

## **Segment Four**

### **Salting, Brining and Smoking Processes**



# Segment Four – Salting, Brining and Smoking Processes

## AIMS OF THE SEGMENT

The main aim of this segment is to help you to achieve objective 4 given on page xiii.

When you have completed this segment you should be able to:

- State the purpose of dry salting of fish ;
- State the effects of brine on fish ;
- Explain the importance of using the correct strengths of brine ;
- List devices commonly used to support fish products ;
- Describe the stages of a hot smoking process ;
- State what is meant by case hardening of a cold smoked fish ;
- State the importance of weight loss during smoking.

## DRY SALTING

The original purpose of the dry salting process was the production of fish flesh which was as well preserved as possible.

However, throughout the distribution chain in the UK refrigeration and even freezing facilities are usually available. They can keep fish for a sufficient length of time without the need for a well preserved product. As a result the dry salting process is not used in the processing of most smoked fish products but, when it is, its purpose is to draw water from the flesh in order to leave the flesh firm.

An example of using dry salt would be in the processing of salmon. There is often a requirement to draw a large quantity of water from the fish before the flesh is sufficiently firm to hang or to place on trays in the smoking kiln.

## BRINING

The main purpose of placing fish in a brine solution of normal strength is to allow the salt in the brine solution to enter the flesh and create a flavour.

If a strong solution is used the fish will be similar to those produced by dry salting.

Another effect of the brining process is that it improves the appearance of the product. This occurs as the brine dissolves the surface proteins in the flesh. During the smoking process this dissolved protein sets to give a glossy sheen to the product. This surface is called a **pellicle**.

Less attention is paid to producing an attractive gloss on some products in modern processes, however, because the sheen tends to be destroyed when the products are stored in refrigerated conditions. If frozen raw material is used the smoked product will not have a good sheen.

When fish are removed from a brine solution there will often be an increase in weight due to the extra water absorbed by the fish.

Finally the colour and flavour of the product can be altered by additions to the brine solution:



- Dyes can be added to deepen the colour and give a more traditional heavily smoked appearance. This is sometimes considered necessary because many modern products are only lightly smoked.
- The flavour can be refined by adding such things as spices, sugar, rum or juniper berries to the brine.

Now for two SAQs for you to attempt:

**SAQ28**

Why is dry salting seldom used with the majority of smoked fish products?

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 **SAQ33**

List 3 ways in which brining affects the fish product.

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### BRINE SOLUTION

Brine is a liquid consisting of water and pure common salt mixed together so that the salt is dissolved.



It is very important to control the strength of the brine solution carefully in order to obtain satisfactory results.

The strength of the solution is described as **degrees of saturation** e.g. 100° means one hundred degrees brine solution, 80° means 80 degrees brine etc.

100° brine solution is produced when the solution is **saturated**.

This means that no more salt can be dissolved in the solution.

The amount of salt which causes saturation to occur will depend upon the **temperature** of the solution.

It is therefore necessary to state the temperature as well as the percentage of salt required when defining a saturated (100°) solution as stated below:

A 100° brine is produced when the solution contains 26.4% of salt at 18°C.

So, a brine which contains half that percentage of salt i.e. 13.2% would be a 50° brine.

The amount of salt needed to make various strengths of brine is shown in table 4.

Brine Strengths at 18°C Salt per 10 Litres of water	
Degrees brine	Kg of salt
100°	3.594
80°	2.672
70°	2.266
60°	1.875
40°	1.188
20°	0.563

Table 4

The stronger the brine used then the shorter will be the brining time needed to achieve a given percentage of salt in the product. If brines in excess of 80° are used, however, they tend to leave a poor appearance on the final product caused by a salt powder deposit on the surface.



Between 70° and 80° are the most commonly used strengths of brine used in the making of smoked fish products.

### Measuring the Strength of the Brine

Various properties of a brine solution vary according to its' strength. Two of these are:

- Density;
- Electrical Conductivity.

Either of these can be monitored using a suitable design of **salinometer** (also known as a brinometer).

To measure the strength of the solution by its density requires a salinometer that is simply a weighted tube which floats upright in the brine. The stronger the brine the more dense will be the solution and less of the tube will be submerged. By including a graduated scale on the side of the tube the strength of the brine can be read directly at the point of the scale level with the surface of the liquid.

Fig 4 shows a salinometer of this type floating in a brine solution. It is constructed of brass or of plastic, **glass should never be used.**

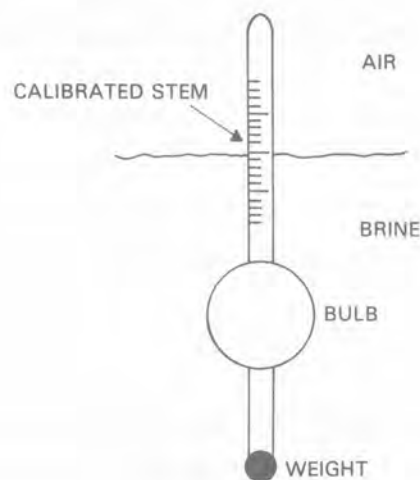


Figure 4 Brinometer

A completely different method of measurement involves a salinometer which operates on the principle of measuring the electrical conductivity between two electrodes placed in the solution. When a voltage is applied between the electrodes the current which flows via the brine will depend upon the salt content. This current is measured and registers as a brine strength on the display.

The strength of the brine will decrease with use because of the water drawn out of the fish by the action of the salt and the salt entering the flesh. Also the density will vary according to the impurities introduced by the fish. Therefore it is important to test the strength frequently and maintain a good quality solution.

**Keep the strength to between 70° and 80° by stirring in more solid salt.**





Do not try to increase the strength by adding 100° brine.

New brine should be made every day.

Scum should be removed from the surface at regular intervals.

Remember that stale fish will pollute fresh brine.

### BRINING TIME

The time a fish should spend in the brine solution will depend upon:

- The size of the fish including the thickness;
- The salt concentration required;
- The strength of the brine;
- The fat content of the fish.

For example small fillets may be sufficiently processed after a few minutes in a 75° brine. Larger fillets may require an extra 15 minutes in the same solution.



- Avoid having to give different times for the same batch.
- Do not crowd too many fish into the solution at one time.

It is important that the percentage of salt remaining after smoking should not spoil the flavour. Extra salt has very little effect on the preservation of the flesh and flavour should be the main consideration.



Brining of hot smoked products is critical on the grounds of safety. The salt concentration in the water of the finished product should be high enough to prevent the growth of any food poisoning bacteria present. A minimum concentration of 3% salt is effective for hot smoked fish.

Examples of brining strengths and times are given later in this segment when dealing with individual products.

### AUTOMATIC BRINER

The most reliable method of ensuring correct immersion times in correct strengths of brine involves the use of an automatic briner.

This piece of equipment is basically a conveyor system which transports the fish for a pre-determined period of time through a trough containing the brine solution.

The solution is continually filtered and regularly monitored for strength. When the solution changes, which happens after a period of use, it is automatically pumped through a separate channel in which the strength is corrected.

Figure 5 shows the basic principles of an automatic briner.

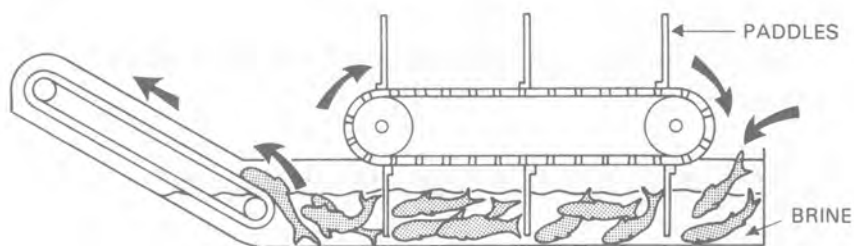


Figure 5 Automatic Briner

Now for three more SAQs to see if you have understood the brining process.

**① SAQ38**

Why is it important to check the strength of brine regularly?

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**① SAQ3**

How can you increase the strength of a brine solution which has become diluted?

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**① SAQ9**

What factors determine the percentage salt in a product during brining?

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## HANGING AND DRAINING

After the fish have been soaked in brine for the required time it is necessary to drain off the excess brine. This can be done by either hanging or placing them on sloping racks. The important points to remember are:

- The fish should be hung **immediately** after brining before the gloss begins to set. If fish are left in baskets overnight they will stick together. Vegetable oil applied to the hanging devices or racks will help to prevent the fish sticking to these devices.

- When fish fillets are laid on sloping mesh trays to drain care should be taken to ensure no parts of brine are left in the belly cavity. These would cause the flesh at these spots to be slow to dry and it would become stale.
- Draining devices should be thoroughly washed and re-oiled between batches.
- The products should be inspected during this part of the process for blemishes. Remove any which have blood marks, scales, dirt or parasitic worms.

Allow the products to drip and dry slowly for several hours. Although room temperature is satisfactory if an attractive gloss is required, it is more easily obtained by using chill rooms. Chill rooms have the additional advantage of offering more hygienic conditions. The temperature should be about 2°C.

### Hanging and Draining Devices

The most common devices used for hanging the fish are:

- **Tenter sticks.** The modern device is made of stainless steel and consists of a central stick with the tenter hooks as shown in figure 6. This device is used for opened fish which are hung from points just below the shoulder bones on either side.

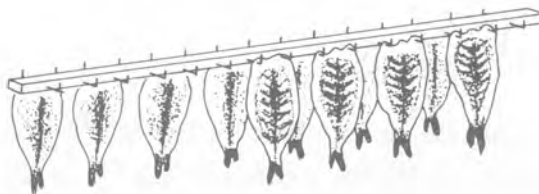


Figure 6 Tenter Stick

- **Speats.** These iron or stainless steel rods 5-6mm in diameter are used for hanging whole fish. A rod is passed through the eye sockets or the mouth and gills of the fish as shown in figure 7.

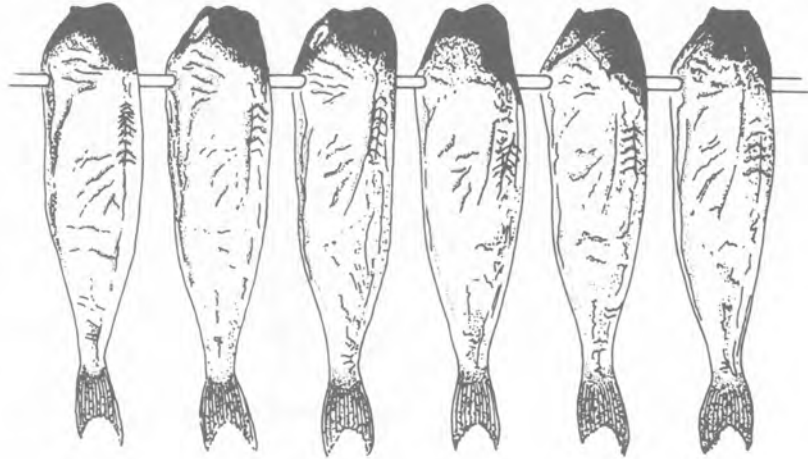


Figure 7 Speat

- **Banjo.** These are rectangular iron or stainless steel frames on which fillets can be laid skin side down. See figure 8.

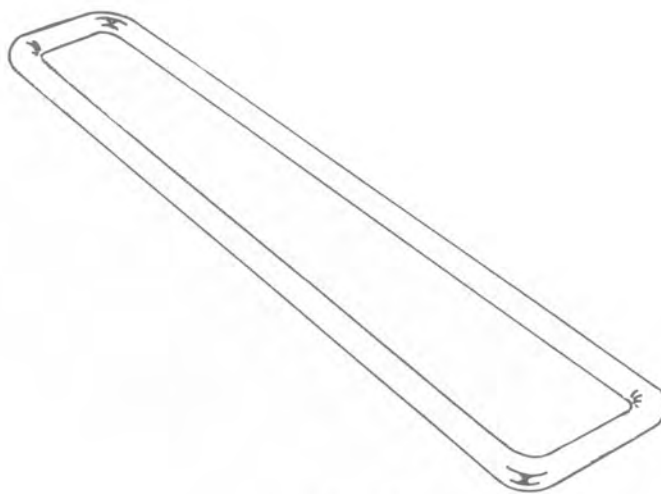


Figure 8 Banjo

- **Butchers hook.** These can be used to suspend cod roes which are hung from a mid point between the lobes. Because of its strength the hook is also used to suspend heavy products such as the sides of large fish.

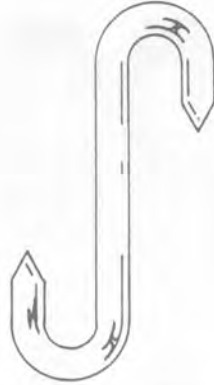


Figure 9 Butchers Hook

- **Trays.** Mesh trays are the most common form of support in Mechanical Kilns. They are used for both small fish products such as haddock, whiting or herring fillets, and for larger products such as salmon fillets. Suitable materials for the trays are stainless steel, plastic or teflon coated wire mesh.

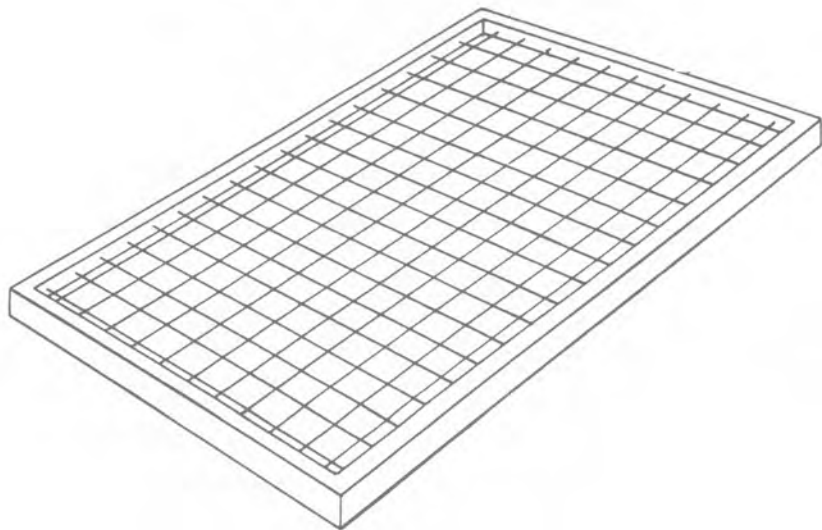


Figure 10 Mesh Tray

Now try these SAQs:

**SAQ14**  
 Why is it important to allow a product to drain after brining?

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**SAQ19**  
 State the type of device you would use to drain the following products.

1. A side of a large fish
2. Whole mackerel
3. Herring for kippering
4. Cod roes
5. Small haddock fillets

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

**HOT SMOKING**

Hot smoking involves temperatures of 70°C to 80°C at some part of the process. As a result the **flesh is cooked** and hot smoked products do not require further cooking before consumption.

The times for various parts of the process will depend upon the types of kiln used. Kilns are described in detail in Segment Five. However, for a mechanical kiln the process is usually in 3 stages:

- A preliminary drying period at about 30°C. During this time the skin is toughened to prevent breakage occurring in the remainder of the process.

- A smoking and partial cooking period at 50°C.
- A final cooking period at 80°C.

The total time could be up to 3 hours. The actual times of each stage will depend upon:

- The species;
- The size and thickness;
- The fat content of the product;
- The loading of the kiln;
- The colour and taste requirements.

Some species are dealt with in a later section of this segment.

### Cooling Period

The hot smoking process must then be followed by a cooling period. This is necessary before packing in order to avoid the product turning mouldy if packed warm.

Cooling should take place down to room temperature and then the fish should be further cooled in a chillroom.

### COLD SMOKING

In a cold smoking process the temperature does not exceed 30°C at any time. This means that the flesh is **not cooked**.



All cold smoked products (with the exception of salmon) must be cooked before consumption.

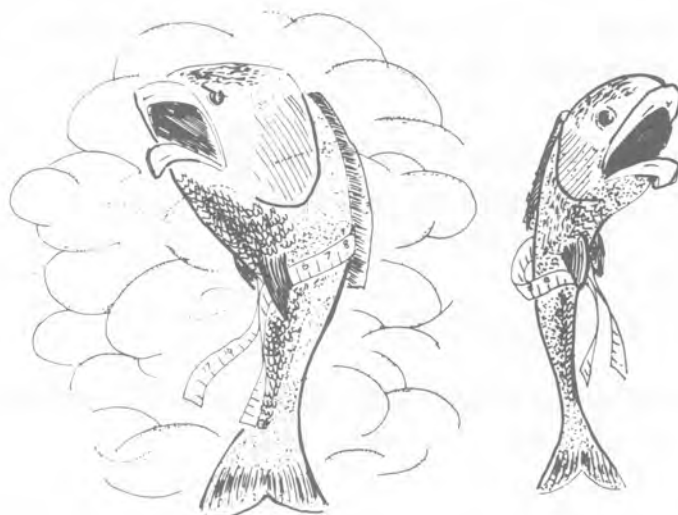
The total time for smoking is 2 – 4 hours when using a mechanical kiln. The exception is salmon which may take up to 10 hours.



### Case Hardening

If, at the early stages of the process, the temperature is too high or if drying occurs too rapidly due to say excessive movement of the warm gases then the surface of the fish may become sealed. This is called **case hardening**. Once this occurs less water can be drawn out of the fish and no further penetration of chemicals from the smoke can take place. This results in a wet layer just under the case hardened surface. This type of product will quickly spoil from the inside.

### WEIGHT LOSS



All products will lose weight during the smoking process. The loss of weight will vary according to the product and the process. Although modern practice tends to limit the weight loss occurring it may be significant and must then be considered in the economics of producing smoked products.



It must also be remembered that the percentage of salt in the product will increase after smoking due to the weight loss. It is this final percentage which determines the salty flavour!

### QUALITY CONTROL

The success of a smoking process depends, to a large extent, on personal judgement. However, it is possible to improve the success rate by keeping adequate records. This allows:

- Corrective action to be taken when necessary.
- Different people can operate the process as required.

For example the sort of control which can be arranged could be to aim to smoke the product until a given weight loss had occurred.

This involves drafting a process specification. An example of this type of simple specification is:

- A hours at X°C followed by
- B hours at Y°C and ending with
- C hours at Z°C.

to produce a weight loss of W.

The specification would vary with species, size, oil content and the finished product that is required.

In modern machine kilns this specification can be programmed into the automatic control which then allows the process to be repeated to the same standard. Of course the smoke itself must be of a consistent density and this still requires the skill of personal judgement.

More SAQs for you to attempt:

**? SAQ24**

State three stages of a hot smoking process and give typical temperatures at each stage.

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**?** SAQ29

Why is it important to allow a hot smoked product to cool before packing?

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**?** SAQ34

Why should a cold smoking process never be hurried by increasing the smoking temperature?

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**?** SAQ39

Why is the percentage salt content of a fish less before smoking than after the smoking is complete?

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### **PROCESSING OF INDIVIDUAL PRODUCTS**

The following information is intended only to illustrate typical process details for various common smoked products which are included in table 3 in Segment Three. Remember that a great deal of personal choice and judgement is used to produce a product that the manufacturer considers to be satisfactory.

### Hot smoked Whole Mackerel

- Fish with at least 10% fat content should be used
- The salt content in the water of the product should be at least 3% in order to stop the growth of any food poisoning bacteria.

To achieve this it would be necessary to leave a batch of average size mackerel for 5 hours in 80° brine. This makes it difficult to complete the gutting, brining and smoking in one day.

An alternative is to leave the fish in a weaker brine overnight.

Examples are given in the table 5.

Weight of headed, gutted fish grams.	Brine Strength	Brining Time
200	40°	17 hours
300	45°	17 hours
400	50°	17 hours

Table 5

Adequate draining can be completed in 1 – 2 hours.

There are many possible variations and the following is given as one example of smoking in a mechanical kiln.

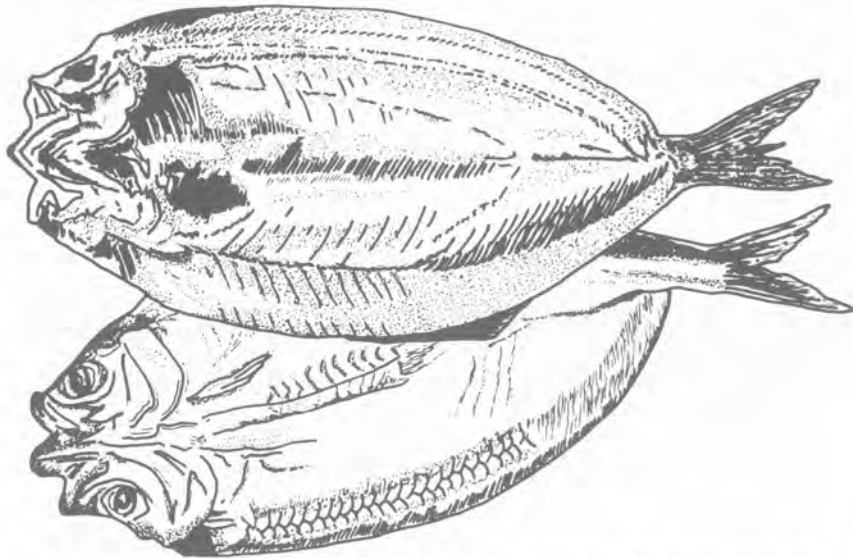
- Pre drying and smoking at 30°C for  $\frac{1}{2}$  – 1 hour.
- Firming of the flesh and initial colouring at 50°C for  $\frac{3}{4}$  hour.

- Final cooking period at 80°C lasts between 40 – 75 minutes depending on the size of the fish.

The whole process takes between 2 and 4 hours including the time taken for the kiln to reach the required temperatures.

At the end of the process the fish should be a dark golden brown colour with a dry skin and glossy sheen. The flesh should be completely cooked.

### **Kippered Mackerel and Herring**



A split mackerel of average size requires up to 7 minutes in 80° brine.

A medium sized herring requires up to 15 minutes in 80° brine.

The brine usually contains suitable dyes to give the kippers a deeper colour.

The cold smoking process takes about 4 hours in a mechanical kiln during which time the temperature of the kiln should not rise above 30°C. During the smoking process a weight loss of around 10 per cent occurs depending upon the fat content of the fish.

If a traditional chimney kiln is used the smoking time varies considerably. This is because of variations in outside weather conditions, control of the fire and the difficulty of re-arranging the tenters of hung kippers during the process. A typical range of smoking times is 6 – 12 hours.

Remember the need to cool the product before packing.

**Mackerel and Herring Fillets**

Fillets from a medium sized herring or mackerel require 3 – 4 minutes in 80° brine or up to 8 minutes for large fillets. If an automatic briner is used with a saturated brine (100°) the time is reduced to about 1½ minutes depending upon the fat content.

The fillets are then cold smoked for 2½ – 3 hours at 30°C in a mechanical kiln or up to 8 hours in a traditional kiln.

**Sprats**

These whole ungutted fish are washed and then brined for 15 minutes in 80° brine.

The smoking process is in two stages:

- A drying period of 30 minutes at 30°C.
- A cooking period of about  $\frac{3}{4}$  – 1 hour during which time the kiln temperature reaches 80°C.

The finished product should be golden brown in colour.

If the sprats are to be canned the second part of the smoking process involves using very thin smoke so that the finished product is silver grey in colour.

The fish are headed before canning.

**Finnan Haddock**

The split fish are placed for between 7 and 15 minutes in 80° brine. No dye is added to the brine. The cold smoking process lasts for 4 - 5 hours at 27°C.

The full colour develops a few hours after the fish are removed from the kiln.

**Golden Cutlets**

These are produced from a block fillet of haddock or whiting.

The brining time is about 3 minutes in 80° brine which has a small amount of dye added. They are then left to drain for about 2 hours. The cold smoking process last 2 – 2½ hours at 27°C.

### **Cod and Haddock Single Fillets**

The skin is left on the haddock fillet but not on the cod. They are placed in 80° brine for 4 – 10 minutes. A small amount of dye is added. They are drained for at least 2 hours. The cold smoking lasts for 2 – 5 hours at 27°C.

### **Arbroath Smokies**

The brining process takes 30 – 40 minutes in 80° brine. The traditional Arbroath smokie has a very dark tarry appearance produced by hot smoking in a small pit over an open fire. Smokies can be produced in mechanised kilns by a 3 stage hot smoked process:

- 2½ hours at 30°C;
- ½ hour at 50°C;
- 1 hour at 75°C.

### **Cod Roes**

Cod Roes may be either dry salted or placed in brine.

- Dry salting consists of packing roes between layers of salt in boxes up to 2 feet deep. They are left for 6 – 8 hours after which they should be repeatedly washed for about 15 minutes to remove salt which forms crystals during the smoking process.
- Brining takes about 1 hour in 70° brine.

Before draining dry salted roes are dipped in almost boiling water to restore a firm appearance. Draining lasts for about a ½ hour.

Cold smoking in a mechanised kiln last 4 – 8 hours whilst in a traditional kiln the process may take between 12 and 24 hours.

The final product is usually dark red in colour and may have lost up to 30% of its initial weight during the process.



## Salmon

### Drysalting

Before applying the salt the thickest part of the fillet is cut on the skin side two or three times. The cuts should be about 2 inches long and just penetrate the skin. This allows the salt to enter more easily. The fish is then laid skin down on a layer of fine grain salt. The exposed side is sprinkled with more salt. Additional layers of fish and salt can be built up into a stack. Weights are then placed on the stack by placing them on a piece of wood laid on the top.

The fish are left in this condition for between 16 and 40 hours depending upon the size, fat content and requirements of the finished product. After they are removed they must be washed in fresh water to remove the surface salt.

### Brining

The salmon are prepared as for drysalting and then placed in a 85° brine for anything from one to several hours depending upon size.

After removal they are left to drain preferably overnight to allow a good gloss to form.

Salmon are cold smoked but, unlike most other cold smoked products, they remain in the process for as long as 12 hours depending on size. The finished product can therefore be consumed without further cooking.

Methods of smoking will vary. Two examples are quoted below:

- Smoke temperature of 27°C until the cut surface of the fish has dried. This is then followed by an increase to 30°C for 6 – 7 hours. Finally the temperature is raised to 37°C for a brief period. This brings the oils to the surface and gives an attractive appearance.
- A more simple method involves creating a dense smoke and leaving the fish in the smoke for up to 10 hours. As with the previous method the final temperature is increased to improve the appearance of the product.

The performance of traditional kilns, which are dealt with in Segment Five, is very dependant on the weather conditions. Smoking salmon in these kilns may last for 24 – 36 hours at a smoke temperature of about 27°C but could continue for much longer.

### Trout

An important feature of the processing of hot smoked trout is the need to ensure an adequate salt concentration in the flesh. This was referred to earlier in this segment under the general section on brining.



Trout are particularly vulnerable to harbouring food poisoning bacteria if not processed and stored correctly.

They should be stored below 4°C and have a minimum salt concentration of 3% in the flesh.

Fish should be immersed in 85° brine for between 2 and 5 hours, depending upon size. The salt intake will be adequate provided that the fish to brine ratio by weight is not greater than 1:3 i.e. 1 part of fish to every 3 parts of brine.

A typical hot smoking process is as follows:

If whole fish are to be smoked they are placed in a kiln where the smoke temperature is gradually raised to 30°C. It is then held at this level for 30 minutes to allow the skin to dry and toughen. This ensures that the skin is able to support the weight of the fish during the remainder of the process.

This part of the process is unnecessary when smoking trout fillets.

The second stage is at 50°C for 30 minutes.

The final stage is 80°C for about 1 hour.

**Eels**

The lightly salted product which is acceptable in the UK is produced by immersing the eels in 80° brine for about 10 minutes only. The eels are then skewered along their length using speats. Small pieces of dowel are used to keep the belly flaps open. This ensures better smoke penetration.

A typical smoking process is as follows:

1 hour at 35°C  
followed by 30 minutes at 50°C  
and finally 1 hour at 77°C all in a thin smoke.

The eels are therefore hot smoked.

**Oysters**

The meats are placed in 50° brine for 4 – 5 minutes. They are then drained and brushed with vegetable oil. The smoking process consists of placing them in dense smoke at 80°C for 30 – 45 minutes. The meats should be turned over after the first 15 minutes of smoking.

The basic process is suitable for the smoking of some other molluscs such as mussels.

## SUMMARY

This segment has dealt with the following topics.

- The dry salting process for both light and heavy cured products.
- Brining including the strength of brine and how it is measured.
- The importance of hanging and draining the fish products.
- The hot and cold smoking processes and the advantages of quality control.

Finally the segment gives a guide to the methods of brining and smoking various popular smoked products.

This completes the segment and you have achieved objective 4 given on page xiii.

This has been a long segment and you may now wish to take a well earned break before looking in some detail at the kilns and smoke production in Segment Five.