a temperature.

Only fish of the highest quality should be used for freezing.

Freshness is probably the most important aspect of quality in fish. The following two tables show some things to look out for in deciding how fresh a fish or a fish fillet is.

Whole Fish	
Fresh	Spoilt
Eyes are bright, clear and sticking out.	Eyes are cloudy, sunken, with grey pupils.
Gills are bright red.	Gills are brown/yellow and covered with a yellow/grey clotted slime.
Skin is bright, shiny, smooth and covered with clear slime.	Skin is dull, bleached and feels gritty and is covered with a thick yellow/brown clotted slime.

List 1

Fish Fillets	
Fresh	Spoilt
Translucent (lets light through), shimmery.	Waxy, some yellowing.
Raw looking	Cooked looking.
Watery white/crystally.	Solid white.
No discoloration.	Reddening near bone.
Firm and compact to touch as one piece.	Soft, gaping and breaking up.
Skinside firm and springy.	Finger pressure leaves marks.
Clean and fresh smell.	Smells of ammonia, sour (fishy).

List 2

If selecting raw material is important to you, you will find the module on 'Maintenance of Fish Quality' very useful.

Later in this module we will be looking at how you can keep this high quality level as the fish goes through freezing, storage and distribution.

Now lets find out how much you have learned so far!

❓ **SAQ7**

Which temperature range is used for storage of frozen fish?
Tick the correct range.

1. 0°C to -5°C
2. -20°C to -30°C
3. +4°C to 0°C

② SAQ13

Which of the following statements are true?

Tick the correct statement.

1. Fish quality can be improved by freezing.
2. Fish for freezing should be of the highest possible quality.
3. Second rate fish can be sold at a premium after freezing.
4. Freezing fish when supply is plentiful enables the processor to stabilize the price to the consumer.

FREEZING

Let us first answer the following question. What happens when fish freeze?

The flesh of fish contains approximately 80% water. Under normal conditions, pure water will change from a liquid to a solid at 0°C i.e. it will freeze.

If we add salts and other chemicals to water it has the effect of lowering the temperature at which the water will freeze.

An example in every day life of how this works is putting salt on icy roads.

The water in fish flesh contains salts and it begins to freeze at about -1°C. As some of the water freezes, so the concentration of the salts in the remaining water increases. This has the effect of lowering the freezing point even further.

By the time we have cooled the fish to -5°C all but 20% of the water will have turned to ice. Obviously we are not going to be satisfied with just cooling to -5°C.

We will wish to continue cooling until all the water in the fish is frozen. Figure 1 shows that this will have happened by the time the fish is cooled to between -20°C and -30°C which is why we recommend storage at these temperatures.

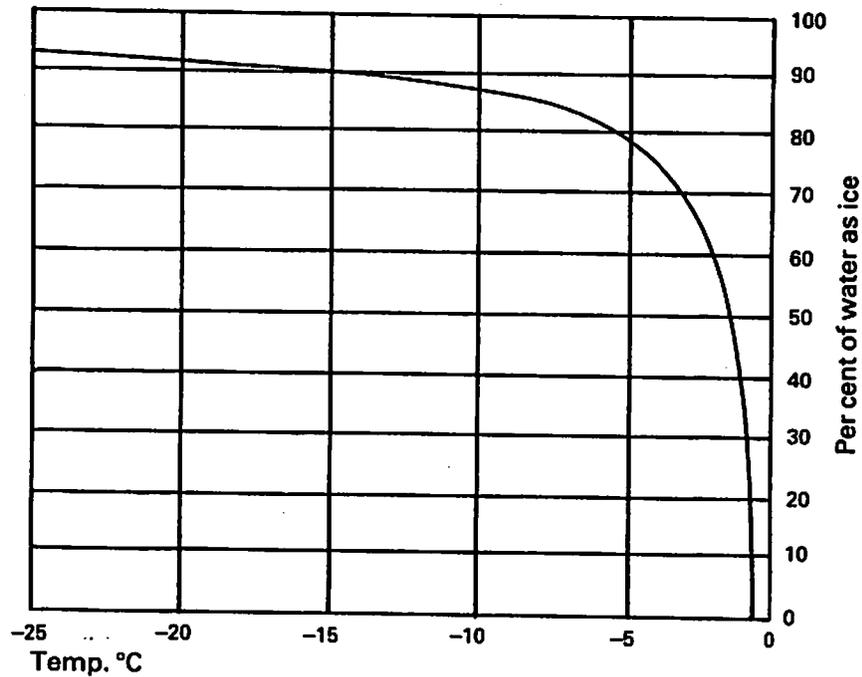


Figure 1: Percentage of total water frozen out as ice.

The next question is why have we bothered to make the point about cooling to -5°C when only 80% of the water in the fish is frozen?

The question is best answered by looking at figure 2 titled 'Typical freezing curve for fish'.

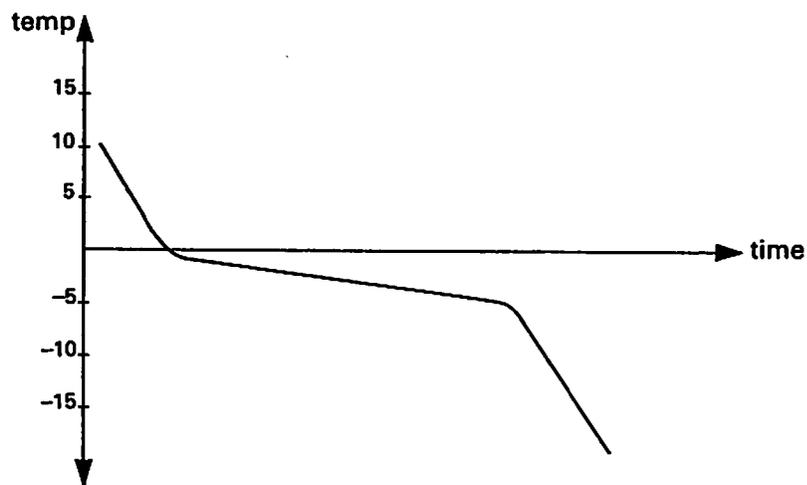


Figure 2: Typical freezing curve for fish.

You will notice that the curve is almost horizontal between the temperatures of -1°C and -5°C and that it takes much longer to drop the temperature between these points than either before or after.

This period is called the **Thermal Arrest Period** and it is the critical stage in the freezing process.

During this period a lot of heat has to be removed from the fish in order to change the water content into ice. To make this change, about **80 times** as much heat needs to be removed as when just dropping the temperature 1°C from say +1°C to 0°C.

Scientists call this **Latent Heat**. You may have heard of it before but, if not, it doesn't matter as long as you see that a lot of heat needs to be removed.

Now why is all this important? Well, it is very important that the fish should pass through this period as quickly as possible for the following reasons:

- Slow freezing produces large ice crystals in the flesh of the fish which may damage it.
- Because the fish does not freeze instantly, we get a build up of salts, or concentration as we called it earlier. Some water tries to flow through the flesh to reduce this build up. However, when the fish is eventually defrosted, this water does not flow back to its starting position and produces the wetness on the fish which we know as thaw drip. The result is a tougher product of lower quality.
- There are certain types of bacteria which are still active at temperatures around 0°C. This means that bacterial spoilage can still occur.

It will be obvious that thaw drip also results in weight loss which will cost money. We will look at this in more detail in segment four.

The quality changes which take place are not so noticeable unless the freezing time extends beyond 12 hours.

This can happen if bad freezing practice is employed, e.g. placing a pallet of fish in a cold store to freeze. In this case, the fish at the centre will freeze very slowly.

Where freezing times of 24 hours or more are used, then the risk of bacterial spoilage making the fish unfit for human consumption is high.

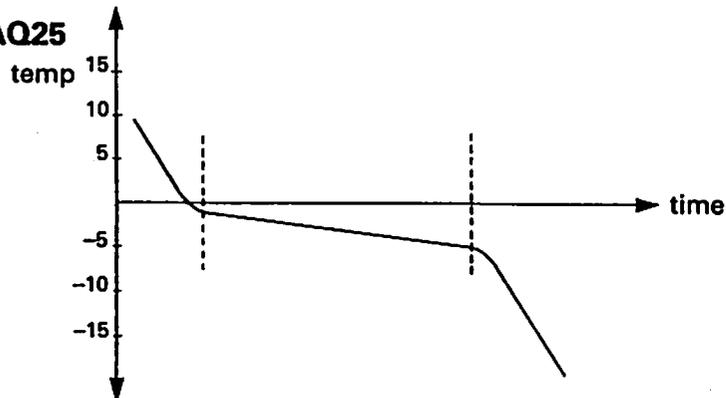
Now let's see if you have remembered the important points. Try the following SAQ's.

② SAQ19

As water freezes, it changes state from liquid to solid. The amount of heat we must remove to cause this change is which of the following? Tick the correct response.

- a) 40 times that to cool water 1°C
- b) 80 times that to cool water 1°C
- c) 120 times that to cool water 1°C
- d) 160 times that to cool water 1°C

② SAQ25



In the above typical freezing curve for fish the time span between the dotted lines is known as which of the following?

- a) Thermal arrest period
- b) Period of slowest cooling
- c) Slow freezing time

This is caused by:

- a) A barrier due to fat under the skin
- b) Change of state from water to ice
- c) A short breakdown in the refrigeration system.

② SAQ31

Poor freezing practice may produce a weight loss in the thawed product due to drip loss. This may be caused by which of the following? Tick the correct line.

- a) Bacterial action
- b) Slow freezing
- c) Formation of small ice crystals.

FREEZING RATES

'Quick freezing' is defined in the U.K. as lowering the temperature of the fish from 0°C to -5°C (the thermal arrest period) in **2 hours or less**. This should be followed by further temperature reduction to the recommended storage temperature of -30°C at the end of the freezing period.

The second part of the process must always be coupled with the first. It is important that the fish should always be reduced in temperature to the intended storage temperature as well as frozen quickly. Equipment which can do the first can be expected to achieve the second.

Now, the rate of freezing is always faster near the surface of the fish where it is in contact with the cooling medium. Naturally, the thicker the fish, the longer it will take to freeze.

The following table will give you an idea of freezing rates normally used.

Term used	Rate of freezing (mm/hour)
Slow freezing	2
Quick freezing	5-50
Rapid freezing	50-100
Ultra rapid freezing	100-1000



The time it takes to freeze different products depends on lots of things. Some of these are product shape and size, the area exposed to the refrigeration medium, the temperature of the refrigerant and the packaging if present.

We will be looking at these variables in Segment 2.

Now answer this SAQ.

SAQ37

The recommended time for freezing fish to -5°C is **no more than** how long? Tick the correct answer.

- a) 2 minutes
- b) 20 minutes
- c) 2 hours
- d) 24 hours

SUMMARY

Well, how did you get on?

In this first segment we have looked at why fish is frozen and the process of freezing and we have explained why quality is important. The important points you should now understand are:

- Fish is frozen to extend shelf life and smooth out the supply rate;
- Quality cannot be improved by freezing but can be reduced if the freezing is done incorrectly;

- The thermal arrest period is a critical part of the freezing process;
- A storage temperature of at least as low as -20°C is necessary.

If there are any sections which you found difficult, why not re-read those sections.

If you are satisfied that you understand the content of this segment, you have achieved Objective 1 given on page xiii. Well done! Have a break and then turn to Segment 2 where we will look at methods of freezing.

Segment Two

Freezers 1

Segment Two – Freezers 1

INTRODUCTION

There are many different types of freezer available for freezing fish. In fact there are so many, it is often difficult to know which to choose!

The right freezer is obviously the one best suited to your needs. Hopefully, you will realise which is the best suited after completing this segment and segment 3.

AIMS OF SEGMENT TWO AND THREE

The main aim of segment two, and segment three, is to help you to achieve Objective 2 given on page xiii.

When you have completed these two segments you will be able to:–

- Recognise the equipment used in various freezing methods;
- Understand the principles used in the different types of equipment;
- Describe the three basic types of freezers used:
 - Plate,
 - Blast,
 - Immersion.
- List the reasons for using each type of freezer;
- Explain some of the ways in which frost and ice can cause problems in freezers;
- Discuss how to load each type of freezer.

BASIC METHODS OF FREEZING

There are three basic methods commonly used for freezing fish:

- By direct contact with a refrigerated surface – plate freezers or contact freezers;
- By blowing a continuous flow of very cold (-30°C) air over the fish – blast freezers;
- By spraying with, or immersing in, a liquified and extremely cold gas or vapour – spray or immersion freezers, sometimes called cryogenic freezers (cryogenic simply means very low temperature).

Let's look at some of these in a bit more detail.

PLATE (CONTACT) FREEZERS

Plate freezers are in common use in the fish processing industry. They are used to freeze regular shaped blocks or slabs of fish, up to about 10cm thick.

Plate freezers work by passing a refrigerant through a series of hollow, flat aluminium plates which lie parallel to each other. The fish to be frozen is placed in the gaps separating the plates. When the gap has been filled, the plates are pressed together. Heat moves from the fish to the refrigerant and is taken away. The fish freezes between the plates.

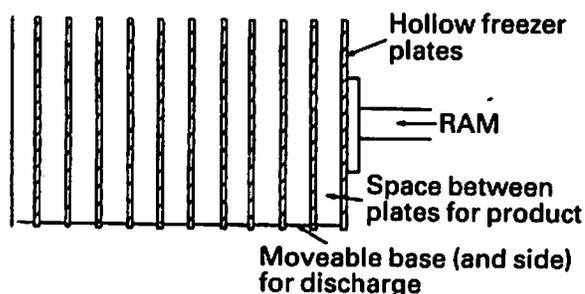


Figure 3: Vertical Plate Freezer

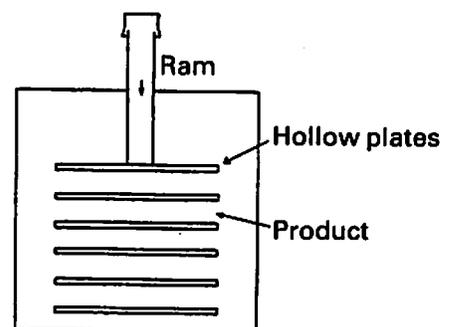


Figure 4: Horizontal Plate Freezer

The plates may be placed vertically or horizontally as shown in the figures on the previous page.

Vertical plate freezers are normally used for freezing whole fish at sea.

Horizontal plate freezers are used mainly for freezing flat blocks of fish fillets or fish mince.

Skinless fillets, fish mince or a mixture of the two are frozen like this to produce a uniform block. This block can then be sawn (using a band saw) into portions which may be wrapped and sold as fish portions or coated with batter and crumb to produce products like fish fingers.

A second use for horizontal plate freezers is the freezing of pre-packed cartons of fish and fish products for retail sale.

There are a number of points you should watch out for when using a plate freezer.

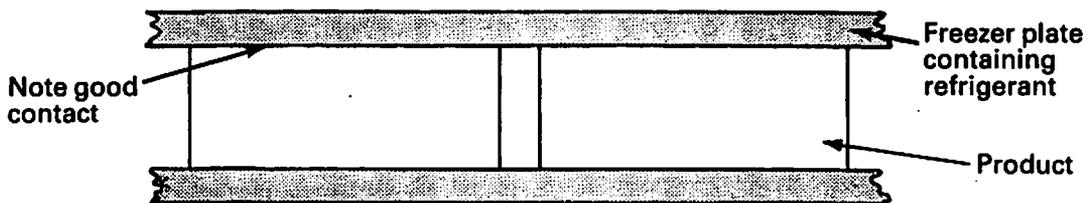


Figure 5: Horizontal Plate Freezer. Good Contact.

Contact

It is essential that good contact is made between the plate and the product. This helps remove heat quickly and the freezer operates more efficiently.

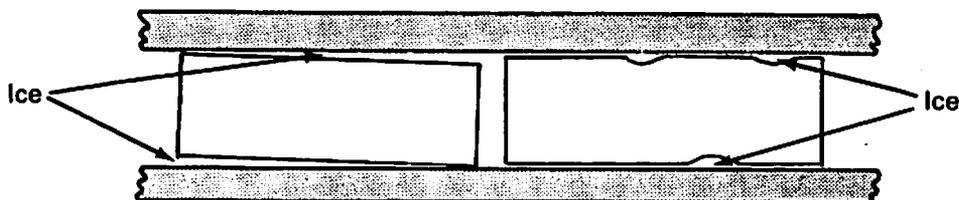


Figure 6: Horizontal Plate Freezer. Poor Contact.

Anything which comes between the fish and the plates will prevent good contact. This may be:-

- Ice
- Frost

Make sure that there is no ice on the plate before loading. If drops of water freeze on the plate to form small ice mounds, this will prevent good contact between the plate and the product.

What causes this problem?

Well, if a plate freezer is allowed to defrost overnight, water will collect on the plates. Most of this is from the frost which builds up on the plates when in use.

The easiest way to get rid of this water is to use a 'squeegee'. If you have not got one, then wipe the plates with a clean cloth to remove the droplets of water.

Always remove water from the plates **before** switching the freezer on. Remember, water collects on the underside of the plate as well as the top of the plate, so both surfaces need to be wiped over.

When the plate freezer is working, frost appears as ice crystals on the plates. **This can form a barrier to the removal of heat.**

The frost can easily be removed by brushing the plates before re-loading.

Pack Thickness

An important point is the thickness of the pack of fish.

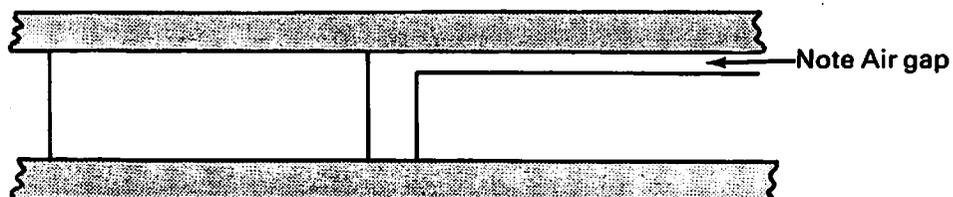


Figure 7: Horizontal Plate Freezer. Poor Contact due to Different Pack Thickness.

Because the plate freezer relies on good contact to freeze the product quickly, **all packs** in a single gap should be the **same thickness**. If packs are of different thicknesses then there will be an air space above the thinnest pack.

Remember the freezer plates are brought together under a slight pressure. **Deeper packs may be squashed and freeze deformed.**

Air/space

Another point to remember is to prevent air/space inside the pack.

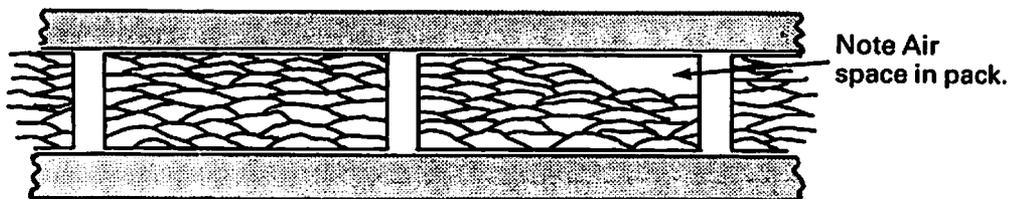


Figure 8: Horizontal Plate freezer. Poor Contact due to not having enough product in pack.

Packs of fish should always be completely filled. Any gap will be filled with air. Air, remember, acts as an insulator, that is, a substance that will reduce the flow of heat. So the fish will not freeze as quickly as fish in a full pack. It could take three or four times as long!

If the blocks are to be used for fish fingers or fish portions, air gaps also make wastage!

Packaging

In horizontal plate freezers the fish is always separated from the freezing plate by some form of packaging. This stops the fish sticking to the plates.

Normally a waxed cardboard is used, but polythene lined paper will also stop the fish freezing to the plates.

Remember, however, that any packaging has an insulating effect.

The packagings mentioned above do not increase the freezing time by any significant amount.

Now is a good time for you to have a go at some SAQ's.

② SAQ43

What are the three main types of freezers?

.....
.....
.....

② SAQ1

What problems may be caused by frost and ice when using a plate freezer and how are they avoided?

.....
.....
.....
.....
.....
.....

AIR BLAST FREEZERS

Air blast freezers are useful where the product to be frozen has an irregular shape. Or, where products of different sizes are to be frozen using the same freezer.

There are two main types:

- Batch – where the product is stationary;
- Continuous – where the product is conveyed through the freezer.

They are widely available in many forms and sizes. Both can be used for a wide variety of products.

Now let us look at some of the features of blast freezers.

Air flow

Heat is removed from the product by air which in turn passes the heat to the refrigeration system.

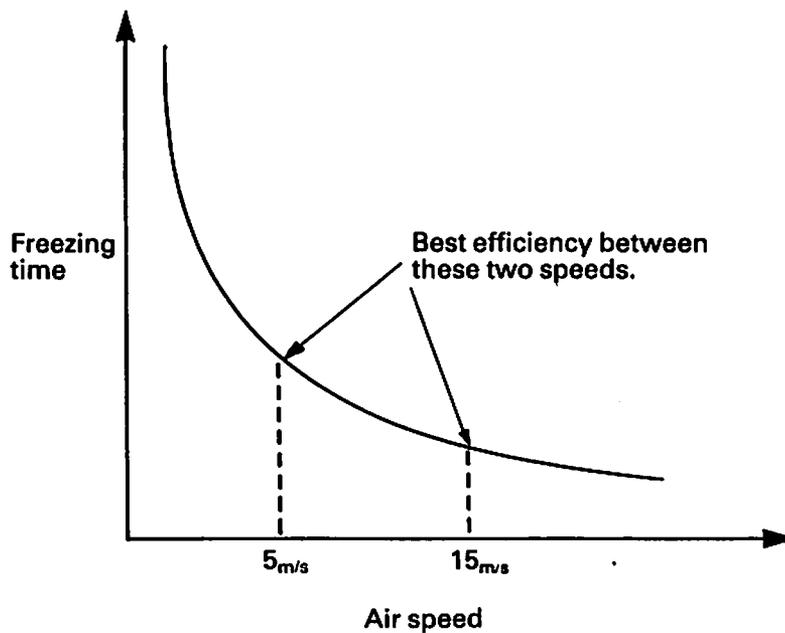


Figure 9: Graph to show variation of freezing time with air speed in an Air Blast freezer.

If you look at Figure 9 you will realise that increasing the air speed flowing over the product will make the product freeze faster.

It is known that in practice air speeds of up to 15 metres/second are possible. However, fast air speeds need expensive fans, so as a cost compromise air speeds of 5 to 10 metres/second are normally used.

Basic blast freezer design

It is no use thinking that placing a fan in a cold room operating at temperatures below freezing point will give you a blast freezer. The design of blast freezers must ensure that there will be good air circulation.

The two examples below in Figure 10, show both the problem and a cure.

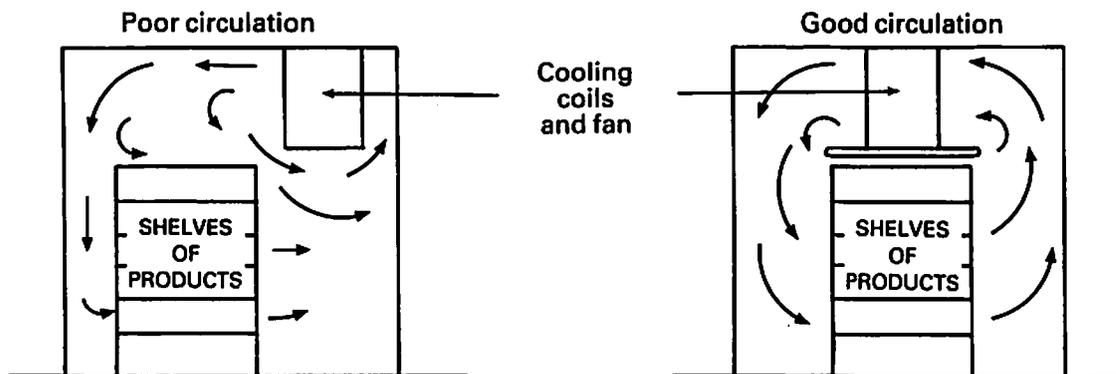


Figure 10: Bad and good design for Blast freezers.

The distribution can be further improved by using baffles as in Figure 11.

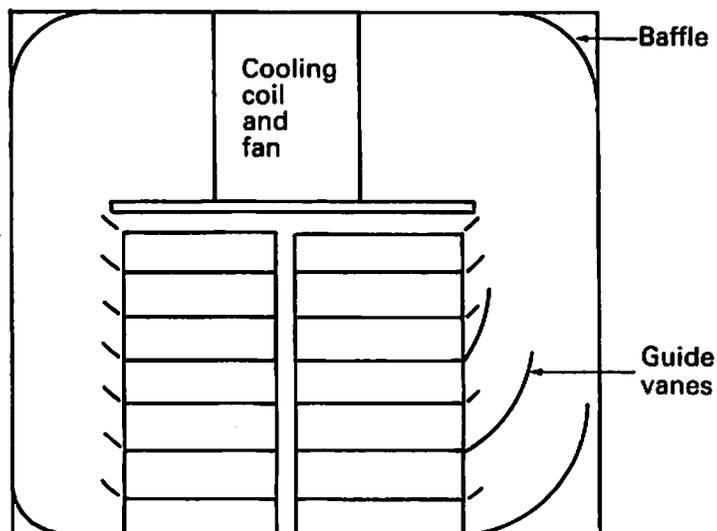


Figure 11: Use of baffles and guide vanes in a Blast freezer to give better air circulation.

The importance of Figures 10 and 11 is to show the distribution of air in the freezer.

Uniform freezing, that is to say, freezing all products at the same rate, gives consistent quality. The best quality is achieved by both fast and uniform freezing. This can be achieved by good circulation of air around the product.

Loading the blast freezer

Remember we wrote about 2 types of blast freezer earlier. Now let us look at how to load each of them with fish.

To start, we will look at the batch freezer. Loading of this type of freezer must allow for the circulation of the cold air around the product.

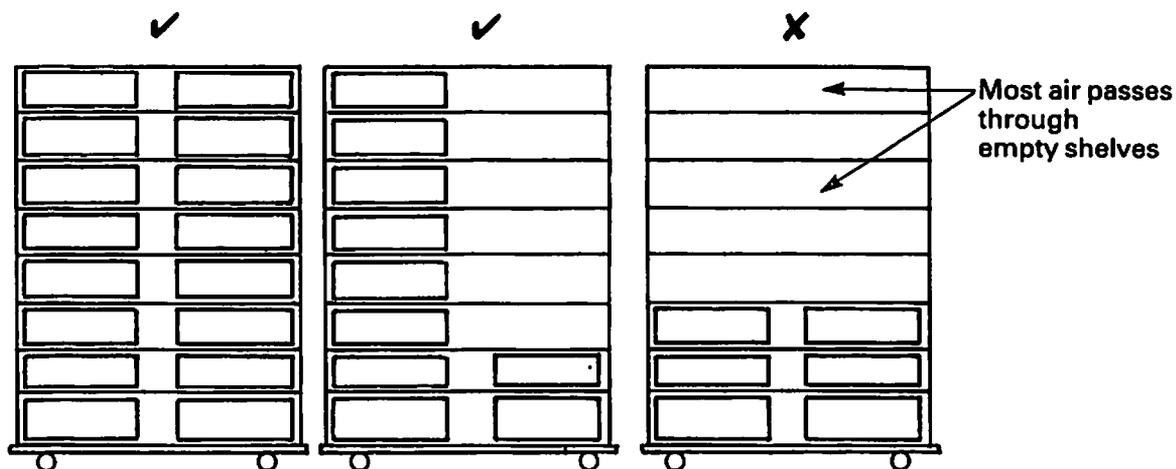


Figure 12: Good and bad loading of trolleys.

Trolleys should be stacked to allow air to pass between layers.

If a trolley is only part filled, use a bit of every shelf. **Do not leave spaces with no product on the shelf.** This will allow most of the air an easy way through the trolley which will lengthen the freezing time.

Sometimes pallets are used instead of trolleys.

The following Figure 13 shows good and bad loading practice.

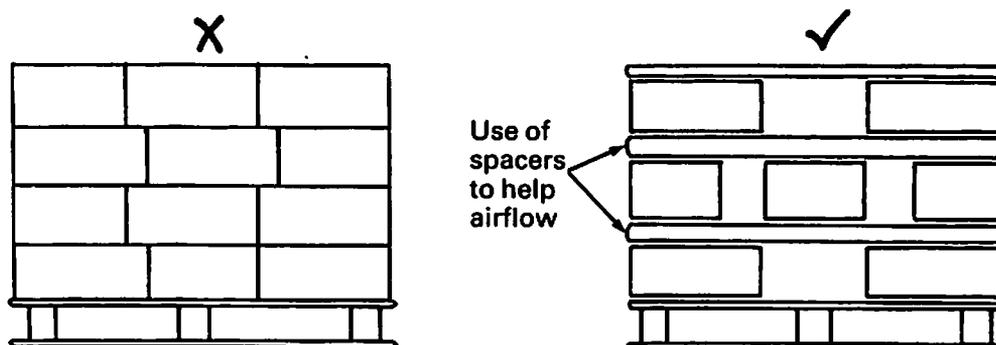


Figure 13: Bad and good stacking on pallets.

Now we will look at continuous freezers.

In continuous freezers, where trolleys are used, the same practice should be followed as for batch freezers.

Where a continuous belt is used then the product should be spread evenly over the surface of the conveyor.

Usually the conveyors are made from stainless steel mesh and this becomes covered in frost which builds up and blocks the holes in the mesh. It is usual to have a belt washing machine as well. This will remove this frost and also product debris. It is clearly important that this washing machine should be working well when needed.

Belt conveyors normally have a variable speed control. This must be set to give the product long enough in the freezer for the fish to freeze and drop to the required temperature.

OTHER TYPES OF FREEZER

We have three remaining types of freezer to look at:

- Fluidised bed freezers
- Immersion freezers
- Spray freezers (cryogenic)

but these will be discussed in segment 3.

Now before you start Segment 3, try the following SAQ's.

② SAQ8

Why does frost build-up cause problems in a continuous blast freezer with a mesh conveyor belt?

Tick the correct response.

- (a) Because it reduces air circulation;
- (b) Because it prevents contact with the conveyor;
- (c) Because it will cause the product to freeze to the conveyor.

② SAQ14

Complete the following statement.

'Good air circulation in blast freezers is achieved by the use of and good technique.'

② SAQ47

Which type of freezer should be used for freezing a mixture of products of different sizes and shapes?

.....

SUMMARY

You have now reached the end of Segment 2 in which we considered the following:

- Principles of plate and blast freezers.
- Some working hints for both plate and blast air freezers.

Perhaps you will feel like a break now, otherwise continue with Segment Three.

Segment Three

Freezers 2

Segment Three – Freezers 2

INTRODUCTION

Welcome to the third segment of this module.

The aims and objectives of this segment were stated in segment two.

The second segment concentrated on the two main types of freezer used for fish freezing:

- Plate freezers;
- Air blast freezers.

In this segment we will look at some different types:

- Fluidised bed freezers;
- Immersion freezers;
- Spray freezers;
- Other freezer types.

Remember, segment 2 stated that there was a wide range of freezers to choose from.

So, let's have a look at some of the rest.

FLUIDISED BED FREEZERS

These are modifications of air blast freezers, where much faster air speeds are used. Cold air is blown upwards through a bed of the product. The air speed is fast enough to make the product 'float' on the air. The product is then said to be in a 'fluidised state'.

Usually the product is moved through the freezer on a continuous mesh belt which allows the air to pass through.

Some freezers can operate without the aid of a moving belt. In these, the product is moved along the freezer by the air alone.

The product to be frozen is normally of a small particle size such as cooked and shelled prawns.

The air speed required to lift the product clear of the belt, changes from one product to another. So this type of freezer is not suitable where a variety of products are to be frozen at the same time.

IMMERSION FREEZERS

It is more efficient to use liquid instead of air as a means of removing heat from the product. However, most liquid refrigerants, otherwise suitable for this use, are not acceptable as they may introduce a health hazard.

One liquid in general use is sodium chloride (common salt) brine. This is used for freezing large fish such as tuna. The amount of salt absorbed by the fish is small and may be allowed for when canning.

The method of freezing is to totally immerse the fish in the brine until the fish is frozen.

This has limited application, but the next freezer could be said to be a modification of this method and has a wider use.

SPRAY FREEZERS (LIQUID REFRIGERANT FREEZERS)

This type of freezer uses a specially purified form of the refrigerant R.12 (dichloro-difluoro-methane).

To use the freezer, fish is loaded onto an inlet conveyor. While on this conveyor, the fish is sprayed with refrigerant. This hardens the fish by freezing the surface.

At the end of the inlet conveyor, the fish drops into a tank of liquid refrigerant. The fish is then moved through the tank to the outlet conveyor. Any surplus refrigerant drains off the frozen product while on the outlet conveyor, and returns to the tank. This is shown in Figure 14.

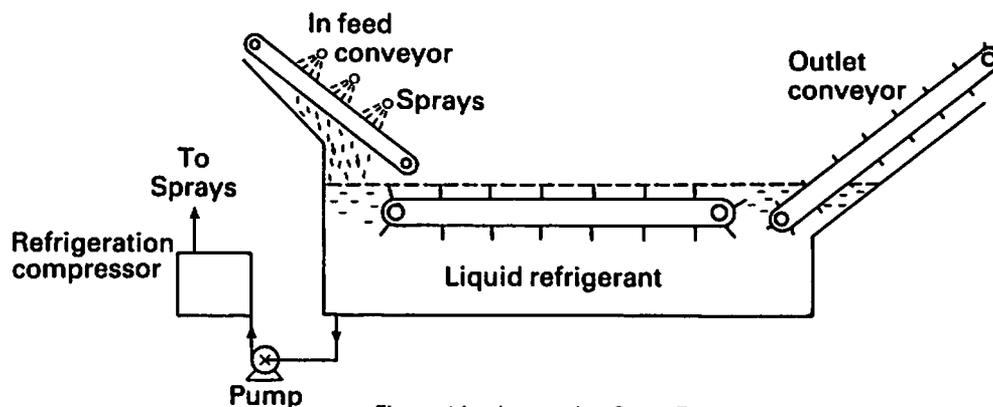


Figure 14: Immersion Spray Freezer.

The heat from the fish gained by the refrigerant causes it to evaporate. The vapour is then recovered by a refrigeration system and returned to the tank as liquid refrigerant.

Though this system costs more to operate than air blast freezers it is cheaper than using liquid nitrogen which we will look at later.

There is of course some loss of refrigerant which means the system has to be topped up during production.

Some of this loss is due to 'carry-over' with the product. This may cause a problem. If the product is to be sprayed with water immediately after freezing, the water will freeze when it touches the fish and produce a coating of ice. This will trap any remaining refrigerant between the ice and the fish. When the fish defrosts, there may be a froth formed as the refrigerant warms up and changes into vapour.

This is sometimes seen with frozen shrimps.

We will talk more about spraying water onto the frozen product later.

All the types of freezer we have looked at so far operate at temperatures between -30°C and -40°C . That isn't much colder than the product needs to be. They all have to use a compressor

to keep taking heat out of the refrigerant.

Now we are going to look at freezers which don't need a compressor.

LIQUIFIED GAS FREEZERS

These are sometimes called **cryogenic freezers** because they work at very low temperatures. Some can be as low as -196°C .

LIQUID NITROGEN FREEZERS

These are the most common liquified gas freezers in use in the fish industry. A typical freezer of this type is shown in Figure 15.

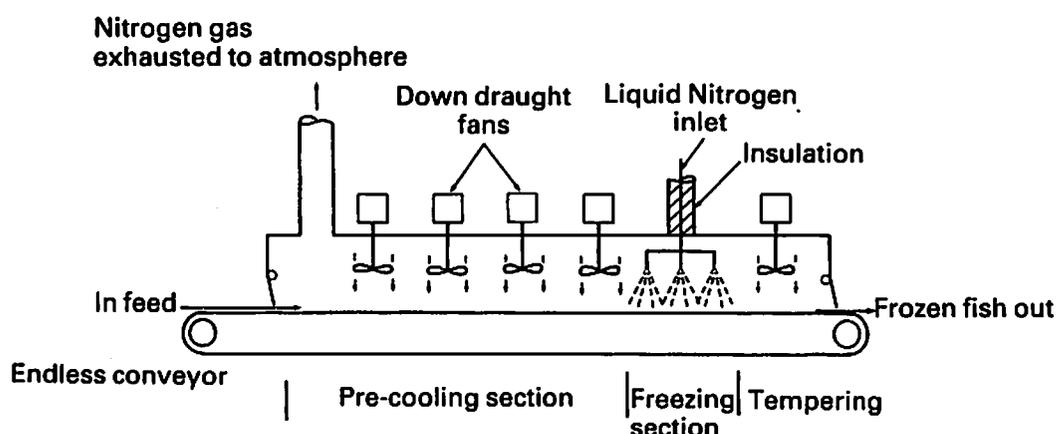


Figure 15: Liquid Nitrogen freezer.

The freezer is basically a long, tunnel shaped, insulated box. Moving through the tunnel is a stainless steel conveyor on which fish is laid.

As you can see in Figure 15 the fish does not come into contact with the liquid as soon as it enters the tunnel. The gas is moving in the opposite direction to the product.

This allows the cold gas to cool the product gradually before it reaches the liquid nitrogen sprays.

At the sprays, the temperature can be as low as -196°C . If the fish were not pre-cooled before reaching these very cold sprays it would be damaged. The fish would cool and freeze so fast that it would crack. This would mean a poor quality product on thawing.

The fans in the first (pre-cooling) part of the freezer take away about half the heat we need to remove from the fish. The outer surface of the fish may begin to freeze at this stage.

In the spraying zone, the liquid nitrogen comes into contact with the fish. The liquid nitrogen takes the remaining heat to be removed from the fish **very, very quickly**. This heat causes the liquid nitrogen to boil and the nitrogen flashes off to become a gas and is drawn down the tunnel towards the extraction flue.

At the same time, the fish freezes at, and to some distance below, the surface.

Now let us look what is happening **inside** the product by studying Figure 16 overleaf.

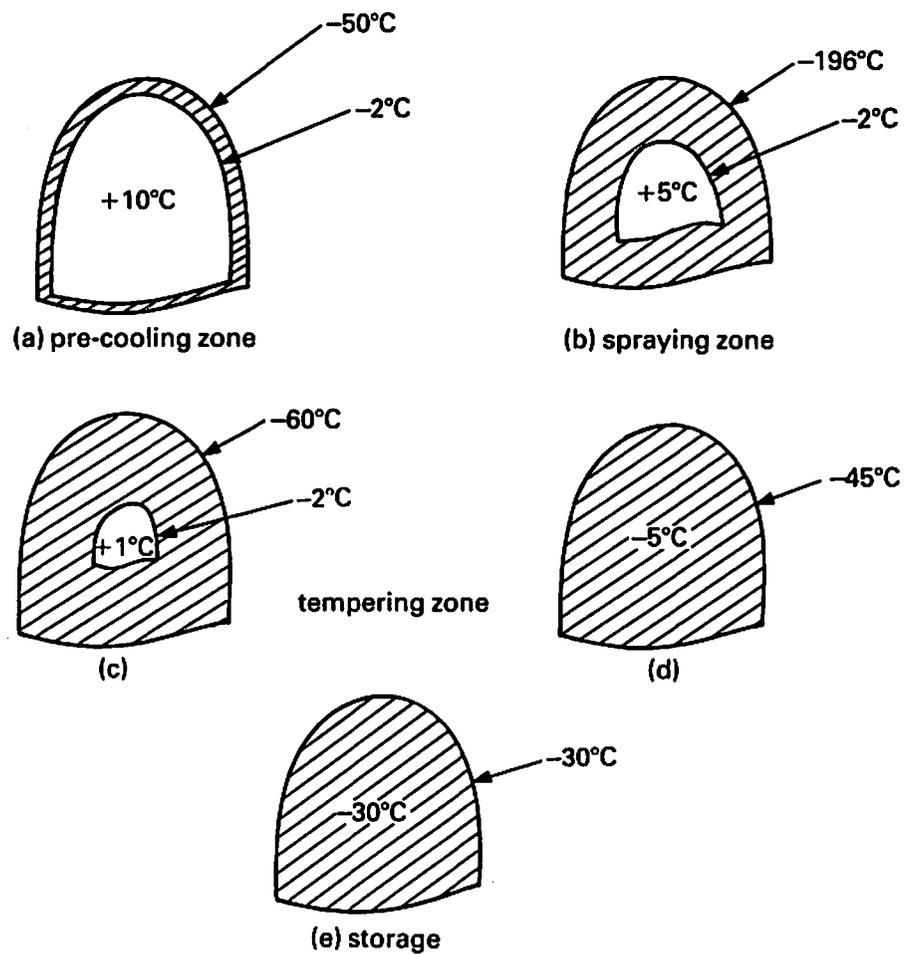


Figure 16: Cross-section of prawn tail showing how freezing progresses in liquid nitrogen freezing.

In Figure 16 we can see the cross section of a prawn which is being frozen using liquid nitrogen.

In the pre-cooling zone Figure 16 (a) the prawn is only frozen at the surface.

Then, as the prawn moves through the spraying zone, the thickness of the layer of frozen flesh increases Figure 16 (b).

After leaving the spraying zone the product enters a final section of the tunnel. This may be called a **temperature zone**. Here the product temperature evens out. The centre gets colder while the outer parts get warmer – though not so warm as to rise above -30°C ! We can see what has happened to the prawn in this final zone if we look at Figure 16 (c) and (d).

It is important that the product should be packed and moved to a deep freeze store (-30°C) as quickly as possible. This would of course apply to all frozen products no matter what sort of freezer is used.

In the case of the liquid nitrogen freezer, the product must come into total balance and be all at the same temperature. This is done by heat moving from the centre to the outer parts Figure 16 (e).

If the outer parts gain heat from outside the product instead, for example from warm air in processing room, then the product centre will not cool down quickly.

Good points for liquid nitrogen

Let's list the good points:

- Freezing is very fast;
- It is non-poisonous;
- The freezer is relatively small;
- The only moving part is the conveyor belt, so maintenance is minimal;
- The capital cost of the freezer is relatively low.

Possible problems with liquid nitrogen

- Liquid nitrogen is expensive and must be bought in so running costs are high;
- Space is required for a pressure vessel to store the liquid nitrogen.

- Nitrogen gas is lost from this pressure vessel each day as it takes in heat from its surroundings. This gas must be allowed to escape into the air to prevent the pressure building up in the storage vessel. Excessive pressure in the storage vessel could cause the vessel to blow up with disastrous results.

So we can see that there are a number of points to be looked at when using this type of freezer.

Now let us consider,

Carbon Dioxide Freezers

This type of freezer is similar to a liquid nitrogen freezer. The liquid this time, carbon dioxide, is again sprayed onto the product. In this freezer, however, 80% of the carbon dioxide can be re-liquified.

As the mechanics of the freezer are similar to the nitrogen freezer just looked at, we need not consider any further details. However a warning for both types is needed.



A most important point with both types of liquid gas freezers is that the gas should be vented to outside the building. High levels of these gases inside the factory are dangerous. They can cause unconsciousness or even death.

Combination Freezers

In Figure 17 a freezer is shown which was developed by the Torry Research station. It consists of a freezing tunnel through which passes a continuous conveyor. The conveyor is of stainless steel sheet. The conveyor acts like a contact (plate) freezer whilst cold air is also blown over the surface of the fish. So this freezer becomes a combination of the contact and air blast freezers.

Note the blade at the end of the belt which helps release the frozen product from the conveyor belt.

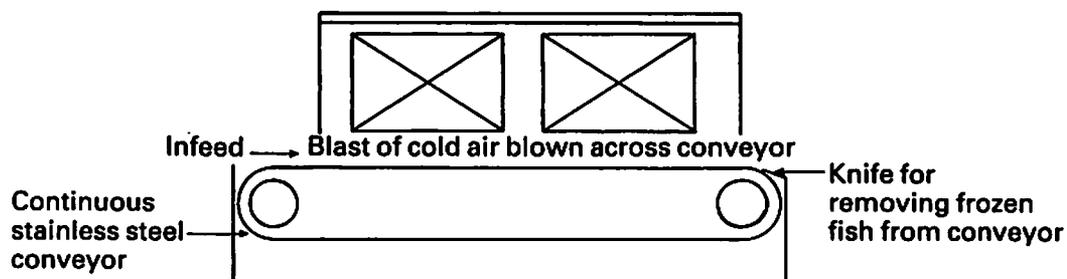


Figure 17: Torry Freezer

FREEZER OPERATING TEMPERATURE

The table below gives an indication of the operating temperatures used by the freezers we have looked at in segments two and three.

Type of Freezer	Operating Temperature °C
Liquid contact (brine)	-21
Liquid 'freon'	-30
Air blast	-35 to -40
Plate (contact)	-40
Liquid carbon dioxide	-50 to -70
Liquid nitrogen	-50 to -196



Remember in freezers operating at these low temperatures, a thin film of water will freeze instantly. Even if you think your hands are dry, there is still enough water on them to freeze your hand to the surface. This will cause a **cold burn** and may even tear off skin when the hand is pulled away. **Always wear gloves** when working at these temperatures.

LOADING/UNLOADING SPACE REQUIRED

Remember that you will need a floor area around the freezer for operators to work in.

There must be sufficient area for loading and unloading. If trolleys are used they also take up space which must be allowed for.

If fish are being frozen on trays, then space must be provided to release the fish from the trays.

Where a liquid gas freezer is in use do not forget to keep the yard clear. This allows the tanker to get to the storage tank when delivering!

Remember, the total space required for a freezing operation is much more than the area taken up by the freezer.

Well, that finished the two segments on freezers. Now there are some SAQ's which cover this segment. One or two of them will make you think back to segment two. This makes it easy to compare the different freezer types.

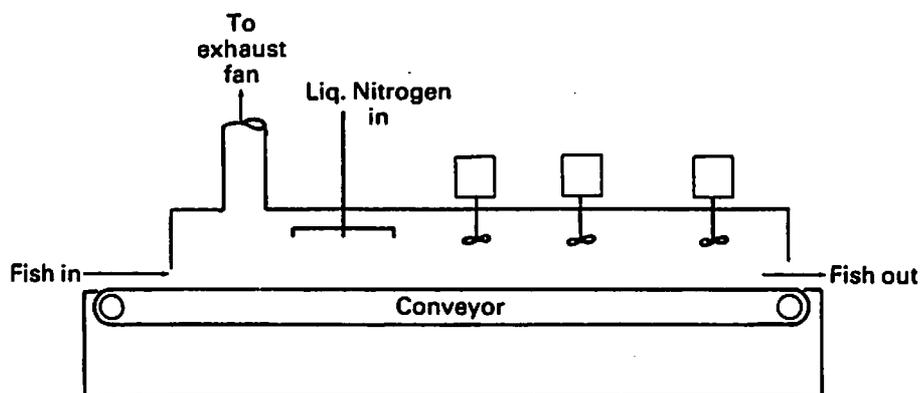
Well, have a go and then turn to the responses to see how well you get on.

② SAQ20

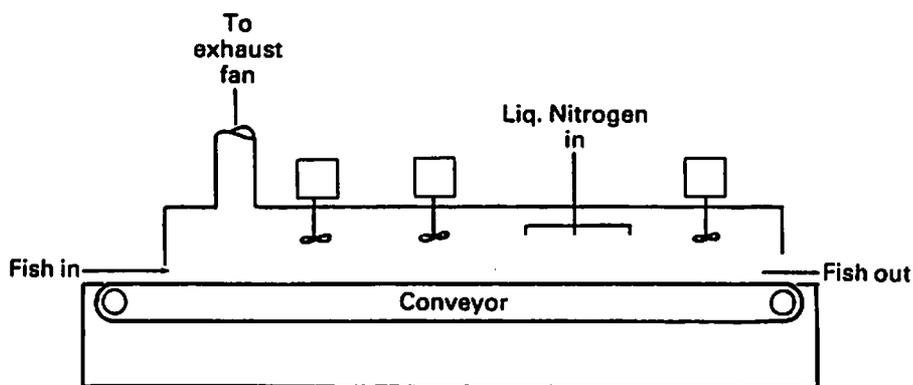
Would you use a fluidised bed freezer for freezing shrimps, crabs or whiting fillets?

.....

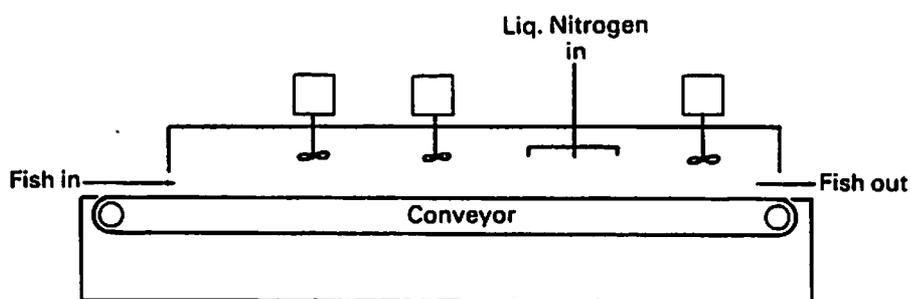
② SAQ26



(a)



(b)



(c)

Which of the above drawings of a liquid nitrogen tunnel is correct? Why are the other two incorrect?

.....

.....

.....

.....

? SAQ12

What does the term 'Cryogenic freezer' mean?

.....

? SAQ38

Give an example of a cryogenic freezer.

.....

? SAQ44

What precautions must you take with all freezers?

.....
.....

? SAQ48

What special precautions must we take with liquid gas freezers such as liquid nitrogen or liquid carbon dioxide?

.....

? SAQ2

Do fish freeze instantly when sprayed with liquid nitrogen? If not, why not?

.....
.....
.....

🔍 SAQ9

Which of the following freezers would you consider using for freezing an irregular shaped piece of fish such as scampi tails. Tick the correct response.

- (a) Plate freezer;
- (b) Blast freezer;
- (c) Fluidised bed freezer;
- (d) Liquid freon freezer;
- (e) Liquid nitrogen freezer;
- (f) Liquid carbon dioxide freezer.

SUMMARY

As we have now completed segments two and three we can quickly summarise the information gathered:

Three types of freezer are commonly used in the fish industry.

1. Plate or contact freezers;
2. Blast air freezers;
3. Spray or immersion freezers.

The choice between them depends on the type of fish product to be frozen, the speed and the amount of freezing to be done.

We have also considered the way in which the fish product should be loaded into each freezer and the important points to be noted in using each type of freezer.

You have also been warned about the danger of cold temperatures and the possibility of suffocation if adequate care is not taken with nitrogen and carbon dioxide.

Having finished segments two and three, you have achieved Objective 2 given on page xiii, well done! Time for a well earned break.



Segment Four

Good Freezing Practices

Segment Four – Good Freezing Practices

INTRODUCTION

Welcome to the fourth segment of this module.

We have already covered the reasons for freezing fish and fish products in segment one. We have also listed and discussed the different types of freezers commonly available in segments two and three.

Whilst reading through the first three segments you will have noticed bits of advice on freezing the fish. In this segment we will concentrate on the **correct** way to produce top quality frozen fish products.

AIMS OF THE SEGMENT

The main of this segment is to help you achieve objectives 3 and 4 given on page xiii.

After completing this segment you will be able to:

- List the essential features of a building designed to accommodate a freezer plant;
- List ways in which hygiene can be maintained during freezing;
- Describe how to handle and select fish for and during freezing;
- State the important points to be considered when packing fish;
- List the important factors affecting freezing times.

BUILDINGS

The buildings used to house a fish freezing operation should be designed for that purpose.

A rather simple statement you may say so what does it mean?

Let's consider the following points:

- The building should be situated in a position where **dust, smoke and strong odours** from any source, but particularly from other processing plants, will not affect the fish. Remember, fresh fish has a delicate flavour and smell. Keep it that way!
- The building should be **kept clean** to prevent any undesirable birds, animals or insects being attracted to the factory.
- **Space for vehicles** to deliver and collect goods must be allowed.
- Great emphasis must be placed on **hygienic design**. More explanation about this is given in the next section.
- The building must be **well constructed** and kept in **good repair**.
- The floors should be constructed of a material which will give a **hard surface**. They should be non-absorbent and adequately drained. Concrete floors require a special finish to make them non-porous.
- Walls should also be **waterproof**, and easy to clean.
- Windows and doors should be **screened** to keep out flies and other pests.
- Ceilings should be designed to prevent accumulation of **dirt and condensation**. Condensation may encourage mould growth.

- Walls and ceilings should be of a **light colour**. This will help in ensuring adequate lighting, especially where close examination of the fish is required.

Now try these two SAQ's.

② **SAQ15**

Which of the following statements is true about buildings used for producing frozen foods? Tick those you believe are true.

- a) They should be large enough to house the equipment, personnel, offices, washroom etc. without overcrowding.
- b) They should be sited next to the town's waste disposal tip.
- c) They should have sufficient space for vehicles to deliver and collect goods.
- d) The area around the building should be kept clean at all times.

② **SAQ21**

Tick a), b) or c) to complete the following sentence.

Adequate lighting in a fish freezing factory is necessary because

- a) It allows the factory to have no windows.
- b) It allows a longer working day in the winter.
- c) It helps inspection of the raw material and finished product to ensure quality standards are kept high.

HYGIENE

We have already mentioned some points to do with hygiene of the buildings.

Here are some more:

- Keep fresh fish **separate** from frozen fish.
- Have well defined areas for:
 - (i) **Receiving** and **storing** fresh fish and other raw materials;
 - (ii) **Preparatory** processes such as filleting;
 - (iii) **Packaging**.
- Keep **offal** separate from fish flesh. This should be done by storing the offal in watertight covered bins. This prevents liquid from the offal leaking from the bin. The cover keeps animals, insects and birds from the offal.
- Have a good supply of **hot and cold water**.
- Ensure **drainage** is adequate to meet your requirements.
- Provide the correct facilities for **washing and sanitizing** equipment. (Sanitizing means reducing the number of bacteria to a safe level).
- Provide **hand-washing** facilities in the processing area.
- Provide **toilet** facilities for the work force.
- Make sure **work surfaces** and materials of construction of equipment meet the demands of the Food Hygiene Regulations.

This list is not necessarily complete but it does give you a good indication of what is required. Hygiene is dealt with in greater detail in the module "Hygiene and Cleaning in the Fish Industry".

Before proceeding, answer this SAQ:

② SAQ27

What are the reasons for having water-tight covered bins for offal?

.....

.....

.....

Personnel

Fish freezing premises are covered by the Food Hygiene Regulations.

People working in a fish processing and freezing factory must maintain a high degree of personal cleanliness.

- They should take all necessary precautions to **prevent contamination** of the fish or fish products.
- If a person is suffering from a **disease** which can be transmitted through food they should **not** handle food. Sores, skin infection and diarrhoea are included in these diseases.
- The workers should **wear clean, protective overalls**. this includes a head covering which should hold **all** hair in place. You will find that in many factories, all the workforce (both male and female) wear hair nets.
- All protective clothing should be **washable or disposable**.
- Waterproof aprons may be used but these should be **washed regularly**, as should gloves if worn.
- Always **wash your hands** after using the toilet.

Check what you have just read by answering this SAQ:

② SAQ33

Can you list some of the ailments that prevent people from handling food, under the food hygiene regulations?

.....

Handling fish before freezing

Perhaps during handling of fish the most obvious problems with hygiene occur. The following points highlight these problems:

- Gutting and filleting operations should be **clean and hygienic**.
- Protect the fish from **contamination** by boxing and covering if there is to be any delay before freezing.
- The fish and fillets must be **kept cool**. Holding at a temperature just above freezing point (0°C) slows down spoilage. **Use ice**.

Any fish which cannot be processed immediately on arrival, should be **re-iced** in **clean** containers. Ideally they should be stored in a chill store. The temperature of the chill store should keep within the range 0°C to +5°C. This prevents freezing or heating of the fish occurring. Both of which would lower the quality.

Remember, chill rooms are designed to **hold** fish at a low temperature. They are **not** designed to bring the temperature of the fish down from ambient temperature. The melting ice lowers the fish temperature.

- Do not use any fish which has deteriorated to the point where it is **unfit for human consumption**.
- Do not use fish which has been **contaminated** with any foreign matter which would make it unfit for human consumption.
- Use only **clean, sound fresh fish**.

Now complete this SAQ:

SAQ39

How can spoilage of fish awaiting freezing be slowed down?

.....

.....

.....

Packing before freezing

As in the previous pages, a list of points for you to consider:

- If the fish is to be placed into packaging before freezing this should be done as quickly as possible.
The temperature of the fish may rise during packing.
This will increase the rate of spoilage if held too long at the packing room temperature.
- Where fillets are to be frozen into blocks, the product should have a **regular, uniform shape**. Such blocks are produced in a plate freezer using aluminium moulds. The fillets should fit neatly into the lining material in the forming moulds. This will ensure good contact in the plate freezer.
- If the fillets are to be interleaved with polythene, the **polythene should be coloured blue**. This helps the operator to spot any polythene which may be caught in a fold of frozen fillet and make it difficult to remove when the block is unwrapped.
- It is important that the **rate of packing** should not be greater than the capacity of the freezers. If fish is to be delayed after packing for any more than half an hour before entering the freezer, it should be returned to the chill store until freezer space is available.

Hygiene is dealt with in more detail in the module called 'Hygiene and Cleaning in the Fish Industry'.

Another SAQ for you to attempt:

② SAQ45

Coloured polythene is sometimes used for interleaving fillets when frozen in blocks. The reason for using coloured polythene rather than clear polythene is:

- a) To indicate that it is your produce.
- b) To make the pack look attractive.
- c) To assist in the complete removal of polythene from the fish when the block is unwrapped.

Tick the correct response.

FREEZING TIME

The freezing time should be as short as possible.

In order to freeze fish effectively we must consider a number of factors. These are now looked at in some detail.

- The **time** taken to freeze a **sample** of fish or fish product down to a storage temperature should be noted before the main production run starts. This will enable the freezer operator to leave the fish in the freezer for the correct length of time. The exact freezing time is determined by direct measurement of the product temperature.
- It is a good idea to **check freezing times** on a regular basis. This is a time consuming process but if done on a frequent basis, checking freezer temperatures will show up any problems that may arise.
- If freezing is **slow, or incomplete**, this can affect the texture, flavour and keeping qualities of the fish.
- If the freezer is **overloaded**, this will have the effect of slowing down the rate of freezing. Therefore, overloading freezers produces poor quality frozen fish products.

- Freezing should **continue** until the storage temperature is reached. The cold store temperature for fish and fish products should be -30°C .
- Keep freezing the fish until a **centre temperature** of -20°C is reached. This will reduce the work load on the cold store.
- It is also important that the fish is not **left** in the freezer **too long**. This is especially the case with air blast freezers. If the fish is left in the freezer for too long a period, the surface will dehydrate (dry out). It produces poor quality fish.

Now for 4 more SAQ's on this section.

? SAQ49

A batch freezer designed to freeze 1 ton batches of fish is loaded with 2 tons of fish for freezing.

What problems do you expect to occur in this instance?

.....

.....

.....

.....

? SAQ3

Consider a small company operating batch blast freezers. The company has bought a large quantity of fish at a good price. Most of the fish is to be frozen as fillets in the blast freezers.

At the end of the working day there is still one batch to be frozen in the blast freezers.

Would you –

- Ice the fillets and put into chill for freezing the following day?
- Put the fillets into the blast freezer to freeze overnight and remove the next day?
- Put the fillets into the freezer and pay two operatives overtime to unload the fish after freezing?

Tick the correct response.

② SAQ10
 There are various factors which will affect the freezing time of fish or fish products.
 Can you list six of these factors below?

1.
2.
3.
4.
5.
6.

Check your response before proceeding to the next section.

② SAQ16
 Tick which of the following statements is incorrect.
 Fish left in an air blast freezer for too long a period of time will:

- a) Dehydrate.
- b) Lose weight.
- c) Get a layer of frost on it.
- d) Be of a poor quality.

Capacity

Sudden changes in levels of supply can make it difficult to decide on how much freezing capacity is needed. A freezer which can cope with the largest amounts likely to be available will not be in full use for the rest of the time. **Having idle machinery and/or staff is not good business.**

At the other end of the scale, a freezer which cannot cope with at least average supply will reduce the amount of business you do. It will stop you from taking full advantage of large landings when prices are low. It will also increase the temptation to overload the system. This will give a poor quality product.

Make sure the **freezing capacity** of the equipment is sufficient to deal with the expected production rates. This will help avoid the problems of delay.

Freezer Operating Temperatures

With the exception of the cryogenic types, the operating temperatures of freezers is not far below the storage temperatures of frozen fish. The operating temperature of plate freezers is usually -40°C . The operating temperatures of blast freezers is usually -35°C to -40°C .

These temperatures are a compromise.

Higher temperatures would mean slow freezing with consequent loss of quality.

Lower temperatures make the fish freeze faster but the cost of freezing is increased.

Check your knowledge of normal operating temperatures by attempting the following SAQ:

② SAQ22

Cross out the figures that you think are not the normal operating temperatures of the following freezers.

Plate Freezer	Blast Freezer	Liquid Nitrogen Freezer
-10°C	-20°C	-20°C
-30°C	-25°C	-40°C
-40°C	-40°C	-100°C
-50°C	-50°C	-200°C

Refrigeration System Operating Conditions

On hot days the refrigeration system has to work harder to get rid of heat taken from the product. This can result in much slower rates of freezing.

Because it is important to rapidly freeze the product the system should have a reserve of capacity to cope with these conditions.

This also applies to refrigeration compressors for cold stores.

Fish Temperature Prior to Freezing

It will take longer to freeze a warm product than a cold product. By keeping the fish cool before freezing, the freezing time is reduced. (Use ice and a chill store if necessary).

Thickness

Obviously the thicker the fish, the longer it will take to freeze. But, by doubling the thickness you will **more than double** the freezing time.

Packaging

Any packaging will reduce the rate of freezing. Some packaging will have little effect whilst others will greatly increase the freezing time.

An example of the latter would be smoked fillets packed into a cardboard outer case and placed in a blast or plate freezer. There will probably be air trapped between the top of the fish and the lid of the box. This air will act as an insulator, thus increasing freezing time.

Cryogenic Freezing Times

Cryogenic means using **very low temperature**.

As you probably know, cooling of any substance causes shrinkage or contraction. Likewise, heating will cause expansion.

In cryogenic freezing, liquid nitrogen at a temperature of **-196°C** is used so it is not difficult to see that the product can cool

faster on the outside than on the inside. This causes the outer layers to shrink faster than the centre. If this cooling is **too fast** then the shrinking forces are so strong that the surface cracks.

This makes the product lose its visual appeal. It also increases drip-loss after thawing.

The problem is overcome by adequate pre-cooling in the freezer itself. (Remember the section on the nitrogen freezers in Segment three).

If the product passes **too rapidly** through the freezer and freezer temperatures are **too low** then cracks are liable to occur on the surface.

Now answer this SAQ:

② SAQ28

Complete the following sentence.

By keeping the fish cool before freezing, the freezing time is

Conveyor Belt Speeds

Where continuous freezers are used, the conveyor belt speed should be slow enough to give a properly frozen product at the freezer outlet. If the conveyor speed is slower, then the time the product spends in the freezer (dwell time) is **longer**.

When operating cryogenic freezers, such as liquid nitrogen freezers, it is important to have complete coverage of the belt with the fish or fish product.

This may be achieved by adjusting the conveyor speed. It should be adjusted until the fish being fed onto the belt lands close together without overlapping. The result is greater economy of liquid nitrogen usage.

DISTORTION OF UNIFORM BLOCKS

Sometimes the dimensions of uniform blocks are critical because they are to be used in another process. An example would be the production of a fillet block for use in making retail fish portions. The length and width of the block depends on the mould used in the plate freezer and the thickness is kept constant throughout the block by applying pressure to the freezer plates.

Such blocks cannot be produced in air blast freezers because the cross section of such a block would be irregular, as shown in Figure 18.

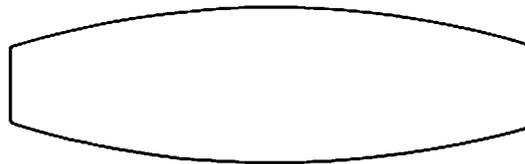


Figure 18.

As you can see, the sides have bulged out and the shape is no longer suitable for cutting into uniformly sized portions.

TREATMENT AFTER FREEZING

As soon as fish is removed from a freezer, it should be glazed, packed and transferred to a cold store.

Even very short periods of storage in a poorly designed or operated cold store will cause severe dehydration.

Glazing

In glazing we are applying a layer of ice to the surface of a frozen product. It is normally done by spraying water onto the frozen product. Another method is to dip the product into water.

There are 2 advantages to glazing:

- It prevents the fish drying out in cold storage. (The ice of the glaze is lost rather than the ice from the fish).

- It helps to prevent rancidity by stopping oxygen from the air reaching the fat of the fish.

However, there are serious disadvantages:

- If the glazing is too thick the consumer or end user will accuse you of selling excess water with your product and probably change to another supplier!
- The drip loss on thawing appears to be increased.

So the motto here is:

“Too much glaze is bad for business”.

The amount of glaze applied must be controlled. The amount will depend on the following factors:—

- Glazing time;
- Fish temperature;
- Water temperature;
- Product size and shape.

The best method of applying glaze is the use of a spray glazer (figure 19).

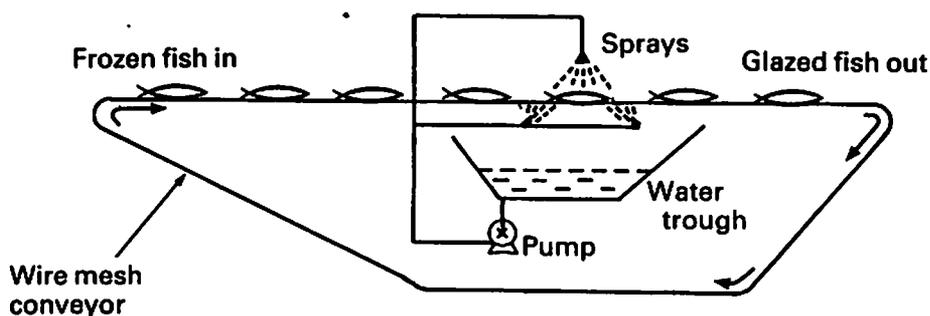


Figure 19: Fish glazing machine

Adjusting the belt speed will give the correct time spent in the glazing zone (dwell time).

Spray nozzles above and below the belt angled both ways will ensure complete glazing.

A variation on this machine is to make the conveyor belt dip into a shallow trough below the overhead nozzle. This means the lower surface is glazed. Such a method is said to use 50% of the water of the open mesh belt type of glazer. You will see a simple sketch of this in Figure 20.

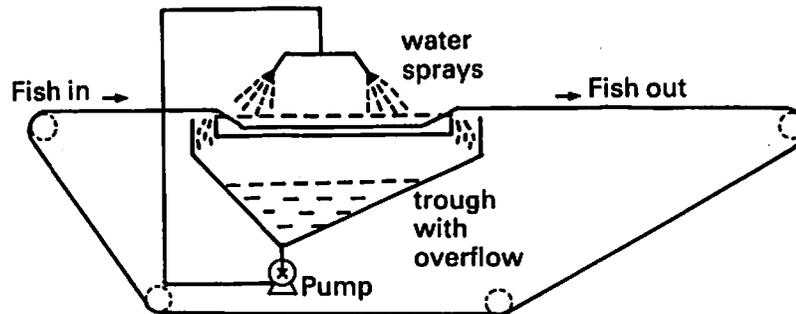


Figure 20: Frozen Fish Glazing Unit (Immersion type)

The water used for glazing must be of drinking quality and ideally at a temperature below 5°C.

If the surface temperature of the fish before glazing is below -70°C, such as after liquid nitrogen freezing, the glaze may be easily dislodged during later handling, so you will need to take care.

Where the frozen product is later to be covered with batter (and possibly crumb), glazing can again be a disadvantage. The glaze tends to melt which allows the batter to run off. This results in incomplete coating of the fish. If the product is then fried, the hot oil will come into direct contact with the glaze or the fish itself. This will cause a small explosion which will blow the remaining batter off.

You should note that, with prolonged storage, the glaze may be lost and re-glazing may be necessary to maintain quality.

A suitable time for 2 SAQ's about the glazing of fish.

② SAQ34

The object of glazing is not to add weight to the product.

Give two reasons for glazing fish products?

.....
.....
.....

② SAQ40

Why is glaze not applied to fish which is later to be covered with batter?

.....
.....
.....

Packaging

Frozen fish should be packed immediately after freezing or freezing and glazing.

The packaging material should meet the requirements of the product.

Factors to be considered are that the package should:

- Be strong;
- Be waterproof;
- Be stain resistant;
- Identify the product it contains;
- Be attractive if a retail pack;
- Be the correct size and shape for the product;

- State when and where made;
- Give advice on storing and thawing.

Within this module we cannot deal with the subject of packaging in detail. Further advice should be sought if you need it.

Storage

After glazing and packaging, the frozen fish should be moved directly to cold storage at -30°C . The time between unloading the freezer and transferring the product to the cold store must be as short as possible.

SUMMARY

In this segment we have learnt about the important features of a building suitable for a frozen fish plant. We have considered personal and general hygiene practices and looked at the important features of handling fish being prepared for freezing. We have also considered the factors associated with packing fish before freezing and those to be considered during freezing itself.

You will realise that **quality** of the final product is the keyword throughout, whether it is simply maintaining appearance, preventing contamination, or preventing spoilage resulting from poor freezing practice.

In the next segment, we will be looking at the cold storage of frozen fish and fish products.

This has been a heavy segment. You have achieved Objectives 3 and 4 shown on page xiii so a break is well deserved.

Storage and Distribution

Segment Five

Segment Five – Storage & Distribution

INTRODUCTION

This is the fifth segment of the module on freezing fish and fish products. In it, we will deal with the cold storage and distribution of frozen fish products.

Before studying this segment make sure you have completed the first four segments.

In segment four, we discussed how to make good frozen fish products. Having taken proper care in producing those products, you now want the consumer to enjoy eating them in the best possible condition.

Freezing the fish is only the first step in the distribution 'chain'. It is vitally important that the product is also stored and transported correctly in properly designed cold stores and vehicles.

If storage and distribution are not carried out correctly, then the product quality is likely to be poor.

MAIN AIMS OF THE SEGMENT

The main of this segment is to help you achieve objective 5 given on page xiii.

On completion of the segment you will be able to:

- Explain the importance of the **speed of transfer**;
- State the best **storage temperature** and shelf life expected;
- Describe an air lock and state why it is fitted;
- List the reasons for temperature fluctuations in a store and explain why they are a problem;

- State the best temperatures for use during transportation of frozen fish;
- List the methods of keeping fish frozen during transportation and the dangers some of these methods introduce.

SPEED OF TRANSFER

You read in segment four about the speed of transfer from the freezer to the cold store. **'Speed of transfer'** controls the time lag between coming out of the freezer and entering the cold store.

Now before getting into the heart of this segment attempt this SAQ to get your mind working.

<p>❓ SAQ50 Why is the speed of transfer from the freezer to the cold store important?</p>

.....

.....

.....

Before moving on to the next subject, check your answer with my response to the SAQ.

THE NEED FOR LOW TEMPERATURE

After freezing the fish, it may take six months, or even up to a year, before the product is eaten by the consumer.

The storage life of the frozen fish depends upon the temperature at which it has been stored.

If we take cod as a typical example, good quality cod, frozen soon after catching and stored at -30°C , will keep in good condition for up to eight months. If the same frozen fish is stored at -10°C then it will keep in good condition for **only one month!**

Increasing the temperature, even for a very short time has a bad effect on the quality of the fish.

The main difficulty is preventing the temperature rising during distribution to the consumer. Even though the fish may not thaw, increases in temperature cause loss of quality.

The spoilage of fish due to dehydration and chemical change can be slowed down by reducing the storage temperature.

In general, the **lower** the temperature the **slower** the rate of spoilage.

Of course, you will realise that the cost of storage increases as the storage temperature becomes lower.

In practice, the recommended storage temperature for all fish products in the U.K. is -30°C . This temperature is also used throughout Europe.

We have stated before that very low temperatures are costly to maintain. In the next section we will look at temperatures that we are likely to find during the distribution of the fishery product between the freezer in the factory and the consumer in the home.

Now attempt the following SAQ's:

② **SAQ52**

Good quality cod, frozen soon after catching, stored at -30°C will keep for up to 8 months. If the same frozen fish is stored at -10°C will it keep for: tick the correct response.

- a) 1 month
- b) 3 months
- c) 12 months

② SAQ4

Complete the following sentence:

Spoilage of fish due to and changes can be slowed down by reducing the storage temperature.

② SAQ11

Which is the correct recommended storage temperature in the U.K.? Tick the correct response.

- a) -18°C
- b) -30°C
- c) -40°C

THE DISTRIBUTION CHAIN

If we follow a frozen fish product from the point of freezing to the point at which the consumer eats that fish product, we are following a series of time intervals of storage and distribution.

This series of time intervals is known as **The Time Chain**. This is shown in Figure 21.

Figure 21 also shows the typical temperature history of a frozen fish product. You should note the following:

- How the temperature tends to rise to a peak during periods of transport;
- How the temperature of storage rises towards the point of sale.

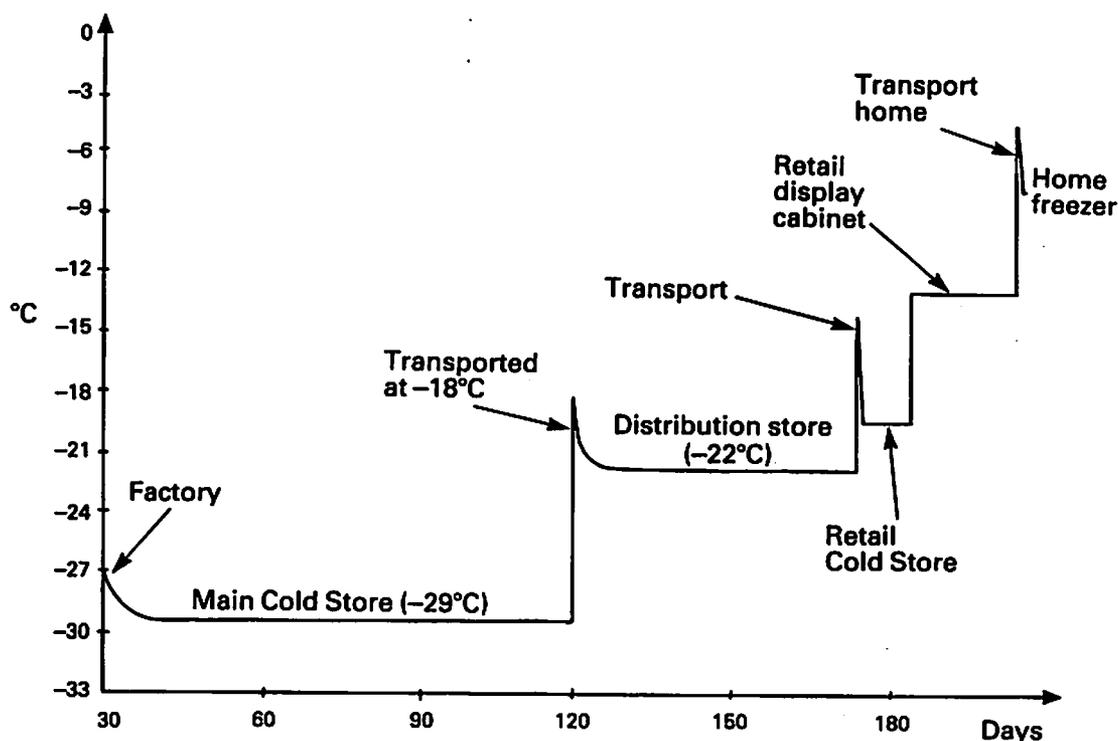


Figure 21: Typical Distribution Chain

For maximum storage life the fish product should be left at -30°C from freezing until the moment at which it is removed from the home freezer prior to preparation for the table.

Of course this is not realistic.

Just imagine picking up a frozen product at a temperature of -30°C in your local supermarket. Unless you were wearing gloves, which is unlikely, then the product would freeze to your hand!

Although it is not practical to maintain this temperature of -30°C , it is important to keep the product as **cold as possible** during the time before it is sold.

This also is true for fish products which are stored prior to being re-processed. (Such as frozen fish fillet blocks which are to be reduced to portion size and used in products such as 'fish-in-sauce'.)

It is fair to say that the larger the cold storage warehouse, then the lower the temperature. The largest warehouse is usually the warehouse used by the factory for bulk storing of the finished product. This is normally situated in the same town or area as the freezing plant itself. The food is distributed from these large cold stores for regional distribution.

These are not, however, the last of the cold stores in the distribution chain, as there is normally a third cold store which is used at the retail outlet.

This last cold store feeds the deep freeze display cabinets within the shops, it is normally operated at a temperature of -18°C .

Once we have reached the display cabinets, we are normally only talking about temperatures in the range of -15°C to -18°C .

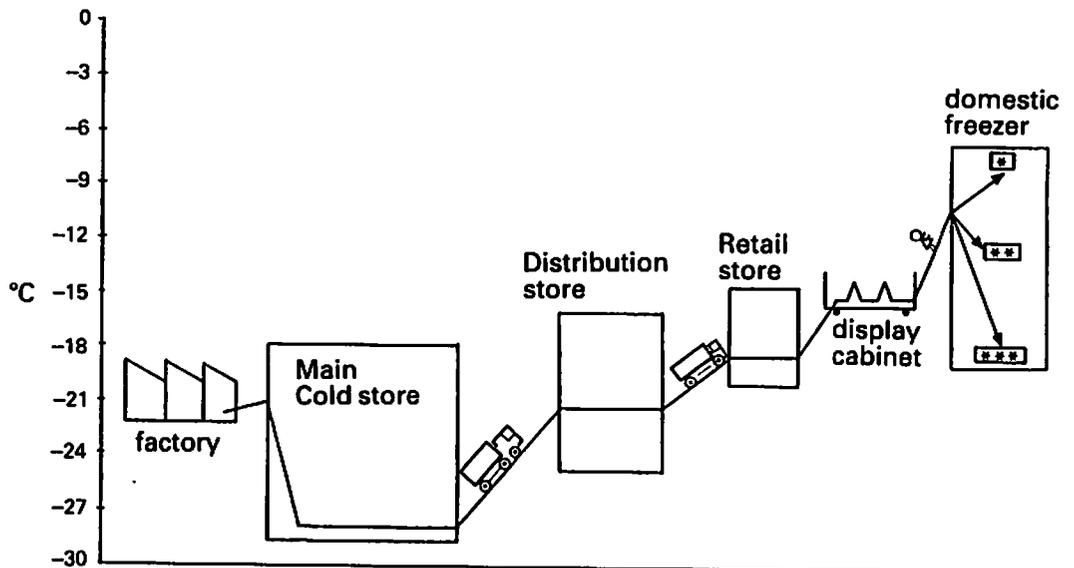


Figure 22: Temperatures in the freezer chain (after Sanderson Walker Int J Refrig)

If you look at figure 22, you will see that the figure at the end of the chain is 'normal household deep freeze cabinet'. The temperature in this deep freeze cabinet may vary between -6°C and -18°C depending upon whether it has * or *** temperature ratings.

Before moving on try this SAQ.

❓ **SAQ17**

Why would it be dangerous to have fish produce at -30°C in the freezer cabinet of your local supermarket?

.....
.....
Now let us consider some of these stages in the cold chain in a little more detail.

COLD STORAGE WAREHOUSES

The features of the large cold stores are obviously important if we are to achieve the ideal of a constant -30°C operating temperature.

Let's now look at some of the design features and storage arrangements which are particularly important.

Loading Bays

These should have an air-lock system and prevent the direct inflow of air from the outside when the doors are opened. An example of this can be seen in the figures 23 (below) and 24 (overleaf).

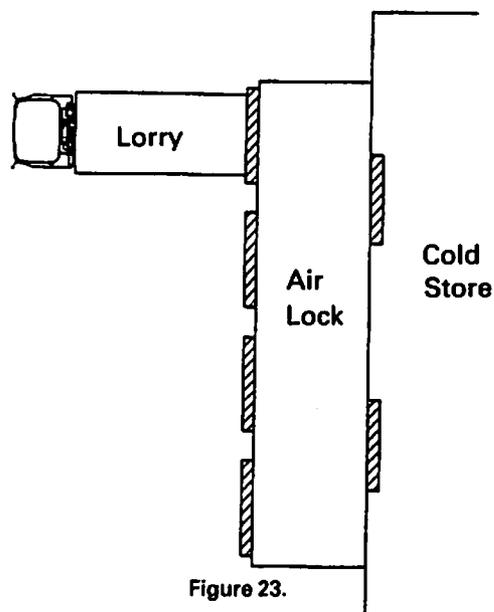


Figure 23.

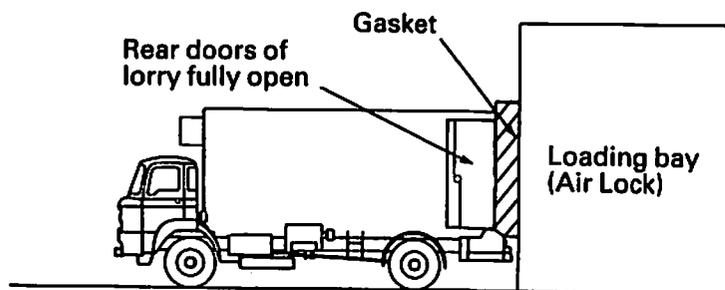


Figure 24.

Figure 23 shows a plan of a cold store with an air-lock at the entrance. Figure 24 shows a side elevation of the store with a lorry backing up to the loading bay and you should notice the use of a rubber cushion which reduces the exchange of air between the inside and the outside of the cold store.

If no air-lock is fitted then the use of plastic strip curtains or 'air curtains' can be used to reduce the loss of cold air. Air curtains are provided by a fan above the door blowing a curtain of air downwards to the floor.

First in – First out

Ideally the frozen products stored in the cold stores should be moved on a "first in – first out" basis. You should try to get as close to this ideal as possible.

This is not always easy to achieve. The cold store worker may find, when looking for a pallet containing a specific product, that it is stacked behind a more recent intake of frozen products.

It is also sometimes not possible to extract the pallet first in, in the time available to the operator. However, with fully automatic handling systems, used in modern cold stores, the principle of "first in – first out" is possible.

In older cold stores, the management of the store should be aware that it is very important to try to achieve this principle.

Warehouse Walls

When designing and building a new cold store, no matter what the size, expert advice should be sought.

This module cannot cover the design and building of cold stores. However, the construction of the walls of the cold store, should be understood.

The cold store wall consists mainly of insulating material. This is normally sandwiched between two layers of another material which gives strength and provides a moisture barrier.

It is important that the outer layers of the sandwich are kept intact. If they are pierced then, almost certainly, water will find its way into the insulating material. Any water which does will freeze and, in freezing, will produce a block of ice which will stretch from one side of the insulation to the other. The block will grow over a period of time causing two problems:

- It will cause the walls to bulge and possibly rupture. This will weaken the structure.
- It will act as a drain for heat to move from the outside to the inside of the store.

Temperature

The cold store temperature should always be monitored on a regular basis. All cold stores should have a thermometer probe **inside** the cold store which records the cold store temperature on an indicator placed on the **outside** of the store. Such a recorder will alert the cold store manager to any fluctuation of temperature within the store. Normally the larger the cold store, the less the fluctuation in temperature within the store.

Temperature Fluctuation in Cold Stores

Excessive fluctuation in cold store temperatures should be avoided.

There will always be temperature fluctuations in cold stores due to the refrigeration compressor cutting in and out. However, these fluctuations are fairly small.

A more important factor leading to temperature fluctuation is the opening and closing of the cold store door. If the door is left open for too long then a lot of warm air is allowed into the cold store. This raises the temperature of the store. Typical temperature changes are shown in Figure 25.

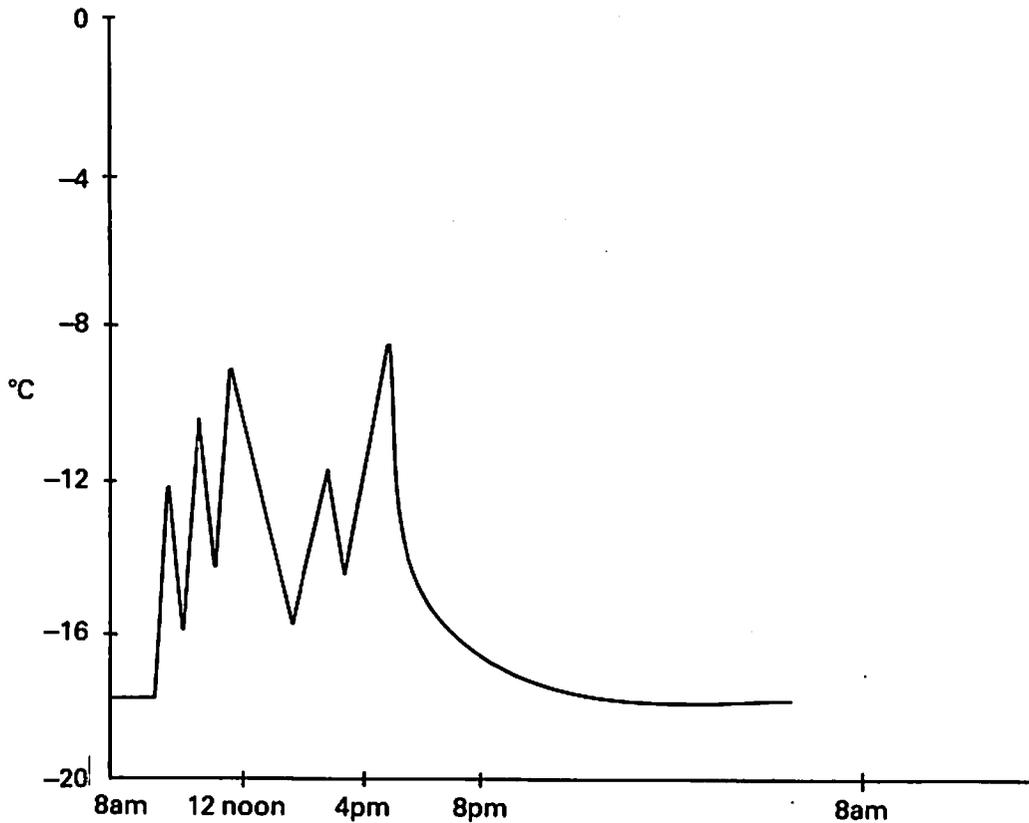


Figure 25: The effect of opening and closing the door of a retail cold store.

It is difficult to avoid some fluctuation in temperature due to the compressor but fluctuation due to exchange of air through the door can be reduced by:

- Fitting an air lock – look back to figure 23;
- Leaving doors open for as short a time as possible;
- Planning movements of products so that the frequency of opening the doors are kept to a minimum;
- Do any necessary sorting of the product **inside** the store, in advance.

Yet another reason for temperature fluctuation is putting 'warm' products into the cold store. If the temperature difference between the product and the cold store is too great, then this will also cause the store temperature to rise.

The temperature fluctuations in the store should ideally be kept to **less than 20°C**. The reason for this is that as the temperature difference between the product and the cold refrigeration surfaces increases, the transfer of moisture from the product to these surfaces is increased.

This causes dehydration of the fish products which is known as '**freezer burn**'. It is for this reason that glazing of the product is often recommended.

Stacking in Cold Stores

When stacking products in a cold store, space should always be left between the product and the walls or floor. This allows air to circulate freely.

The speed at which the air moves around the store should not be excessive as this will accelerate problems of dehydration mentioned above.

You have read quite a lot in the last few pages, now see how much has sunk in by attempting these SAQ's.

② **SAQ23**

What is the purpose of an air lock on a cold store loading bay?

.....
.....

② SAQ29

If an air lock is not available, what other precautions might be taken?

.....
.....
.....
.....
.....

② SAQ35

If the outer layers of the insulating sandwich of a cold store are pierced this will cause which of the following:
Tick the correct response.

- 1) Air to enter the cold store.
- 2) Insects to enter the cold store.
- 3) Water to enter the insulating layer.

② SAQ41

Why is temperature fluctuation in cold stores a problem?

.....

② SAQ46

List 3 factors leading to temperature fluctuation in cold stores:

- 1)
- 2)
- 3)

② SAQ51

How can temperature fluctuations be avoided? List four ways.

.....

.....

.....

.....

② SAQ5

Though we have not mentioned this in the text, regular removal of frost build up from the cooling coils in the cold store is essential.

Why do you think this is?

.....

.....

.....

.....

HANDLING AND TRANSFER OF FROZEN FISH PRODUCTS

Frozen fish is most vulnerable to a rise in temperature during the loading and unloading of the distribution vehicles. But, by following the recommendations set out below, the temperature rise can be kept small:

- Where possible, pre-cool the distribution vehicle before loading.
- Use loading ports and air locks wherever possible. The vehicle should be in direct contact with the cold store loading port.
- If loading ports are not available, use covered loading bays. Avoid direct sunlight and protect from wind and rain.

- Use pallets and mechanical handling to reduce loading/unloading time to a minimum.
- Carry out any sorting operation required in the cold store. (E.g. pre-assembly of loads).

TRANSPORT OF FROZEN FISH PRODUCTS

Vehicles used for the transportation of frozen fish products should be designed to operate with holding temperatures of -18°C or lower.

The container should be insulated sufficiently and regularly inspected to make sure that both the insulation and refrigeration system are kept at peak efficiency.

When carrying out this inspection, particular attention should be paid to door seals and any puncturing of the skin surrounding the insulation.

The most important consideration in refrigerated transport of frozen fish is that the vehicle is capable of maintaining the low temperature required to retain the quality of the product.

Primary Distribution

Where products are being moved from one cold store to another, the vehicle should be capable of maintaining the frozen fish at the temperature of the first cold store. This is the situation in Primary Distribution using "Truck vehicles" where temperatures lower than -18°C are normal.

Refrigeration methods used in Primary Distribution may include any of the following three:

- **Solid Carbon Dioxide (Dry Ice)**

The blocks of dry ice are placed in a metal container above the frozen food. The solid ice reverts to a gas as it keeps the food cool and so the container fills with carbon dioxide gas.

On opening the container doors, time must be allowed for this carbon dioxide gas to be replaced by air before anybody can enter the container.



If this is not carried out there is a danger of suffocation due to a shortage of oxygen.

- **Liquid Nitrogen**

The same safety precautions mentioned above apply.

- **Mechanical Refrigeration Systems**

These normally have their own power unit which, as mentioned earlier, must be serviced regularly.

Secondary Distribution

Secondary or Radial Distribution is the term used for final delivery to the point of sale. With these vehicles the doors are opened and closed frequently and the refrigeration system must therefore be capable of bringing the temperature down rapidly after a delivery has been made. Of the three methods of refrigeration mentioned earlier, the use of 'Dry Ice' is least likely to achieve the good temperature recovery rates needed.

It is worth noting that if 'eutectic' or 'hold-over' plates are used, these should be regularly brushed to remove frost build up and also regularly defrosted. Failure to carry out these simple operations will dramatically reduce their efficiency.

Thermometers

Temperature indicators for frozen distribution vehicles are essential. The indicator should be located in the driver's cab in order that any problem can be noticed at an early stage and wherever possible a temperature recorder should also be installed. In many cases the customer may in fact insist on a temperature recorder being fitted in the vehicle so that a complete picture of temperature changes during the journey will be available.

Let us test your understanding again by your trying the last SAQ's in this segment.

② SAQ12

How can we reduce the temperature rise during transfer between cold store and refrigerated transport? Try to list five things we might do.

.....
.....
.....
.....
.....

② SAQ18

What is the maximum temperature to be allowed in the vehicle container during distribution? Tick the correct response.

- a) -12°C
- b) -18°C
- c) -30°C

② SAQ24

What special problem do we get when using either solid carbon dioxide or liquid nitrogen as refrigerants in the transportation of frozen fish?

.....
.....

SUMMARY

Well, you have come to the end of the main part of the storage and distribution of fish and fish products. In the final segment we will be looking at retail sale and also briefly at methods of thawing.

You should now appreciate that it is not always possible to keep the fish at the ideal temperature of -30°C and in fact that it is necessary to raise the temperature to -18°C or thereabouts in a display cabinet in order to prevent the customers from burning their fingers.

You have learnt about the storage warehouses, means of transport, need for temperature recording and methods of handling frozen fish.

You have achieved Objective 5 given on page xiii. A good time for a break before the next segment.

Segment Six

The Retail Outlet and Thawing

Segment Six – The Retail Outlet and Thawing

INTRODUCTION

This final segment takes the form of an appendix to the main module. In it you will learn something of the management of retail freezer cabinets and problems which may arise at this point in the distribution chain.

There is also a brief discussion on the thawing of fish. This is a subject which is difficult to treat in depth in this module, but some of the commonly used methods of thawing have been included.

MAIN AIMS OF THE SEGMENT

We are now considering objective 6 on page xiii as our main aim. In order to achieve these, on completing this segment, you will be able to:

- State three types of retail freezer cabinets;
- Explain how stock rotation should be arranged;
- List the hygiene procedures when selling from bulk packs;
- Discuss the problems associated with retail freezer cabinets;
- State what is meant by thawing and list some methods of thawing.

THE RETAIL FREEZER CABINET

We will start this segment by taking a look at the last link in the retail chain which is the display freezer cabinet.

It is clearly important that frozen fish products should be offered for sale from refrigerated cabinets specially designed for the purpose.

Many display cabinets are in use and they can vary in design from chest cabinets (see fig. 26) to upright cabinets (see fig. 27 and 28).

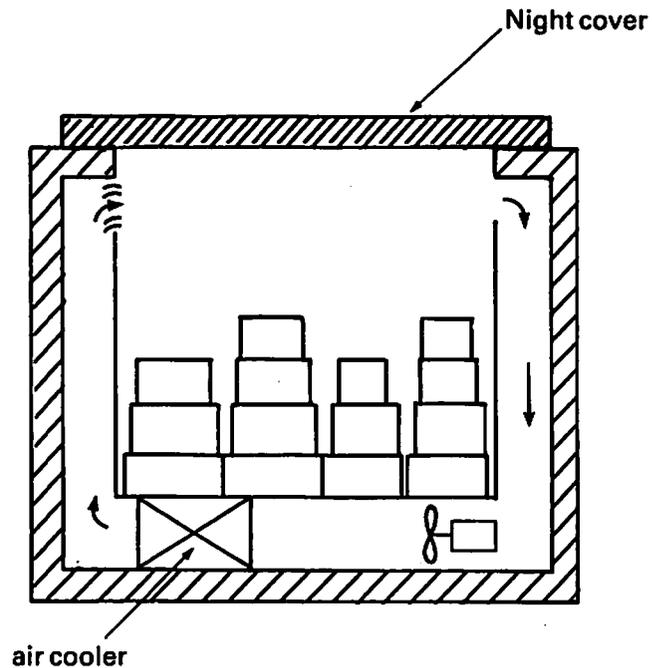


Figure 26: Display chest freezer

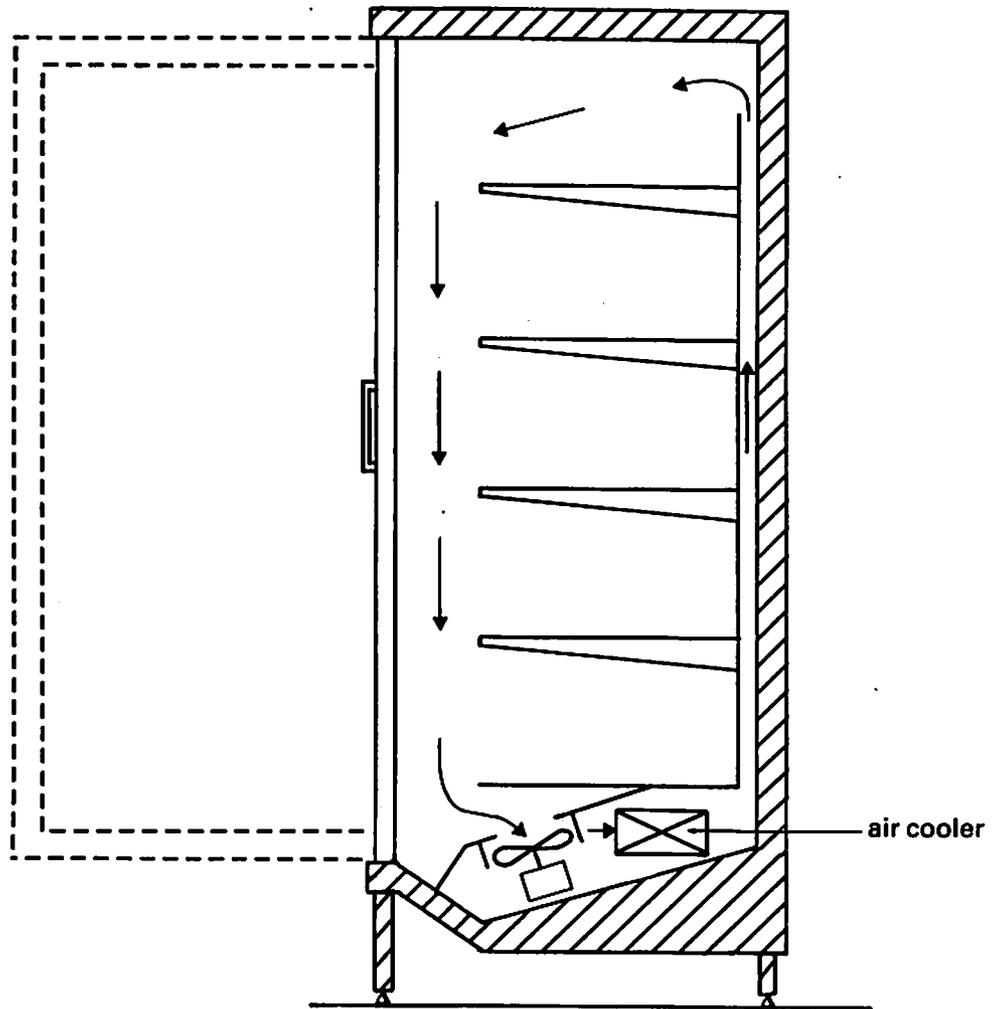


Figure 27: Upright display freezer cabinet with door

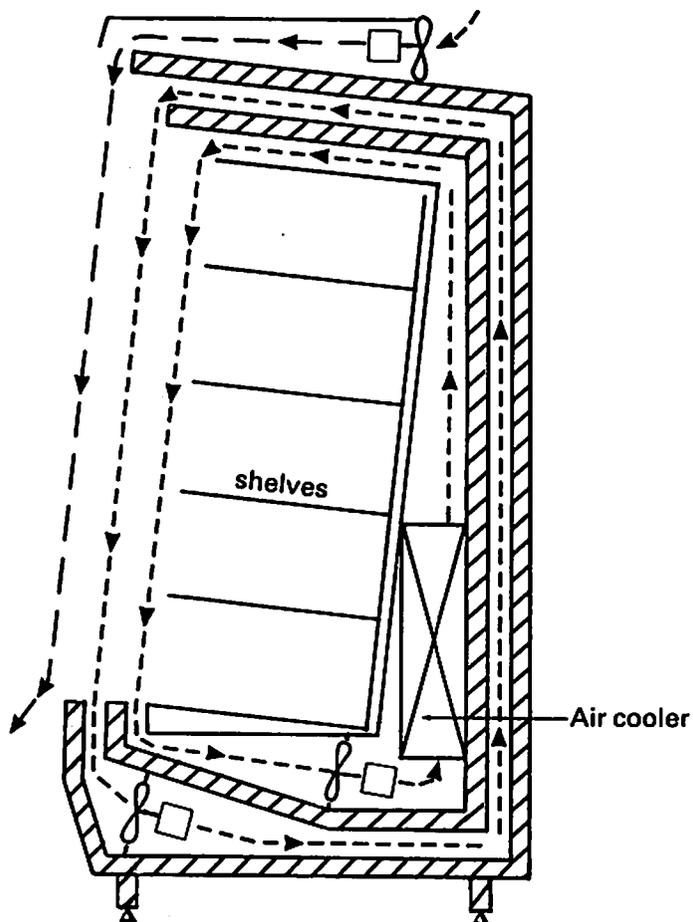


Figure 28: Upright open freezer display cabinet

Remember **all cabinets** should be capable of maintaining food at temperatures **below -18°C** . Of course when a shop is open and staff or customers are foraging in the cabinet there will be slight rises in temperature for short periods of time. Such rises however should not bring the temperature above -15°C .



Remember, the retail freezer cabinet is not designed to store frozen fish for long periods of time. A separate cold store must be used for this purpose.

Where retail cabinets are used, good stock rotation should be practiced. The **“first in–first out”** principle is easy to follow here. **All new stock** should be placed at the **bottom of stacks** or at the **back of shelves**.

Frozen fish products should **never** be stacked above the load line of the freezer display cabinet or in a position where they cover the air ducts. These mistakes can lead to defrosting of the product which must be avoided at all cost.

Bulk Packs

In some freezer centres the retail stores frozen fish is weighed out for customers from bulk packs.

The potential for contamination is very great and staff serving from these packs should be trained to observe the hygiene procedures which follow:

- Protective clothing should always be worn.
- Hand washing facilities should be provided, and the staff should be encouraged to use these **frequently**.
- Display cabinets dealing with these bulk packs should have
 - i) removable containers
 - ii) high front serve-over glazing for products protection.
- Scoops and tongs to remove portions from the bulk containers should be of non absorbent material and there should be sufficient provided to avoid using one scoop for two products. This will help avoid cross contamination, apart from impressing the customers.
- When empty, all containers should be **removed, washed, sanitized, dried and refilled if they are to be re-used**. They should **not** be just topped up.
- Records of the manufacturers’ codes should be kept in a manner which easily relate to the day’s sales of products. This will help in the identification of any complaint which may arise.

HINTS ON THE PROPER USE OF FREEZER CABINETS

- **Cleaning of cabinets** – The walls of display cabinets must be kept clean and free from heavy ice build up. When cleaning, the use of chlorine based sanitizers or abrasive cleaners is not recommended.
- **Advertising flash cards** may deflect or even restrict the flow of air over frozen foods. Consult the manufacturer of the cabinet as to the correct use of such advertising display material.
- **Night covers** should be used during the period when the store is closed. This will reduce power consumption and help preserve quality.
- **Have retail display cabinets serviced regularly.**
- **Power failure** – where the power failure is of a short duration, i.e. an hour or two, then application of night covers to preserve the low temperatures will be sufficient. If however, the power failure is of longer duration, transfer the frozen fish to a back-up cold store.



Where fish has thawed out it should **never** be re-frozen and offered for sale. Where appropriate, you may obtain a condemnation certificate from your local Environmental Health Officer. This may be useful for insurance claim purposes.

THAWING OF FROZEN FISH

Fish which has been frozen at sea is often thawed, processed and re-frozen. Other frozen fish is sold uncooked in a defrosted state or used for a different process, (e.g. the fish frier).

To produce good quality thawed fish we must start with good quality fish before freezing.

The freezing process must be **controlled** to give good quality frozen fish and the thawing process likewise must be controlled to give good quality thawed fish.

There are two groups of thawing methods used for frozen fish.

The first is by applying heat to the surface using warm air or water.

The second is by direct electrical heating, using mains, radio, or microwave frequencies.

In both groups we must **avoid overheating** the fish. At temperatures as low as 30°C the fish can start to cook!

Thawing in Air

The most effective method of thawing in air is to use an air blast thawer as shown in Figure 29.

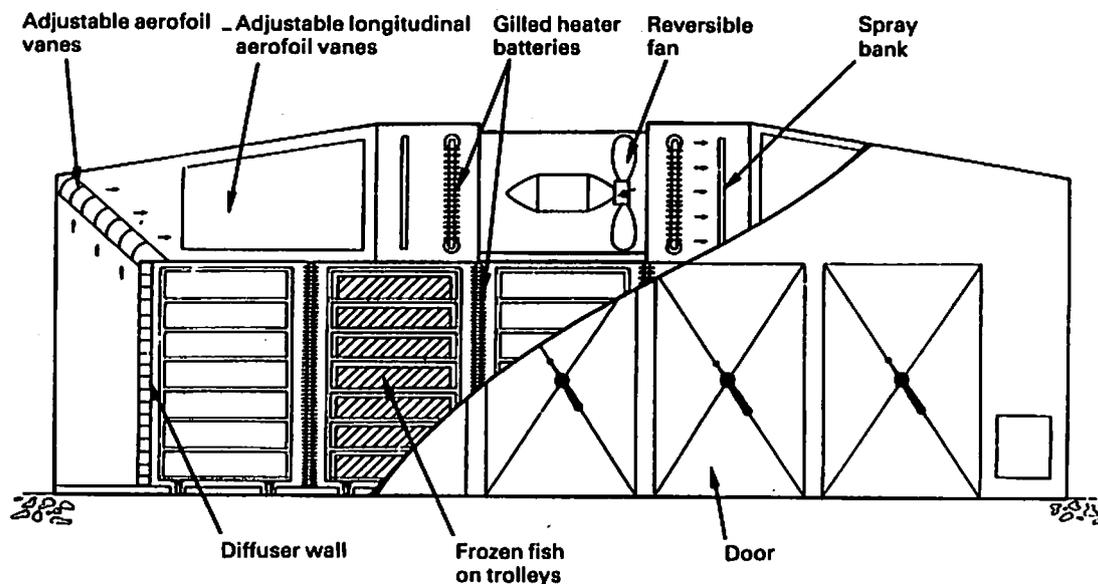


Figure 29: Batch air blast thawer

(Reproduced from Fish Handling and Processing, H.M.S.O.)

Fish thaws much more rapidly in moving air than in still air.

The fish is supported on open mesh trays stacked on trolleys and warm air is blown over it.

The air temperature **should not rise above 20°C** and the flow of air should be uniform over the blocks.

The air should also be moist. This helps heat transfer to the fish and it also prevents the drying out of the fish surface.

Thawing in Water

Thawing in water can be a cheap and simple method of thawing whole fish.

Blocks of fish are immersed in a large tank of clean water. Heat will be transferred from the water to the fish increasing its temperature and thawing out the frozen liquids.

Circulation of water is sometimes used to reduce energy costs and this means that filtration will be needed to remove fish particles and scales etc.



Please note that thawing fillets in water is not a good idea. The fillets will take up water and tend to lose flavour. This will reduce the eating quality of the fillet.

Electrical Methods of Thawing

These methods consist of:

- Microwave heating;
- Dielectric heating;
- Electrical resistance heating.

The problem with all these methods of thawing is one of **overheating**. The electrical energy used is converted to heat energy. Where the absorption of energy is not uniform, it leads to localised overheating and cooking of the fish.

With irregular shaped fish, correct thawing by these techniques is difficult to achieve.

These methods do however provide a rapid and satisfactory means of thawing **if properly used.**

Where such methods of thawing are being contemplated, expert advice should be sought.

In the first instance you are recommended to read chapter 9, of "Fish Handling and Processing" (2nd Edn.) published by H.M.S.O. (1982).

Frozen fish once thawed behaves like fresh fish. As such, it must be protected from spoilage by keeping it chilled until processed or distributed to the consumer.

Now for your last 4 SAQ's in this module:

② SAQ30
What is meant by the term 'good stock rotation' in connection with the stocking of retail freezer cabinets?

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.....
.....

② SAQ36
List four points of good practice when using a retail freezer cabinet.

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.....
.....
.....

? SAQ42
Why should display cabinets have removable containers?

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? SAQ6
Why should moist air be used when thawing fish by this method?

.....
.....
.....

SUMMARY

In this segment you have covered the use of retail freezer cabinets and now know that temperatures of -15°C to -18°C are normal in order to allow the fish products to be handled. This does mean that the spoilage rate is increased and so it is important to keep stock moving and maintain high hygiene standards.

You are also now familiar with many of the problems in using retail cabinets and so will be able to maintain a better quality of product for sale to the consumer.

The second part of the segment covered the methods of thawing fish products, the dangers of overheating and hence starting to cook the fish!

You have achieved Objective 6 given on page xiii and that completes the module. I hope you have found it interesting and useful. It will also provide a useful reference for you in future studies or work. Don't forget the other modules mentioned which might be of use to you.

**Responses to
Self Assessment Questions**

Responses to the Self Assessment Questions

SAQ 1

You should have mentioned that frost can reduce the rate of removal of heat from the fish by preventing contact between fish and plates. The frost can, of course, be removed by brushing. Overnight, the plates are usually allowed to defrost.

I hope you remembered that ice also gives poor contact between plates and product. You will remember that it can be avoided by wiping off after defrosting. I wonder if you thought of the problems due to those lumps of ice pressing into our uniform blocks? On removal after freezing the blocks would contain voids!

SAQ 2

You should have pointed out that only the outside of the fish freezes instantly. The outer part of the fish 'crust freezes' and the temperature drops very low (below -50°C). After a while the temperature at the centre falls below freezing as the outside of the fish warms to -30°C .

It may be some time after the product has been packed and put into cold store that full equilibrium is reached. As long as the frozen product gets into the cold store **without delay** this is satisfactory.

SAQ 3

I hope you decided that (c) was the correct answer!

If you chose (a) then the fish would be losing quality whilst in the chill store. There would probably be a drip loss from the fillets. This would lead to lost yield as well as the extra cost of ice!

By choosing option (b) you would again have a reduced yield as well as dehydrated fillets.

SAQ 3 (continued)

The correct answer is (c). The additional cost of overtime for the operatives may be offset by finding other tasks for them to complete whilst waiting to unload the freezer. It is cheap insurance against having to sell fish from option (b) at a discount!

SAQ 4

You should have written:

Spoilage of fish due to **dehydration** and **chemical changes** can be slowed down by reducing the storage temperature.

SAQ 5

If the frost build up is not removed it reduces the efficiency of the refrigeration system.

SAQ 6

Moist air assists in transferring heat to the fish. It also prevents the surface of the fish from drying out.

SAQ 7

Answer 1 isn't correct. Although this range is below the freezing point of pure water it is too high for storage of frozen fish, and could lead to thawing of the product. Also, some bacteria can survive within this range so spoilage could occur.

If you gave answer 2 as correct well done! The correct temperature range for storage of fish products is between -20°C and -30°C . It is preferable to use storage temperatures nearer to -30°C for preservation of good quality.

If you have answer 3 as correct, you may be confusing freezing with chilling. This temperature range is used for storage of chilled fish products.

SAQ 8

If you thought (b) you may be mixing up blast and plate freezing. Unlike a plate freezer, contact with the belt does not improve freezing rate. Nor does freezing to the belt cause a problem because, at the discharge point, the conveyor bends but the product does not. So, the product separates from the belt. (c) isn't correct either.

Hence, we are left with (a) as the correct answer because the flow of air around the product is reduced.

Frost can cause other problems in the freezing process. We will be looking at these in segment five.

SAQ 9

Well, the answer to this S.A.Q. is all except (a) the plate freezer. All the other freezers are capable of freezing the scampi tail rapidly. Rapid freezing as mentioned in segment 1 is most important. You may like to think about the types of fish you handle and what would be the best freezer to use for freezing them.

SAQ 10

Variables which affect freezing time are all concerned with the rate at which heat can be removed from the fish product.

They are:

1. Freezer type (Plate, Blast etc.)
2. The operating temperature of the freezer. The lower the temperature the faster the rate of freezing.
3. The refrigeration system and its operating conditions.
4. The rate of flow of refrigerant
5. The temperature of the fish on loading.
6. The thickness of the fish.

SAQ 10 (continued)

7. The shape of the fish.
8. The species of fish – fatty fish may freeze more quickly than lean fish.
9. Whether or not the fish is packaged before freezing. Packaging will reduce the rate at which heat is removed and so increase the freezing time.

SAQ 11

- b) -30°C .

SAQ 12

You could have included the following points:

- Pre-cooling the distribution vehicle before loading.
- Use of loading ports and air locks.
- Use of covered loading bays.
- Use of pallets and mechanical handling.
- Carry out sorting operations **inside** the cold store.

You may have thought of some more.

SAQ 13

If you have put 2 and 4 as correct then well done! Only first quality fish should be used for freezing. Also, by buying fish when plentiful, the processor will pay less per unit than when scarce. This also enables the processor to supply fish when 'out of season' or when weather conditions stop landings of fish.

If you have said answer 1 is correct, this is not true. Freezing at best maintains the quality of the fish as it was immediately before the freezing process.

SAQ 13 (continued)

If you have ticked answer 3 as correct, this also is not true. You may be able to sell such fish once, but there will be no repeat sales!

SAQ 14

The statement should read:

Good air circulation in blast freezers is achieved by the use of **Baffles** and good **loading** techniques.

SAQ 15

A, C, and D are all true. Only B is untrue. It is not ideal to locate a fish processing factory of any kind next to the local waste disposal tip. The possibility of cross contamination from such a site is far too great, and this should be avoided at all costs.

SAQ 16

The only statement not true is statement c. It is unlikely that frost will appear on the surface of the fish. Normally in a freezer the frost appears on the cooling coils near to the fans.

The moisture in any freezer always moves to the coldest point. This is the cooling coils in a blast freezer or in the case of a plate freezer it is the freezing plates themselves.

Remember from segment two, frost in plate freezers should be removed before loading with fish.

SAQ17

There is a danger that the product may stick to the purchasers hand at temperatures as low as -30°C . This could give a severe burn. The temperatures used in freezer cabinets are nearer to -15°C .

SAQ 18

The correct answer is -18°C .

SAQ 19

The correct answer is b) 80 times that to cool water 1°C.

However, once frozen, ice cools approximately twice as fast as water when heat is removed at the same rate.

SAQ 20

I hope you put shrimps as the answer to this question. They are small enough to be lifted by the upward air flow.

The crabs would be too heavy as would the whiting fillets. The fillets are also not rigid enough to float.

SAQ 21

Answer C is correct.

Adequate lighting in a fish freezing factory is necessary because it helps the inspection of the raw material and finished product to ensure quality standards are kept high.

SAQ 22

You should have been left with the following table.

Plate Freezer	Blast Freezer	Liquid Freezer
-40°C	-40°C	-100°C

Liquid nitrogen boils at -196°C, however the normal operating temperature of this type of freezer is nearer -100°C. If the product were to come into contact with the nitrogen gas at -196°C it is likely to cause cracking on the surface.

SAQ 23

This will prevent a direct flow of warm air from the outside when the cold store doors are opened.

SAQ 24

The container fills with gas. This gas must be replaced with air in order to allow the operative to enter the container safely.

SAQ 25

The answer to the first part is a). This period of time is known as 'the thermal arrest period'.

The cause of this is the removal of heat producing a change in state from water to ice, rather than a drop in temperature. So b) is correct for the second part.

If you have ticked (a) you are incorrect but an interesting point is introduced. The fatty layer does slow down the cooling and freezing process but the fat content of the fish also reduces the water content compared to a similar sized demersal or white fish. The end result is that a similar cooling curve applies to both types of fish with some variations dependent upon fish species and season.

If you thought (c) was the correct answer, look at the curve again. If there were to be a breakdown in the refrigeration system then the temperature of the fish would tend to rise rather than continue to fall slowly.

SAQ 26

The correct drawing is (b).

Drawing (a) is wrong because the fish would not be pre-cooled before coming into contact with the liquid nitrogen.

Drawing (c) is wrong because there is no exhaust to remove the nitrogen gas from the building.

SAQ 27

It prevents contamination of other products caused by liquid from the offal seeping out of the bins. It also protects against animals, insects and birds, especially if the bins are sited outside the building.

SAQ 28

By keeping the fish cool before freezing the freezing time is **reduced**.

Use of a chill store may help in this case.

SAQ 29

The precautions could include:

- 1) Have a covered loading bay.
- 2) Protect from direct sunlight.
- 3) Protect from rain.
- 4) Protect from strong winds.
- 5) Use plastic curtains.
- 6) Use air curtains.

SAQ 30

For good stock rotation the principle of 'first in – first out' should be followed. This means that all new stock should be placed at the bottom of stocks or at the back of shelves.

SAQ 31

The correct answer is (b), slow freezing produces problems of excessive drip loss. One cause of drip loss is the formation of large ice crystals so (c) cannot be correct.

The second cause is removal of fluid from the cells. Bacterial action is not normally the cause of excessive drip loss though it will cause the quality of the end product to be poor.

SAQ 32

I hope you remembered that cryogenic is simply a word meaning very low temperature. So 'cryogenic freezers' are freezers which operate at very low temperatures.

SAQ 33

Some ailments preventing people from handling food are:-

1. Sores
2. Skin infection
3. Diarrhoea and vomiting.

In fact, any disease which might be passed on via the food.

SAQ 34

One reason for glazing fish products is to provide a layer of ice around the product which will prevent drying out of the product. The glazing will slowly disappear during storage and will require renewal.

A second reason is that it helps to prevent rancidity.

SAQ 35

The correct answer is c), water. This will in turn freeze causing further problems.

SAQ 36

Any four of the following would be a suitable comment:

- The cabinet must be kept clean.
- The air flow over the food must not be restricted.
- Night covers should be used.
- Cabinets should be regularly serviced.

SAQ 36 (continued)

- In the event of a long power failure, the stock should be transferred to a cold store.
- Never refreeze fish which has thawed out.

SAQ 37

You should have chosen (c), 2 hours.

This is the U.K. recommendation for 'quick freezing'. But, remember that freezing **must** then continue until the temperature of storage is achieved. This temperature is normally -30°C .

SAQ 38

Well, the answer to this question could be liquid nitrogen tunnel or liquid carbon dioxide freezers. Both these freezers operate at very low temperatures.

SAQ 39

By keeping the fish cool. This may be done by using ice, or better, by the use of ice and a chill store.

SAQ 40

Fish which are glazed before covering with batter do not get a complete covering of batter. The reason is that the glaze tends to melt, allowing the batter to run off the fish. This produces an incomplete coating.

When the product is subsequently fried, the hot fat comes into direct contact with the glaze or the fish flesh itself and the batter is "blown off" the surface of the fish.

SAQ 41

Temperature fluctuations in cold stores lead to dehydration of the product.

SAQ 42

Removable containers allow these, when empty, to be easily washed, sanitized and dried before being refilled. Remember they should **never** be topped up.

In addition removing all containers allows the freezer cabinet to be cleaned more hygienically.

SAQ 43

You should have put:

1. Contact
2. Air blast
3. Immersion or cryogenic

SAQ 44

You should have answered: Not to touch cold freezer surfaces with bare hands. The cold surfaces can burn just as badly as hot surfaces.

SAQ 45

The correct answer is of course, C.

Coloured polythene is used to help the operator check that no polythene is frozen into a fold of the fillet. Normally, polythene which is coloured blue is used for this purpose as it shows up well against the pale colour of the fish flesh.

SAQ 46

Temperature fluctuations in cold stores may be caused by:

- Opening and closing the cold store;
- Leaving the cold store door open for too long;
- Placing warm products in the cold store.

SAQ 47

You should have answered 'Blast freezer'. If you put 'plate freezer' then remember that it is only good for freezing objects of regular shape.

Immersion freezers, which we will look at in segment three, tend to be less versatile. Some spray freezers can be used for a range of products but their running costs are much higher.

SAQ 48

I hope you have mentioned venting the gas to the atmosphere. If the gas is not vented, it will reduce the proportion of oxygen in the air. This may lead to operatives losing consciousness and even possibly dying.

SAQ 49

Because the freezer is overloaded, it will not have the refrigeration capacity to cool the fish quickly enough. This means that instead of fast freezing we will have slow freezing. Slow freezing will produce poor quality fish with excessive drip loss on thawing.

It is better to hold the second ton of fish in chill prior to freezing rather than overload the freezer.

SAQ 50

The speed of transfer from the freezer to the cold store should be as quick as possible. This reduces the risk of the frozen fish warming up.

The warming up need not necessarily cause the defrosting of the product.

Even warming the fish up to -10°C can be harmful. Though the fish is still frozen at -10°C , it is spoiling much more rapidly.

By moving it to a cold store operating at the correct temperature, then this spoiling process is slowed down.

SAQ 50 (continued)

You will see that the transfer of frozen fish occurs between – cold store and lorries – and – lorries and retail outlets. The final transfer will be between the retail outlet and the consumer's deep freeze.

Problems can be avoided by maintaining a low temperature.

SAQ 51

You should have listed the following points:

- Use an air lock.
- Use an air curtain or strip curtain.
- Leave doors open for as short a time as possible.
- Make sure the product temperature is down to the cold store temperature before it enters the cold store.

SAQ 52

The answer of course is 1 month.

If the storage temperature is raised, the 'shelf life' is reduced.

Other Training Programmes

There are a number of other modules which are intended to help you get a better understanding of different parts of the trade. These include:-

Hygiene and Cleaning in the Seafood Industry – Printed Text, Taught Course. Covering food poisoning, maintenance and standards, premises, materials, routines, pests and laws. Leads to Foundation Food Hygiene and Elementary Food Hygiene Certificates via examination. Available in English, Lithuanian, Polish and Portuguese.

Health and Safety in the Seafood Industry – Printed Text, Taught Course. Leads to Foundation H&S and Elementary H&S Certificates via examination.

Maintenance of Fish Quality – Printed Text
The module is about good handling practice at all stages from quayside to retailer. Advice is given on how spoiling can be minimised. It covers different quality levels, changes in fish after death, icing, effects of handling, parasites, pollution and contamination.

Fish Identification – Digital file
This will teach you how to identify a wide range of fish and shellfish used in the industry.

The Frozen Fish Chain – Printed Text
Covers common freezing processes, benefits, handling, temperature control, premises, good practice during thawing and retailing.

Chilled Fish Chain – Printed Text
This module explains the reason for keeping fish chilled. It covers the different ways of doing so and the correct methods to use. It will help you understand some of the handling problems in the distribution system, putting you in a better position to discuss supplies and quality with your supplier.

Introduction to Fish Frying Skills – Printed Text
This module explains how to prepare and cook fish and chips. Topics included are preparing and frying fish, batter preparation, potato preparation and frying skills.

Included with this module is the *Introduction to Food Hygiene and Health & Safety in Fish Frying* module. This focuses on food

hygiene principles, temperature control and health & safety. Following a practical/theory assessment, these two modules can lead to a Seafish/NFFF Fish Frying Skills certificate.

Introduction to Customer Service in Fish Frying – Printed Text.

This module covers the importance of customer service in a fish frying business. Topics included are workskills, getting ready for opening, dealing with customers and how to deal with customer complaints and incidents.

Included with this module is the *Introduction to Food Hygiene and Health & Safety in Fish Frying* module. This focuses on food hygiene principles, temperature control and health & safety. Following a practical/theory assessment, these two modules can lead to a Seafish/NFFF Customer Service Skills certificate.

Introduction to Fish Monger Practice – Printed Text

This text covers the various duties expected of an assistant in a Fishmongers' premises. It stresses the importance of a correct attitude both to work and to customers.

Primary Processing of White Fish – Printed Text

Deals with hand and mechanical processes together with packaging, quality control and stock control. The need to maintain a high standard of hygiene is dealt with from the point of view of staff, equipment and buildings.

Fish Smoking – Printed Text

This module covers the basic principles of fish smoking. It deals with the choice of raw material, its preparation and packing. There is also a segment on the types of kilns and fire boxes in common use. The module includes two segments dealing with fish spoilage and the preserving properties of smoke.

Scallop Handling and Shucking Practices – Available only with the associated DVD. This incompany training pack provides all the material needed to train and inform your staff through workplace coaching.

Workplace Coaching – Ever wanted to train your own staff in how its done in your company? This easy to follow distance learning pack will help you to coach and train your own staff. Includes a supporting DVD.

Training Films – on DVD

Strikeback II - Developed in 2006 to support Seafish's hygiene and cleaning in the seafood industry open learning module and taught course. Can be used on it's own for staff induction training. A translated script is available for use with staff who speak Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Hand Processing of Seafood - a masterclass. Possibly the most extensive review on DVD of hand processing skills. The hand processing of almost 50 species of fish and shellfish are demonstrated by Duncan Lucas, one of the UK's top fishmongers. Developed in 2006.

Fish Filleting Training Programme – This DVD was developed in 2006 to support the taught fish filleting training programme. Containing six demonstrations of fish filleting techniques.

Identification of Marine Fish and Shellfish – With 45 species shown and described in detail. Developed in 2006.

Health and Safety in the Seafood Industry - Developed in 2006 to support Seafish's H&S in the seafood industry open learning module and taught course. Can be used on it's own for staff induction training. A translated script is available for use with staff who speak Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Scallop Handling and Shucking Practices – Available only with the associated incompany training pack. This DVD provides powerful arguments for the correct handling and shucking of scallops and demonstrates how it should be done. Developed in 2006 with assistance from the Food Standards Agency (Scotland)

Fish Frying Skills - The Movie – This DVD takes the viewer through the process of how to prepare and cook the perfect fish and chips. Topics covered include the preparation of potatoes, batter and fish along with the frying of the fish and chips. Developed in 2005.

Misc DVDs – Various training films that were first produced as VHS videos are now available as DVDs. These older programmes include Upfront - selling skills for fishmongers. For an up to date list contact Seafish.

Training Courses

Seafish have a range of training courses in fish quality assessment, health and safety and food safety.

Our short food hygiene course (*Introductory food hygiene for the seafood industry*) is available in English, Latvian, Lithuanian, Polish, Russian, Portuguese and Spanish.

Other courses are available directly from Seafish or through our network of Group Training Associations. For an up to date list and current information see www.seafish.org or email training@seafish.co.uk