9

Malting

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9.1 Introduction

This chapter covers the processing of barley to produce malt for, principally, the brewing and distilling industries. Initially, the 'on site' intake and storage of green barley are discussed, followed by information on barley drying and dried barley storage. Each production stage of the malting process is then described, with a general description of the structures, plant and equipment currently favoured. Finally, storage and dispatch of the finished product are outlined.

9.2 The UK malting industry

In the United Kingdom, there are three major producers of malted barley for brewing and distilling; the Brewer Maltster, the Distiller Maltster and the Sales Maltster. The Brewer and Distiller Maltsters have traditionally produced malt in quantities substantially below their own requirements, relying on Sales Maltsters to top-up any shortfall. If, for example, there is a fall in the overall production of beer and whisky, the Brewer and Distiller Maltsters can normally continue to operate their own maltings at full production, their lower overall requirement resulting in a reduced demand from the Sales Maltster. Some Sales Maltsters produce malt on contract for Brewers and/or Distillers. The arrangement in the UK whereby Sales Maltsters make up the deficit for the end user who produces only a proportion of his own malt requirement is also found in many other parts of the world.

Over the last 25 years or so, the demand for malted barley in the United Kingdom has fluctuated greatly, and this has made life difficult for the Sales Maltster, who is particularly vulnerable to reduced demand, for whatever reason, both at home and abroad.

The UK malting industry recorded steady growth in the years leading up to 1974, when the distillery market peaked; external factors, such as the oil crisis and contraction of world markets, resulted in an overall drop in production for some years thereafter. In that year, the demand for brewing and distilling malt in the UK reached a high point at about 1 370 000 t, with approximately 680 000 t processed by brewers and 690 000 t by distillers. The demand for brewing malt continued to increase until about 1979, when approximately 735 000 t of malted barley was processed.[1]

A downward trend in overall UK malt requirement followed for some years, although some improvement occurred before 1990, when the total figure was approximately 1 270 000 t, with the brewers showing a slight increase in the 1974 figures, up to 700 000 t; distilling malt had dropped substantially to around 570 000 t. Since 1990 there has again been a general downward trend, although fluctuations have occurred from year to year. The 1998 figures show a small decrease in total production compared with the previous year, with exports rising marginally, and home requirements falling slightly.

The position after 1974 was exacerbated by a large increase in capacity from new plant, constructed by Brewers, Distillers and Sales Maltsters, following a perceived increase in demand which, however, was short lived; in particular, the requirement for distilling malt dipped sharply in the early 1980s. As a result of the increased capacity, the situation arose where excess malt produced by Distiller Maltsters was sold on the open market, making life even more difficult for the traditional Sales Maltsters. This continuing uncertainty, both at home and worldwide, has led inevitably to the consolidation of sales malting companies in the UK, in an effort to maintain a trading profit in these difficult times. This overall pattern of mergers and acquisitions, and the need to produce malt to a multitude of specifications, has led to the demise or takeover of many smaller Maltsters, and the closure of uneconomic units.

Not long after the Second World War, there were perhaps 70 or 80 malting companies, decreasing to about one quarter of this figure in the early 1970s.[2] At the present time, there are only five major malting groups in the UK, with a small number of Brewer Maltsters and Distiller Maltsters still producing a substantial quantity for their own requirements. A handful of small specialist Maltsters also continues to trade; a few traditional floor maltings are still in use. The current major Sales Maltsters are:

1. *Bairds Malt*
   This company was formed in 1998 as a result of a joint venture between Hugh Baird & Sons Ltd, and Moray Firth Maltings plc. This group has seven active maltings, from Essex to Inverness, but the recent merger may result in rationalisation of production.

2. *Crisp Malting Group*
   This group has four major maltings, and has remained relatively unaffected by merger or acquisition for a number of years. Malting capacity is currently concentrated in Norfolk, but a plant to serve the need for distilling malt was constructed in North East Scotland, early in the 1980s.

3. *Muntons Malt*
   This company operates three maltings in Norfolk, Yorkshire and Fife, the latter principally devoted to distilling malt.

4. *Pauls Malt Ltd*
   This group is by far the largest Sales Maltster in the UK, and was recently acquired by Greencore, an Irish conglomerate, from the parent company Elementis (formerly Harrison & Crosfield). The combined malting capacity of the Greencore Group, which also has plants in Belgium and Ireland, makes them fourth largest in the world at present. Pauls currently operate seven maltings, stretching from Oxfordshire to Moray. Their plant at Bury St Edmunds is the largest maltings site in the UK, capable of producing over 150 000 t of malt per annum.

5. *J. P. Simpson & Co.*
   This Maltster operates two major units, in Berwick and Norfolk.

The largest Brewer Maltster is Bass, with the main concentration of production in Burton-on-Trent, including the recently acquired Allied Malting Tower. Carlsberg Tetley also produce a limited amount of malt.

The largest Distiller Maltster is United Distillers, operating four plants in Scotland. A number of other distillers produce malt, but are not self sufficient. To illustrate the development of the largest UK Maltster, Pauls Malt, Fig. 9.1 shows the extent of acquisitions and mergers since the early 1960s, and also indicates their current position within the Greencore Group.

The present situation in the UK is one of relatively steady production by Brewers and Distillers, with Sales Maltsters having to concentrate on overseas selling into a market suffering recent downturn, due to the financial situation in the Far East, South and Central America. Over the past few years this has resulted in depressed trading for these companies, some of which sell more than 50 per cent of their production overseas.

9.3 Basic malting process

In the United Kingdom, malt for brewers and distillers is normally produced by the germination of selected dried barley under controlled conditions of moisture and temperature, until the requisite degree of growth has taken place in the grain, after which the germinated barley is dried by gentle heating to produce ‘malt-in-culm’ (i.e. malt with the rootlets formed during germination still attached). The malt-in-culm is then ‘dressed’ mechanically to remove the rootlets, leaving a friable granular product, malt. This is normally stored for some weeks, before dispatch to the end user.

To the untrained eye, malt appears to be generally similar in appearance to the original barley, but the malt corn, with a lower moisture content, is more brittle, and has a malty taste when bitten. This compares with the tasteless nature

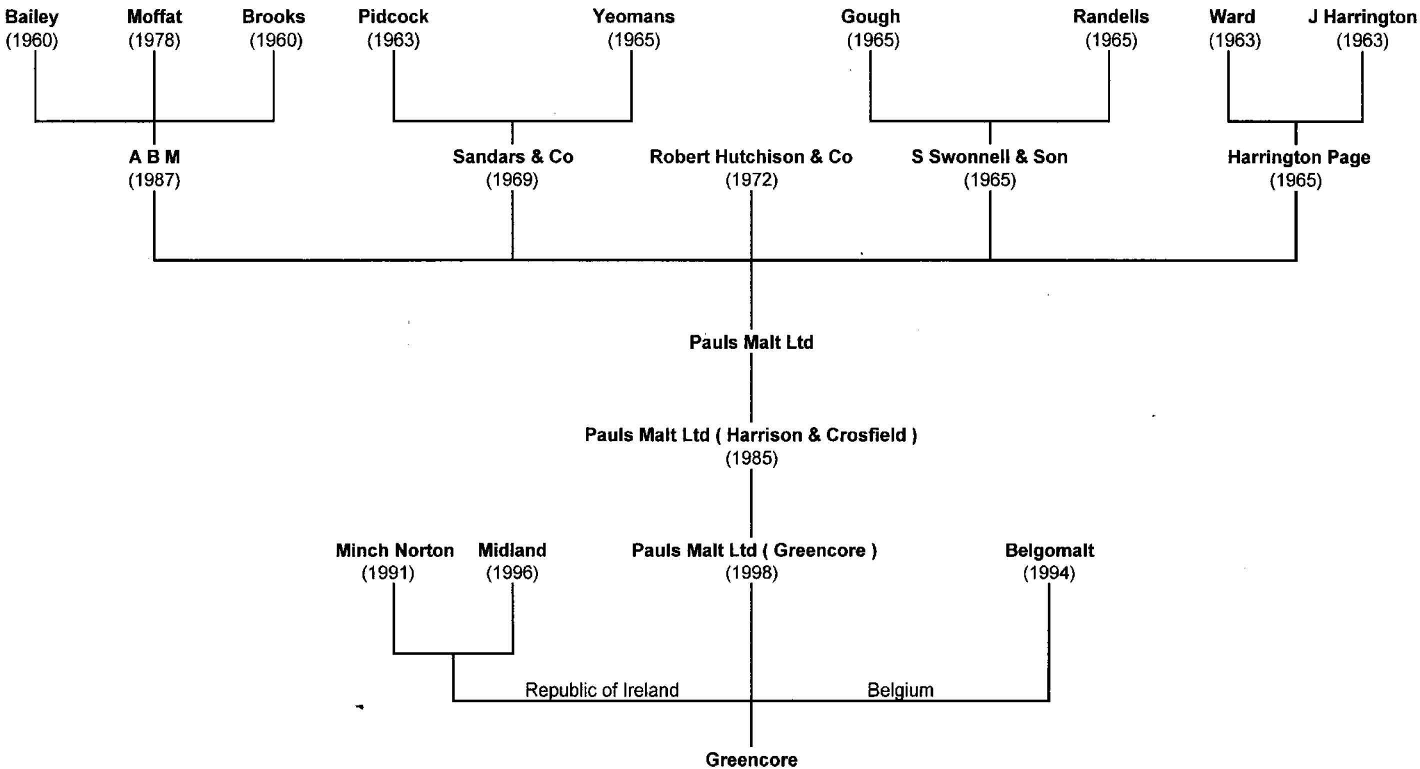

Fig. 9.1 Pauls Malt Ltd structure.

of a barley corn. Significant biochemical changes have taken place in the process. The barley used for malting will have been harvested some time previously, dried, cleaned, probably graded, and will have been stored in large bulk storage units, either sheds or bins, for sufficient time to allow the natural dormancy of the grain to cease. It is essential that the raw material has been expertly selected and carefully husbanded until ready for malting, so that it is capable of up to 100 per cent germination. A diagrammatic layout of the basic malting process is shown in Fig. 9.2.

The first stage in the process is steeping, where a weighed batch of dried barley is divided equally into a number of steeps, normally circular stainless steel vessels. After the steeps are filled, clean water is introduced to promote absorption into the grain, thus raising the moisture content. The grain swells, and this initial wetting starts growth in the barley. Steeping typically continues for two days, and during this cycle the grain is subjected alternately to wetting and drying, with concomitant aeration of the barley during wetting, and extraction of carbon dioxide during the dry periods.

When the moisture content of the grain has reached, typically, 43% to 46%, and initial sprouting of the corn has occurred ('chitting'), the moist grain is transferred onto the perforated floor of a germination unit. Here, under controlled conditions of humidity and temperature, growth of the barley is encouraged, and rootlets gradually develop. The relative humidity of the air passed through the bed of grain is maintained as near 100 per cent as possible, within a temperature range of approximately 12ºC to 19ºC, depending on barley variety and malt specification. Under conditions of high ambient temperature, refrigeration may be necessary to prevent overheating of the grain. A typical germinating vessel is shown in Fig. 9.3. During germination, which might typically take four to five days, enzymes within the grain are released, these converting the insoluble starch cells in the barley into sugars and more soluble starches, dextrins. When this process of 'modification' has reached the appropriate stage, the batch of 'greenmalt', as the material is now known, is transferred to the kiln, for the third and final stage of processing.

In the kiln, the grain is spread on a perforated floor, and warm air passes through the bed under fan pressure. Gentle heat is applied, causing withering and initial drying, arresting the germination process, and stabilising the structure of the grain. Kilning continues for some time under relatively constant temperature, until the moisture content is significantly lowered, after which the air flow is steadily decreased, and temperature increased, to achieve the desired curing and final moisture content of the malt. Malt of differing characteristics, including colour and flavour, can be produced by varying the curing regime of air flow and temperature, to meet the particular specifications which might be required by the Brewer or Distiller. Most kilning cycles in modern kilns take approximately 24 to 30 hours. A typical kiln is shown in Fig. 9.4.

After kilning, ambient air is passed through the grain bed, and the cooled grain, with the rootlets still attached, is transferred to a holding bin before dressing and storage for subsequent blending and dispatch. Ideally, malt is

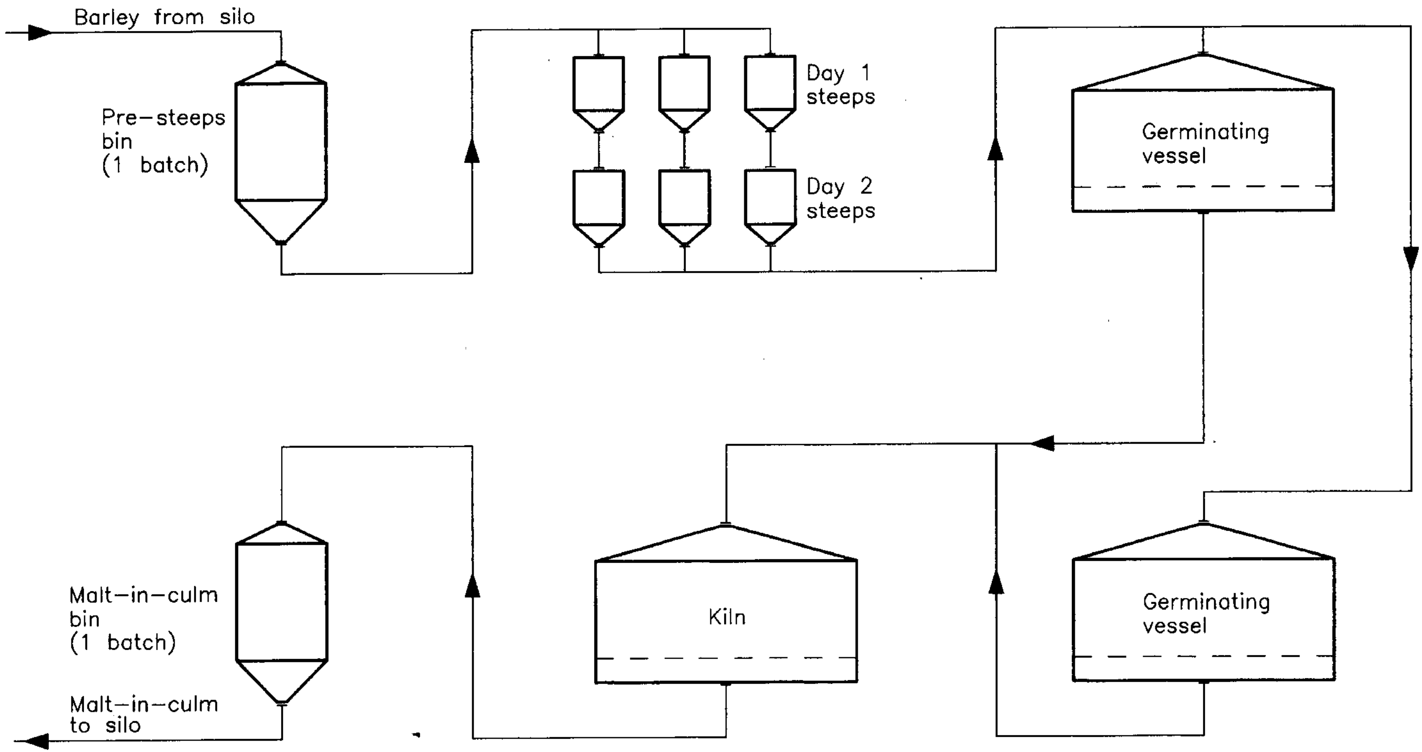

Fig. 9.2 Flow diagram of typical malting process.

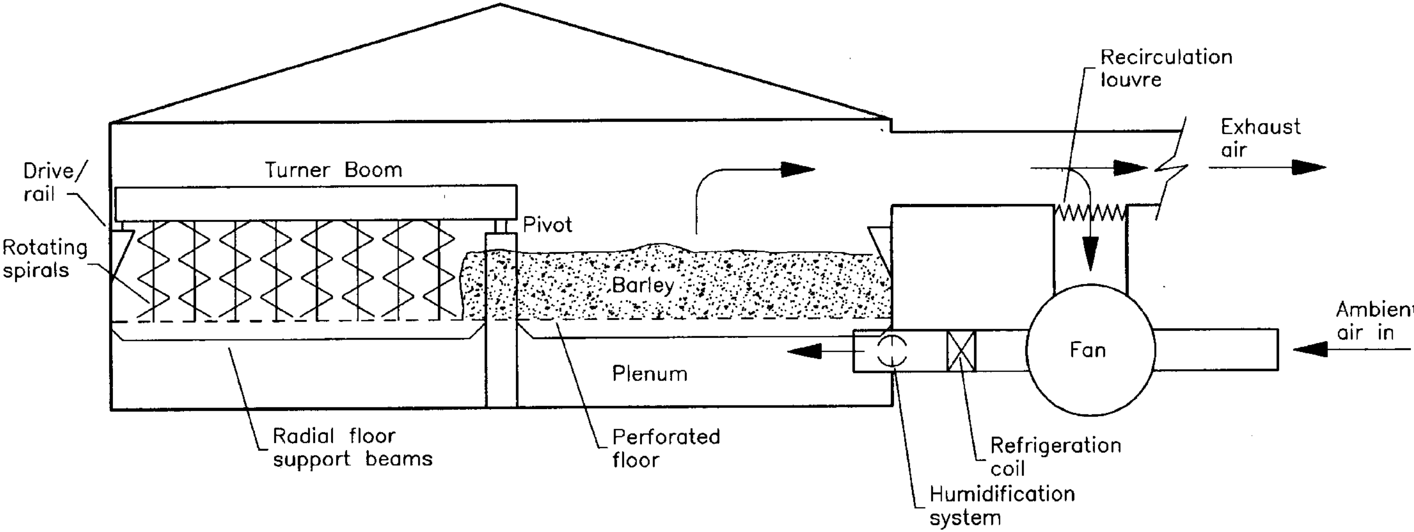

Fig. 9.3 Diagrammatic layout of circular germinating vessel.

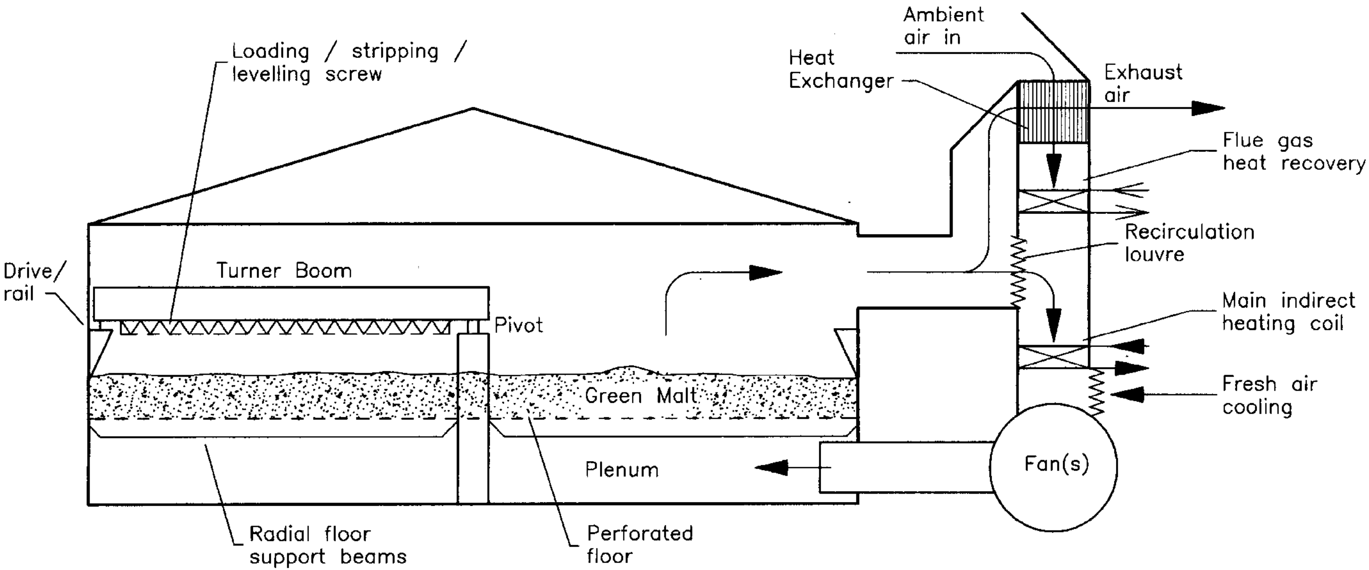

Fig. 9.4 Diagrammatic layout of circular kiln.

stored in relatively small hoppered silos, up to a few hundred tonnes capacity, to allow separation of batches produced to different specifications, and to minimise possible damage to the friable malt through over-handling. Before dispatch, the malt is finally dressed and cleaned to ensure the highest possible product quality.

In the brief description above, it has been assumed that steeping, germination and kilning occur in discrete sets of vessels. There are instances, however, where two or more elements of the process have been combined in one vessel; steeping and pre-germination may be carried out together, germination and kilning may be carried out in suitable units without requiring the movement of grain, and in a few instances steeping, germination and kilning are carried out in single vessels. These options will be described in more detail later in the chapter.

9.4 Barley intake, wet bin storage, and drying

After harvesting, barley must be prepared for storage during its period of dormancy before conversion to malt, under conditions minimising the risk of infestation from insects, fungal attack, etc., which can lead to spontaneous heating. To achieve this, it is necessary to dry the ‘wet’ or ‘green’ grain from the fields for long-term storage, down to a moisture content of 12 per cent, although initial drying down to 15 per cent could be acceptable, providing that further drying is carried out later in the season. To allow the drying of the large quantities of grain which are harvested within a short time, large drying complexes have been set up, both by Merchants and Maltsters.

9.4.1 Barley intake and wet bin storage

In any maltings or grain drying complex, due consideration must be given to the design of deliveries to site, the raw material intake and the planned drying regime. The first essentials are to determine the maximum weekly throughput of the drying plant, and the programme for green barley deliveries, to ensure the availability of the raw material as required. Thereafter, the barley intake rate, wet bin storage capacity, drying capacity, and handling rate can be calculated. For example, if intake takes place over five days per week only, averaging ten hours per day, and, say, 5000 t is the required dryer input per week, then barley must be taken in at an average of 100 t per hour. As there is always time lost at the intake, it would be wise in this case to install a minimum intake conveying system of 150 t per hour. This would allow a 25 t capacity lorry to discharge in ten minutes.

The minimum plant incorporated in the intake system should be effective magnets and a pre-cleaner with dust extraction, these to match the intake capacity.

If drying is likely to take place seven days a week, 24 hours a day, then it should be assumed that operations might be limited to, say, 160 hours per week allowing downtime for cleaning, delays, etc. The average input to the dryer,

therefore, would need to be in excess of 30 t per hour. The actual throughput will vary, depending on various factors discussed elsewhere, but the dryer should be sized on the basis of a reasonable initial moisture content for the geographical location of the plant. This may vary from perhaps 16 per cent up to 20 per cent or higher as the site progresses northwards.

If there is no barley intake from, say, Friday afternoon until Monday morning, then there must be a minimum of at least 60 hours storage of wet barley adjacent to the dryer, to maintain uninterrupted drying operations, and the wet bin capacity should therefore be not less than 2000 t. Although the intake capacity to the wet bins would be adequate at 150 t per hour, the conveying and elevating equipment to the dryer, and from the dryer to storage would be lower, but should be rated well in excess of the nominal capacity of the dryer, to take account of periods when the field moisture content of the barley is significantly lower, allowing a throughput above nominal dryer capacity.

During conditions of lower moisture content in the barley, and on the assumption that the weekly throughput of the dryer would be increased because of this, the intake time would need to be extended beyond the average ten-hour day, five days a week, to ensure that the available wet bin storage is adequate for any period when there is no intake operating.

If 2000 t of storage of wet barley were to be provided, then this should be divided into smaller units of, say, 500 to 700 t each, to allow cyclical emptying of the bins, ensuring that no wet grain remains in any bin for an excessive length of time, and to permit basic separation of barleys if required, for example, into different varieties, nitrogen values, moisture contents, etc. The bins should be hopper bottomed, self emptying, with sufficiently large outlets to minimise blockage from straws and other impurities which may have passed the pre-cleaner.

9.4.2 Barley drying

Normally, dryers can be classified as either continuous or batch.

Continuous dryers may be of a vertical or horizontal format, although the former is very much in the majority. In these, grain is in continuous vertical movement, being fed in at the top level, and allowed to gravitate through the drying column, the rate being controlled at the point of discharge, to achieve the required moisture content. In horizontal dryers, a layer of grain is transported on a horizontal moving perforated floor, with warm air passing vertically through the bed.

The essentials of good drying are:

1. Sufficient clean ambient air.
2. A heat source of adequate capacity to raise the incoming air from ambient to the required air-on temperature.
3. A method of ensuring that the grain has maximum contact with the heated air at low relative humidity, to evaporate moisture. It is necessary to ensure that the grain has sufficient time within the drying sections of the unit to

allow gentle drying without subjecting the corns to excessive heat, affecting its viability as malting barley.

4. Final cooling of the grain in the lower part of the drying column, to ensure a safe air-off temperature for storage. If adequate cooling of the grain is not achieved, there are potential risks of moisture migration during further cooling, insect infestation or fungal growth.

The air is normally heated by oil- or gas-fired burners, and the products of combustion can either be passed directly through the grain (direct firing) or through a suitable heat exchanger, so that the air which passes through the grain mass does not contain any of the products of combustion (indirect firing). Indirect fired units are likely to incorporate air-to-air heat exchangers, or hot water radiators.

Direct firing offers a cheaper installation, with minimum heat loss, and is generally of simpler construction, but grain in the dryer can be contaminated by the products of combustion, and there is a risk of fire in the grain from the ignition of debris passing across the burners. Indirect dryers are more expensive, and less economical, but have the advantage of minimising contamination and the risk of fire.

Various factors affect the capacity of any grain dryer, including the initial moisture content of the green barley, ambient conditions of temperature and relative humidity, the temperature of the air applied to the grain, and the final discharge temperature. All of these factors must be defined when new drying plant is being specified.

Batch drying is principally carried out in maltings where kilns can be made available for drying during the harvest period. It is likely that the drying time will be in the order of 12 to 14 hours; the capacity of the kiln for drying will be approximately 50 per cent more than the tonnage of original barley for which the kiln had been designed as a malting unit. For example, a kiln designed to handle greenmalt from an original barley batch of 200 t, drying on a 24-hour cycle, is likely to be able to handle batches of approximately 300 t of field barley.

9.4.3 Current trends

In the past ten to twenty years, there has been little in the way of development of intake systems, wet bin storage or dryers in the UK. Relatively little demand for additional process capacity has resulted in minimal investment in new drying plants; most of these which were installed during the 1970s and 1980s are still proving to be satisfactory. It is unlikely that any major changes will take place in drying procedures in the foreseeable future.

9.5 Dry barley storage

After drying, malting barley is maintained in long-term storage at a moisture content of around 12 per cent, and, if kept at normal ambient temperatures,

preferably not exceeding 15ºC, the grain should be safe from infestation, spontaneous heating, and subsequent loss of germination. The majority of long-term barley storage units are aerated, using ambient air; this provides the means of counteracting any rise in temperature, if pockets of grain show signs of overheating. Temperature monitoring should be installed, with automatic sensing, to locate and identify significant rises in temperature.

Each Maltster has his own regime as to the amount of barley purchased at harvest, in relation to his foreseen annual demand. This barley would normally be dried and stored under his direct control on site, or at Merchants' premises. Some Maltsters tend to hold little barley at the maltings; a few have the facility to dry and store upwards of 90 per cent of their anticipated annual requirements.

Currently, by far the greatest proportion of barley is stored in one of four forms:

1. Large sheds ('flat stores') of up to about 30 000 t.
2. Large circular steel bins, with flat concrete slab bases, of up to about 4000 or 5000 t.
3. Round hopper-bottomed steel bins, of limited capacity, around 750 to 1000 t.
4. Reinforced concrete silos of varying capacity; few, if any, concrete silos have been built for the malting industry in the past thirty years, due to the high cost of construction.

Brief details of each type are given below.

9.5.1 Flat stores

Many flat stores have been constructed, principally up to the mid 1980s, with capacities up to around 30 000 t. These are the cheapest way to store large quantities of single-grade barley, although some sub-division can be achieved with either permanent or movable internal partitions. This sub-division, however, greatly decreases the potential storage capacity, due to the limitation on height of internal walls. Where greater separation of varieties is required, circular bins are normally used, but with a significant cost penalty.

Most flat stores consist of structural steel frames with steel or concrete grain retaining panels around the perimeter. The floor is normally of reinforced concrete. The roof sheeting can either be of fibre cement, which absorbs a certain amount of moisture, or of steel decking which, however, can lead to problems of condensation, unless insulation is incorporated; this significantly increases the cost of the roofing.

In some instances, concrete aeration ducts are formed in the sub-floor, with perforated steel cover plates at floor level. These are not common, and a much cheaper expedient is to install on-floor perforated steel ducts of large diameter; these are, however, inconvenient to use and prone to damage while the sheds are being emptied. Aeration fans supplying ambient air to the ducting are normally

situated externally, on the perimeter of the shed, and may be portable, one fan serving several aeration duct laterals.

If the roof is steeply pitched, beyond the normal roof slope, a filling conveyor can be located on a walkway immediately under the ridge, clear of the grain. Typically, if a shed is 30 m to 40 m wide, a roof slope of about 30° will allow this arrangement, assuming a natural angle of repose of the dry grain of about 23°.

The normal method of filling is by overhead conveyor, with multiple outlets allowing maximum filling capability. To ensure complete filling of the corners, up to the height of the retaining panels, additional grain throwing or mobile conveying equipment is required. Normally, emptying is by tractor fitted with a large bucket, but this is labour intensive and relatively slow. A few sheds have been constructed with under-floor conveying, or other automatic unloading system, and although this clears a high proportion of the barley from the shed without the need for labour, a tractor with blade or bucket is still required to recover the remaining grain.

Based on a retained height of 6 m around the perimeter, and assuming the corners are filled, the approximate capacities of single compartment sheds of varying widths and heights is shown in Fig. 9.5.[3] The grain is assumed to be dry barley, with a density of 705 kg/m^3, and a natural angle of repose of 23°.

9.5.2 Flat bottomed circular steel storage bins

A very significant proportion of dry barley stored before malting is held in large capacity circular galvanised steel bins, holding from about 1000 to 5000 t per bin. Bins of larger capacity are available, but have not found favour with UK Maltsters, who would be more inclined to use flat stores, or a series of smaller bins for such large quantities of single-quality barley.

Flat bottomed steel storage bins are normally erected from thin, curved circumferential corrugated sheets, reinforced with vertical steel posts, preferably external to minimise grain 'hang-up' and infestation problems. The roof is normally conical, constructed from bolted steel segments. Flat bottomed bins are available in a large range of diameters and heights, from about 8 to 20 m diameter, and to heights in excess of 20 m. Figure 9.6[3] shows the potential barley capacity for bins of varying diameter and height, again based on the standard figures of 705 kg/m^3, and an angle of repose of 23°.

The bin bases are normally constructed with a circumferential reinforced concrete beam, infilled with hardcore, and topped with a reinforced concrete floor slab. When aeration is incorporated, it is normal to construct ducts as part of the floor slab, with perforated steel covers, fitted flush with the concrete slab. An external fan is used to provide ambient air. This duct configuration is essential to allow rotation of the sweep auger, which is pivoted at the centre of the bin; this device clears the last of the grain from the bin to the central hopper after perhaps 90 per cent of the contents have been discharged by gravity through the central hopper, into the conveying system.

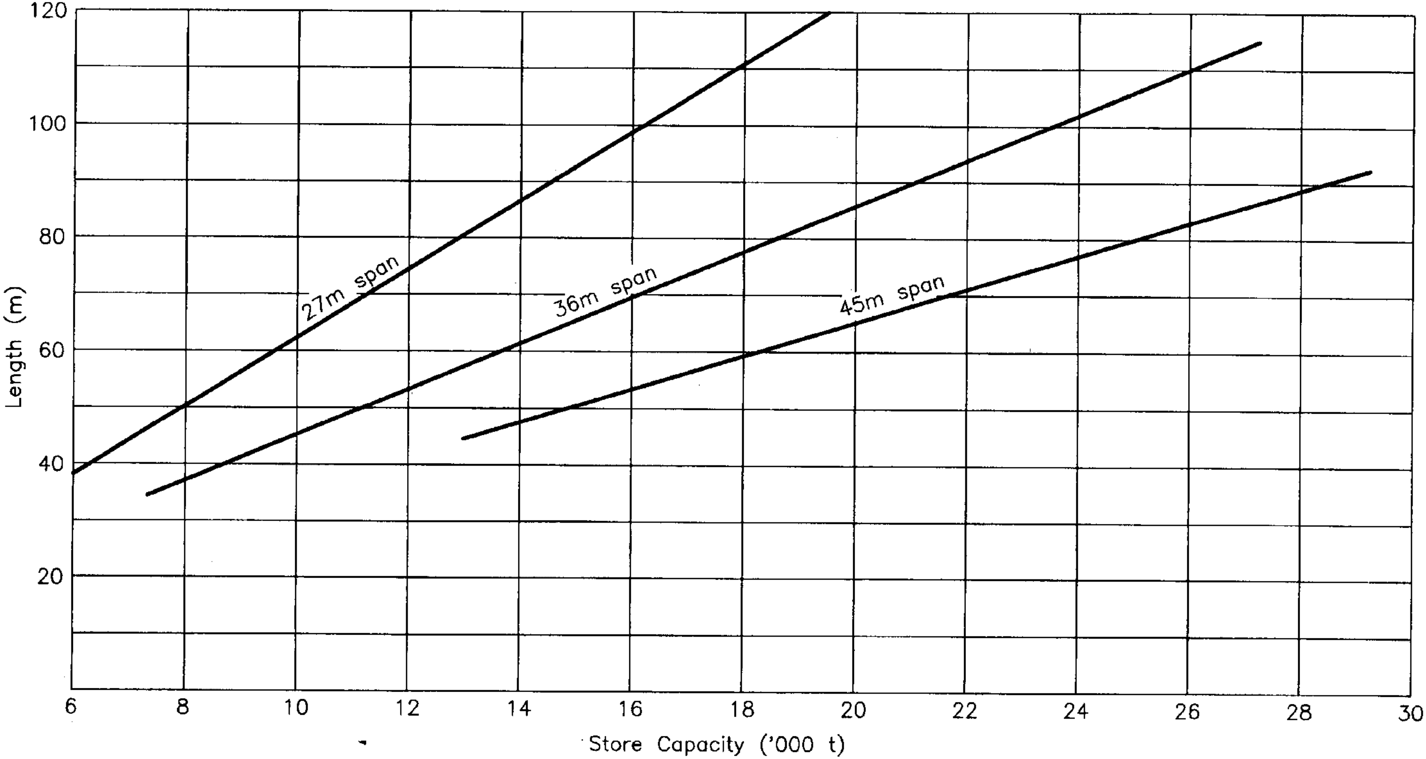

Fig. 9.5 Capacity of single compartment barley stores.

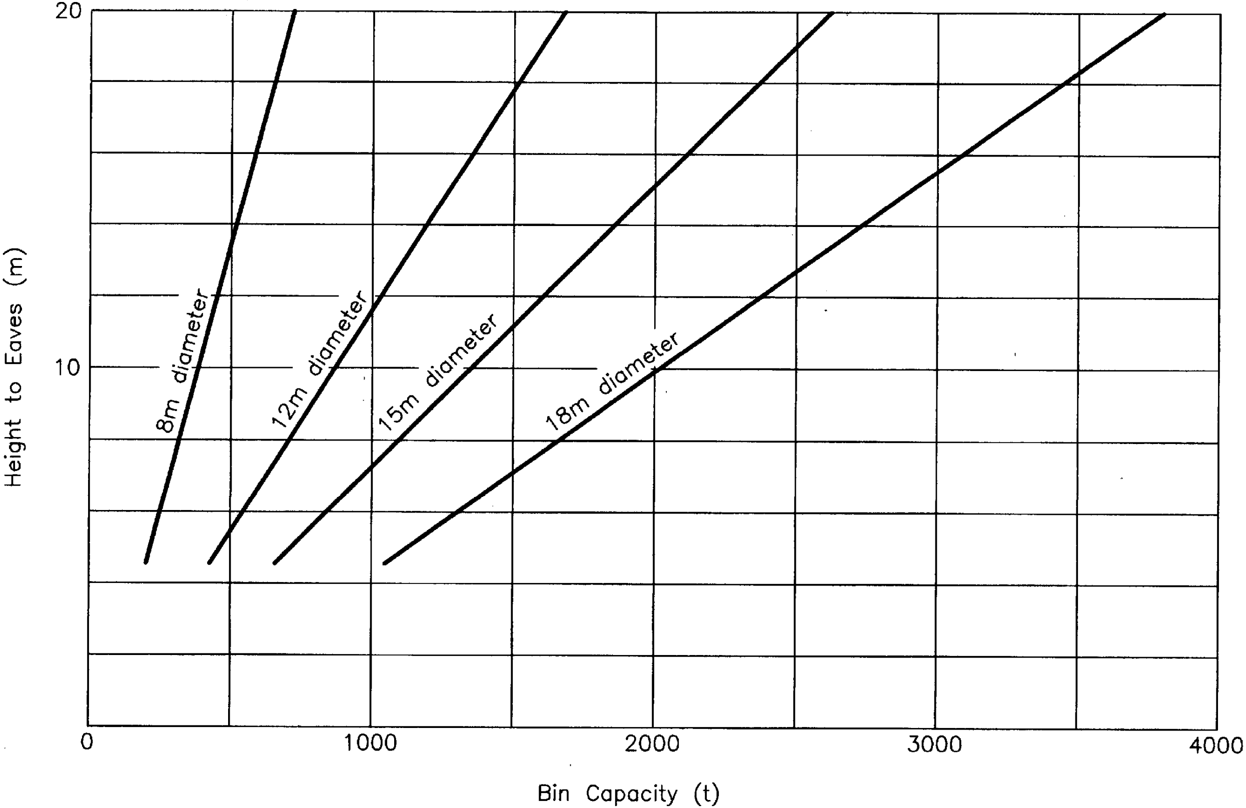

Fig. 9.6 Capacity of circular flat bottomed bins.

The machine carrying barley from the central hopper under the slab is normally a circular tube auger, discharging to the main conveying system located outside the bins. Filling is achieved by an over-bin conveying system or spouting, situated on gantries normally bolted to the bins at eaves level.

The construction of circular corrugated steel bins is relatively flimsy, and they can readily distort if asymmetrical loading is applied to the walls, for example if eccentric spouts are used for filling or emptying the bins. It has been known for bins to collapse where the design requirement of central filling and emptying has been ignored.

9.5.3 Square and round hopper-bottomed bins

It is frequently of advantage to the Maltster to store small quantities of barley for specific purposes, such as batches about to be processed, which require to be transferred rapidly to the steeps, and by-products, such as screenings, pellets, dust, etc. This type of bin is relatively expensive, with the cost per tonne rising steeply when the capacity exceeds around 500 t.

With the current trend of processing large batches of barley, it is essential to have the requisite weight readily available for high speed transfer from a pre-steep bin to the steeps themselves. With this set-up, the barley required for steeping can be cleaned and weighed at low capacity, the pre-steep bin being used to hold the measured quantity. This bin would normally be located as close as possible to the steeps, to minimise the use of high capacity transfer equipment.

Circular hoppered bins are available with corrugated or flat sides; most square or rectangular bins are constructed of corrugated side panels, but bins with flat panels, externally stiffened, are also available, these providing a nominally smooth internal wall, which minimises the accumulation of dust.

As the cost of hoppered bins is considerably greater than for larger flat bottomed bins or grain sheds, described above, the use of these hoppered bins for barley is restricted to requirements for low capacity storage.

9.5.4 Concrete silos

Reinforced concrete silos make good use of restricted ground area, as they tend to be ‘high density’ storage, the height of the concrete silo being normally much greater than the alternative storage methods already described. This type of silo is normally divided into hoppered cells, either circular, hexagonal, or square, which can be used flexibly for relatively small parcels of different types of barley (or malt).

In the 1950s and 1960s, most major Maltsters constructed reinforced concrete silos, but since then, with the increase in size of batches, Maltsters have found it necessary to store barley in quantities larger than can be accommodated in the average cell in a reinforced concrete silo. This has led to the development of the larger types of bins described above, although many Maltsters have found it

convenient to convert their reinforced concrete barley bins into storage for malt, which is normally stored in smaller quantities, to allow blending to meet customers' specifications.

In the UK, the cost of large cell concrete silos is prohibitive for Maltsters, and this type of storage is no longer an economic consideration for malting barley.

9.5.5 Current trends in dry barley storage

The current inclination of Maltsters is to adopt large capacity circular steel bins for longer-term barley storage, this giving maximum versatility in the separation of varieties, good control over the condition of the barley, and the ability to fill and empty storage units without the use of labour, apart from nominal cleaning.

Barley storage sheds, previously constructed in considerable numbers, and relatively cheap to construct, can be expensive to operate. The storage of different varieties of barley is uneconomic, and the cost of labour and machinery for filling and emptying has become significant. The use of the circular flat bottomed steel bin is therefore likely to continue as the favoured method of storage in the foreseeable future.

9.6 Malting plant

The past thirty or forty years has seen a considerable polarisation of the type of equipment used for malting barley. In the first stage of the process, cylindro-conical steeps (i.e. circular steeps with a vertical walled portion, and conical hopper below), were used almost exclusively in the 1960s and 1970s. The development of the flat bottomed steep followed, this being essentially a large circular open-topped tank, with a perforated floor onto which the grain was loaded. A shallow plenum below the perforated floor ensured good distribution of air while the barley was being aerated. Automatic loading provided a uniform depth of barley and the whole area of the steep was subjected to consistent conditions during processing.

Major disadvantages were the amount of water required to fill the plenum prior to submerging the grain, and the difficulties in cleaning below the perforated floor. Consequently, with increased demands on hygiene, there has been a tendency to revert to cylindro-conical steeps, of stainless steel construction, with automatic aeration and carbon dioxide extraction facilities.

During the development of maltings in the late 1950s and 1960s, Maltsters used various types of germinating units, all incorporating similar features. Apart from the continued use of floor maltings, although in ever-decreasing numbers, Maltsters tended to favour the rectangular Saladin or Wanderhaufen Boxes; the adoption of drums by some Maltsters followed in the late 1960s and 1970s. The capacity of rectangular boxes increased from perhaps 30 t to around 150 t or more, whereas the majority of drums were restricted to about 30 t capacity. Over the last twenty years or so, there has been an almost universal movement in the

UK towards the introduction of much larger circular stainless steel vessels for germination. These are essentially large enclosed tanks, with the grain loaded onto an intermediate perforated floor. The plenum below the floor provides the means of uniformly distributing the humidified air to the barley during germination.

Rectangular kilns of brick and/or concrete which were common in the 1960s and 1970s have, like germination units, gradually given way to circular vessels with perforated floors; the principle is essentially the same as in germination, with warm air from the heat source being passed into the plenum below the perforated floor, and upwards under pressure through the bed of germinated barley. Various features such as recirculation, cooling and heat recovery are normally incorporated. The construction of the vessel shell is again predominantly of stainless steel, this providing the best means of achieving the required standards of hygiene. Loading and stripping (unloading) are automatic.

In the 1950s and early 1960s, it was normal to process a barley batch of around 30 to 50 t, this figure increasing with the availability of larger Saladin or Wanderhaufen boxes, up to around 150 to 200 t. Circular vessels have given the Maltster the facility to process much larger batches efficiently. The largest in the United Kingdom at present have a batch size of over 500 t of barley, although this would not be universally acceptable; this plant was designed to produce large quantities of single-quality malt for distilling.

Recent plants have batch sizes ranging from 200 to over 300 t. The size of batch is governed by the annual capacity required from the plant. The normal procedure for maximum efficiency is to kiln one batch each day, regardless of the combination of steeping/germinating/kilning vessels. For example, a batch of 200 t of original barley, based on kilning one batch per day, over 350 days per year, would give an output of approximately 60 000 t of malt per annum, which is perhaps currently about the lowest capacity economically viable for a completely new malting plant. The recently constructed plant at Bury St Edmunds has a batch size of 340 t, and is therefore capable of producing in excess of 100 000 t of malt per annum.

The main features which are likely to be incorporated into the design of a modern malting plant are detailed below.

9.6.1 Steeping vessels

In the majority of recently constructed maltings, cylindro-conical steeps have been installed. These are essentially elevated circular tanks, with steeply sloping conical lower sections. These incorporate, as necessary, valves or connections for grain discharge, water filling and draining, pressure aeration, and carbon dioxide extraction. Stainless steel is now used extensively for steep construction, together with the associated pipework, ducting, etc. This allows the highest possible standards of hygiene, and minimises future maintenance costs.

The steeps are normally open-topped, but may have covers where dry filling of the steeps is adopted, to minimise dust in the steeps room. Completely dust-

free filling of steeps can be achieved by first wetting the barley, and pumping a barley/water slurry up to the steeps.

For a given batch size, Maltsters have their own views as to the optimum capacity of each steep. For example, in the case of a 200 t batch, the arrangement of steeps could vary from four at 50 t to eight at 25 t. The smaller steep will minimise both the hydrostatic pressure developed in the barley during steeping, and the variation in depth of barley between the perimeter and the central cone. This will give more uniform treatment during steeping, aeration, and carbon dioxide extraction. All items such as fittings, fixings, etc., increase in number with smaller steeps, resulting in a greater capital cost.

Two-day steeping would normally be designed into the system, and two sets of steeps are therefore required. If the steeped barley is transferred from one set to the other, at the end of day one, rather than remaining in the same steep for two days, then the second day steeps need to be relatively larger to accommodate the swelling of the barley in the later stage of steeping. The steeping process might typically have three periods when the grain is submerged, with rest periods between each wetting.

Pressure aeration of the barley, to assist in the rousing of the grain in the steeps and to maximise uniformity of the mass during wetting, is achieved by passing compressed air into the steeps, via nozzles in the sides of the cone and/or the area adjacent to the steep discharge outlet. The essential removal of carbon dioxide is achieved by suction fans drawing air from the bottom of the steep during the rest period, via a system of large ducts.

To maximise production, Maltsters in some instances have produced a circular, roofed, pre-germination vessel between the conventional elements of steeping and germination, where the grain is subjected to increased volumes of humidified air, to bridge the gap between steeping and germination, so that by the time the grain has been transferred to the germinating unit itself, growth is sufficiently advanced to allow a reduction of the time spent in the germinating vessel. This facility is not widely used, and is expensive, but may provide limited additional capacity, or better quality malt, in existing plants.

9.6.2 Germinating vessels

In the past few years, all new germinating capacity in the UK has consisted of circular vessels, and steel construction has predominated, although concrete malting towers are widely distributed throughout the world. Their high cost in the UK has restricted this form of construction to situations where lack of space or other justification prevails. Only two major concrete tower developments have been constructed in the UK to date, both for brewers in Burton-upon-Trent.

A tower, of whatever construction, has the basic advantage of minimising or eliminating the elevating of wet barley. One main elevator can be used to transfer the original dry barley to the top of the tower, where, ideally, the steeps would be located. From this level, barley can be transferred to the germinating

vessels below by gravity, and subsequently, following germination, to the kiln at ground floor level. To date, no structural steel tower construction in the UK has involved vessels more than two-high, either for germinating or kilning, but technically steel towers of greater height could be developed. As in the case of concrete, the cost of steel construction increases relatively with height, and available space on a particular site will most often dictate the concept adopted.

Since the inception of the circular germinating vessel, little has changed in respect of the basic layout, although engineering improvements can be seen. The construction of the modern circular germinating vessels consists of a series of steel columns around the perimeter of the vessel, with a thin curved stainless steel shell attached to the inside face. This method of construction permits good circularity, essential for rotating equipment. The steel structure of the roof is usually conical in profile, although the stainless steel sheets forming the ceiling of the vessel are normally flat, suspended from the roof structure. The height of the plenum is normally designed to allow personnel access below the perforated floor for cleaning and washing down.

Vertical spiral turners are provided above the perforated floor, to allow turning of the grain during germination. This keeps the grain loose, so promoting better growth and minimising matting of rootlets. Spraying facilities are normally built into the turners, so that water, perhaps with additives, can be added to the grain in process. See Figs 9.3 and 9.7.

Two fundamental concepts of germinating vessel philosophy have been developed, the first where the perforated floor is fixed in position, with the spiral turners mounted on a boom rotating around the centre of the vessel. The second type has a rotating floor, with a fixed boom carrying the turners. There are arguments for and against each type; the fact that both exist shows that there is no one method favoured by Maltsters.

At ground floor level, a reinforced concrete slab would normally be used for the base, although, at upper levels in multi-storey vessels, stainless steel sheets on a structural support would be adopted.

On the basis of providing a plenum with adequate headroom, and taking into account the depth of structure supporting the perforated floor, the grain bed depth, and the height required above the bed for equipment, etc., the overall height internally of a typical germinating vessel would be in the order of 7 m to 8 m.

During germination, ambient air is drawn through a multi-speed fan via a humidification system (usually spinning discs or some form of spray nozzles) into the plenum, below the germinating grain. This ducting is normally stainless steel. The air for germination, as near 100 per cent relative humidity as practicable, is forced from the plenum upwards through the bed of grain, under the pressure generated by the fan.

Where required, refrigeration plant can be incorporated in the system, to maintain accurate control over the air-on temperature to the grain. After passing through the grain bed, the air can either be exhausted to atmosphere, or recirculated in any desired proportion with fresh air, depending on ambient conditions and process requirements.

Fig. 9.7 Fixed floor germinating vessel – loading in progress (photograph courtesy of Seeger GmbH).

During germination, the Maltster's requirement is to provide an adequate supply of high humidity air at the desired temperature, the volume and velocity of the fan being designed to maintain as little temperature differential through the bed as is practicable, linked with the need to minimise the loss of moisture by evaporation through the depth of the bed. Ideally, depending on the barley variety and the type of malt to be produced, the temperature should be maintained in a range of about 12 to 16ºC, or 15 to 19ºC. To achieve these targets, the depth of grain bed must be restricted, and a normal design figure would be to adopt a loading on the floor of about 550 to 600 kg/m^2 of original barley. For example, in the case of a 300 t batch of original barley, the area of the germinating vessel floor might therefore be approximately 500 to 545 m^2, or about 26 m in diameter. This would give a depth of steeped barley, after loading, of about 1.2 m. Increasing the depth of the bed not only makes the control of humidity and temperature more difficult, but also increases electrical energy costs for the fan.

The residence time for the barley in the germinating vessel can vary considerably, depending on such factors as the variety of barley, the growth which has taken place in the steep, the method of filling the vessel, temperature, humidity, type of malt required, and additives used, but normally the duration would be in the order of four to five days. Ideally, five germinating vessels would be provided.

Where the plenum has adequate headroom, manual cleaning can be readily executed, although automatic underfloor washing is offered by manufacturers. It is also possible, where a rotating turner unit is incorporated (with a fixed floor) to

provide an automatic system to wash the upper walls and ceiling of the vessel. The requirement of cleanliness and a good standard of hygiene is high on the Maltster's agenda, and the modern design eliminates earlier problems in under-floor access and adequate cleaning. During germination, the temperature and humidity of the air provide ideal conditions for the formation of bacterial fungal growth.

It is now common practice to provide germinating vessels which are completely automated. Both loading and unloading can be achieved in this way, and during processing of the grain the provision of appropriate sensors can control air volumes, humidity, temperature, etc.

9.6.3 Kilning vessels

As with germinating vessels, all recent major kiln developments in the UK have been based on circular stainless steel vessels. Although construction is generally similar to that of germinating vessels, a more complicated system of large ducting is required, for the greater air flow, the larger fans, recirculation of the process air, and heat recovery.

One significant difference between the germinating vessel and the kiln lies in the layout of the loading/unloading unit. While, once again, the boom can be fixed, with the floor rotating, or vice versa, turning of the material after loading is not required in a kiln, hence the vertical spirals of the germinating vessel are absent. In their place is a horizontal loading/levelling screw conveyor, which can be adjusted to vary its height above the floor, so that pre-selected depths can be adopted for loading or stripping (see Figs 9.4 and 9.8).

A further factor to be taken into account in kiln construction is the need for a higher standard of insulation, to minimise heat loss. The kilning operation uses more energy, both in the form of heat and electrical power than any other part of the malting process, perhaps up to 85 to 90 per cent. Most kilns incorporate some form of energy conservation, although with current fuel prices, it is doubtful if the retro-fitting of heat recovery to existing kilns can be justified. In most cases, the principal heat source is gas supplied on an 'interruptible' basis, with oil storage being provided as a standby. Ambient air is drawn into the main heating system (after pre-heating, if heat recovery has been fitted) and thence through a variable speed fan, or fans, into the plenum chamber below the perforated floor on which the grain has been loaded and levelled.

To minimise energy costs, albeit at higher capital cost, it is desirable to reduce the grain bed depth compared with germinating vessels, and an ideal figure for a new kiln design would be around 350 to 450 kg/m^2 of original barley, which in the case of a 300 t capacity kiln would give a diameter of about 30 m. This compares with about 26 m diameter for a similar batch size germinating vessel.

If a single kiln is used in the design for the malting process, and on the basis of a 24-hour cycle, it is necessary to size the fans, heating equipment, ducting, etc., to allow drying and cooling to be completed in approximately 20 hours, allowing approximately four hours for loading, unloading and cleaning.

Fig. 9.8 Fixed floor kilning vessel – fully loaded (photograph courtesy of Seeger GmbH).

At the early (drying) stage of kilning, the heated air passes through the grain bed, picking up moisture in the process, with the saturated air being exhausted to atmosphere. After some hours of drying, when the moisture content of the grain has decreased substantially from the initial 40 to 45 per cent, a start is made to recirculate the air, initiating the curing stage of kilning. Progressively, the 'air-on' temperature is increased, and the air volume reduced. A proportion of the exhaust air is recirculated, and re-heated together with additional ambient air, making up the required volume. This regime continues until the final moisture content has been reached, typically four to five per cent. Initially the drying temperature might be in the range of 60–65ºC, rising during curing to perhaps 65ºC for lager or other lightly kilned malts, to as high as 100–110ºC for traditional ale malts.

During the initial drying stage of kilning, when saturated warm air is being discharged, low grade heat can be recovered from the exhaust, to preheat incoming ambient air. In recent developments, almost without exception, heat recovery has been introduced through the medium of thousands of glass tubes around 20 mm in diameter, arranged in bundles, in the shape of chevrons when viewed from above. There are two fundamental concepts: in the first, the exhaust air passes around the outside face of the glass tubes which are normally disposed

vertically, before discharge to atmosphere. The incoming ambient air is drawn downwards through the tubes by fan suction, heat transfer through the thin glass providing a significant preheat to this air.

In the alternative arrangement, exhaust air is discharged through the tubes, with the ambient air passing around the external faces of the tubes. As before, there is worthwhile transfer of heat. Both arrangements give equally effective heat transfer, the choice being a matter of disposition of plant, or the Maltster's preference, although the latter arrangement may offer better self-cleaning of the tubes. The glass tube units are normally installed at high level, coincident with the level of the main kiln exhaust. A typical arrangement is shown in Fig. 9.4.

To reduce and minimise contaminants in the final malt, indirect heating is normally installed, whereby the ambient air which passes through the grain bed does not come into contact with the products of combustion of the fuel, oil or gas, having obtained its heat indirectly from a heat exchanger, with a primary heat source of hot water, steam, air or thermal fluid, although the latter is not currently favoured.

In some instances, kilns have been constructed with interconnecting ductwork, to improve thermal efficiency, and this can be an attractive proposition, depending on the available cycles matching production requirements. Further development has been the combination of final germinating and kilning into a single vessel, and this is described below.

As in the case of germinating vessels, most modern kilns are computer controlled, not only to automate loading and unloading, but also to provide the facility allowing the Maltster to set up and operate a variety of recipes for the kilning cycle, depending on the malt specification called for.

9.6.4 Combined vessels, steeping, germinating and kilning

A development of the use of separate germinating and kilning vessels has been to combine, in one vessel, the last day of germinating with kilning, based on a 48-hour residence time. When a vessel is used solely for kilning, on a 24-hour cycle, only about 18/20 hours is available for drying, curing and cooling. However, when a combined germinating and kilning vessel is used on a 48-hour cycle, it is possible to devote 24 hours to drying, curing and cooling. The remaining 24 hours can be broken down into four to six hours for filling, stripping and cleaning, and 18 to 20 hours final germination and initial withering. For the same bed depth, a longer kilning time will reduce energy consumption.

To take full advantage of this system, it is essential to have two germinating/kilning vessels operating together, sharing one burner unit, fans and heat exchanger. The construction of the fans ducting, etc., of the heating system allows the air to be switched from one kiln to the other every 24 hours, allowing virtually a full day for kilning/cooling in each vessel. Compared with a dedicated single kiln, the extended drying time available results in lower capacity heating units, fans and heat exchanger, and also provides the Maltster

with greater flexibility. One batch of malt is still produced every 24 hours. If necessary, it is also possible to incorporate humidified air for germination during the last hours in the combined vessel, although most combined vessels constructed to date have not incorporated this facility, the Maltster preferring to allow withering to start during the last hours of germination.

The down-side of this arrangement is the need to provide two germinating/kilning vessels instead of one germinating vessel and one kiln, resulting in some additional capital cost. As with the dedicated kiln, the combined vessel does not have vertical spirals on the loading/stripping machine, so that no turning of the greenmalt is carried out during the last stage of germination. This ensures that the level surface of the grain is not disturbed before kilning, as the furrows which can develop during turning would encourage uneven channelling of the warm air through the grain bed, resulting in drying variations. If germinating/kilning vessels are incorporated, the normal layout would be to adopt four germinating vessels and two germinating/kilning vessels, giving up to about five days germination plus 24-hour kilning.

A further variation adopted in a few maltings has been the combination of all three stages of the process into one unit, thereby avoiding the need to transfer grain from initial loading of the barley until the end of kilning. While this has some advantages, the negative factors probably outweigh these, as there is an excessive requirement for water for steeping, similar to that associated with the flat bottomed steep, referred to in Section 9.6. Again, if the depth of the plenum were minimal, cleaning becomes a problem, with a lower standard of hygiene. With rising effluent treatment costs, it is essential to minimise the use of water for steeping.

In addition, as the optimum depth of grain in each vessel of the three separate stages varies, a design depth has to be evaluated which will give the best compromise between the greater depth acceptable for steeping and the shallow depth preferred for kilning, to minimise energy costs. As turning of the grain during germination is necessary, furrowing of the surface leads to some unevenness of drying during kilning.

Both rectangular boxes and circular stainless steel vessels have been built as combined steeping, germinating and kilning vessels, but these were designed before 1980, since when this combination of process plant has not been adopted to any degree.

9.6.5 Conveying equipment

Where steeping, germinating and kilning are carried out in discrete stages, there are four major conveying operations. Where one batch of malt is produced each day, it is desirable for the operations to be timed to take place during the working day, so that the average time available for each transfer is in the order of two hours, including appropriate vessel cleaning.

The first stage in the daily sequence is to empty the dried malt-in-culm from the kiln to a suitable storage bin, in about two hours, before this is de-

culmed, dressed, etc., later in the day at a lower capacity en route to storage. After the kiln is emptied and cleaned sufficiently, a start can be made to stripping the relevant germinating vessel and transferring its contents to the kiln. Again, a two-hour target is desirable, and it must be borne in mind that adequate cleaning of the germinating vessel must be carried out before re-loading.

The steeped barley can thereafter be discharged from the steeps after the second day into the appropriate germinating vessel, again allowing approximately two hours, including steep cleaning. As the steeps are normally emptied sequentially, cleaning can start before the completion of the transfer. If two sets of steeps are incorporated, then a start can be made to transfer from the upper 'day one' to the lower 'day two' steeps before loading of the germinating vessel has been completed.

The final operation is to re-fill the steeps, usually from a pre-steep bin which contains a weighed batch of barley. This transfer can either be dry (although complete dust suppression is difficult), or by means of a barley/water slurry, which eliminates dust in the steep room, and introduces water to the barley at the earliest possible time. High capacity plant is desirable for this transfer, to ensure that all steeps have similar gross process times.

It can be seen from the above that the requirement to carry out transfers in a specific time establishes the capacity of the conveying equipment required in each operation. For example, in the case of a 300 t batch, if the kiln is to be emptied and made available for re-loading in two hours, the conveying equipment must be sized to cope with minimum of 150 t of original barley, as malt-in-culm, and must take account of possible surges which occur during loading and unloading of vessels. The automatic unloading system for the kiln must also be designed for this capacity. Similarly, when transferring grain from the germinating vessels to kilns, provision must be made to cope with variations in the rate of transfer.

Cleaning of the kiln floor and under-bed area is a dry operation, and, with good design, can require little manual daily input. In the germinating vessels, the conditions of temperature and humidity promote the growth of mould, and adequate time must be allowed for cleaning down on a regular basis.

A wide range of conveying and elevating plant is available, and care must be taken to ensure that the appropriate equipment is selected for each stage of grain transfer. Due attention must be given to the following.

1. The material to be handled, bearing in mind the 'bulking' which occurs in the volume of the original barley during processing, and when being transferred in a conveyor or elevator.
2. The method of cleaning, conveying and elevating equipment where wet grain is being handled. In particular, an efficient cleaning system must be developed for machines handling greenmalt and steeped barley, to maintain an acceptable standard of hygiene. Belt conveyors are favoured for transferring wet grain, as these can be cleaned more easily than enclosed

machines, and an ideal layout, if space permitted, would be to eliminate elevators, all transfers being carried out by inclined belt conveyors.

3. The extraction of dust, where dry transfers are being carried out. This is most likely to occur in the transfer of dry barley to the steeps room, and during the transfer of malt-in-culm from the kiln to an adjacent storage bin. The design of an appropriate dust extraction system is an essential feature of any dry transfer of grain, particularly at high capacity.
4. The problem of noise, when equipment is located in the open air. Noise attenuation must be considered, where environmental aspects must be taken into account. Conveyor manufacturers offer various solutions to this problem, but in spite of this there are still many instances of conveyors producing excessive noise, particularly when running empty.

9.6.6 Current trends in malting plant

From the discussions above, it is evident that the majority of recently constructed plants have followed a common pattern. In steeping, there is preference for cylindro-conical steeps, with effective aeration and carbon dioxide extraction, this giving the simplest and cheapest construction, while affording the best option for optimum hygienic conditions. Where new process units have been provided for germinating and kilning, these have been constructed, almost without exception, in a circular format. In the United Kingdom, these are of structural steel frames, with stainless steel inner wall lining and ceiling. Outside the UK, the adoption of towers constructed in reinforced concrete is widespread, this form of construction being frequently more economic, although the demand for a high standard of hygiene may result in additional costs for an acceptable inner lining of stainless steel or equivalent standard. There is some preference for combining the last stage of germination with kilning, in combined germinating/kilning vessels. The adoption of this type of unit provides a greater flexibility towards the end of germination, and for kilning.

In addition to the provision of heat recovery as a means of reducing fuel costs, combined heating and power has been investigated by a number of Maltsters in the UK, but has not been adopted to any significant degree. While the heat produced can usefully be incorporated into a kiln heating system, where batches of malt are produced daily, there tends to be an overproduction of electrical energy, requiring this to be exported to an alternative user.

The development of handling plant has concentrated on equipment providing the best means of cleaning, with belt conveyors being used extensively. The use of elevators for handling barley as greenmalt in process is kept to a minimum, and such elevators as might be required are being provided with the best possible method of automatic cleaning for maximum hygiene.

As the capacity of each batch dictates the annual output of malt, on the basis that a batch is produced each day, there is no single optimum size. However, as a 300 t batch will result in an annual production of about 90 000 t of malt, it is

unlikely that this size will be widely adopted, with a more likely capacity being around 200 t to 250 t, giving around 60 000 t to 75 000 t per annum of malt.

During the time up to the mid 1970s, when there was considerable investment in new plant, specialist firms, principally from UK and Germany, supplied the major plant items. Unfortunately, with the down-turn in UK maltings development, and the lack of success in obtaining sufficient export work, the two main UK firms fell on hard times, and stopped producing malting equipment. However, the 'know-how' from one firm was procured by a manufacturer in a similar line of business, and they can now offer the relevant specialist malting plant. German firms have, therefore, increased their share of the available UK market, winning a large proportion of recent contracts in this country. Firms from continental Europe are probably the main suppliers globally.

9.7 Malt storage

After kiln drying, malt should be transferred via a high capacity conveying system to temporary storage in a malt-in-culm bin. This allows rapid stripping of the kiln so that refilling can start in about two hours. As the malt-in-culm bin is not required for a further day, the product can be conveyed to long-term storage at a lower capacity, via the appropriate cleaning, dressing and weighing equipment. Dust extraction is highly desirable during this series of operations.

Where malt required for customers has a wide range of specification, it is normally stored in smaller individual quantities than barley. As for barley, there is widespread use of steel bins, either circular or square. Where the capacity is up to about 500 t of malt, hoppered bins are feasible; for larger capacities, flat bottomed circular bins can be used. These are less convenient, and are only viable when large quantities of a single specification are being produced.

When concrete silos were constructed in the 1950s and 1960s, a greater proportion of the storage cells was dedicated to barley, with smaller amounts to malt. With the capacity of many maltings being increased substantially, it has been found convenient to construct large bulk barley storage, and convert the majority of the cells in these concrete silos to the storage of malt, allowing separation of malts of different specifications. No aeration is required for the storage of malt. The total quantity of malt stored on site varies greatly; ideally the Maltster would be looking to have about six weeks' production available on site.

Before dispatch, the malt is weighed, and then cleaned, with generous aspiration, to remove any remaining light impurities. By far the greatest proportion of malt is despatched from the maltings in bulk, either in dedicated vehicles, or by container. Small amounts of malt are still despatched in sacks for specialist requirements.

The current trend in malt storage is, wherever possible, to provide storage of malt in hoppered bins, to minimise damage. As the output at a maltings increases, there has been a move towards converting existing hoppered barley

storage to malt storage. Any additional barley, and that displaced from existing silos, can then be stored in cheaper, flat bottomed bins. Where new malt storage is required, this is provided, ideally, in hoppered bins of capacities up to about 500 t. Unless there is a change in the multitude of specifications required by customers, this arrangement is unlikely to alter.

9.8 Automation

Over the years, as available control systems have become more sophisticated, Maltsters have generally adopted the latest available technology, in an effort to produce consistent quality malt, to a variety of specifications. The majority of maltings built before current control systems were available have been upgraded retrospectively to incorporate higher standards of control, although this does not have the complexity or capability of plants built within the last twenty years where complete automation has been integrated into the initial plant design.

It is now possible in a maltings to provide total control of all aspects of malt production with a PC, from barley intake to final malt dispatch. The malting process is such that two discrete control systems can readily be embraced, one handling the raw material and finished product, the other devoted to the malting process itself.

As the majority of new maltings plants have a pre-steep bin or hopper available for rapid transfer of a batch of barley to the steeps, this forms a convenient ‘breakpoint’, as the availability of grain for steeping is normally a function of the silo operation. The process control system can ‘pick-up’ the barley at this point, and control the process completely, from the transfer of the barley into the steeps, through the remainder of the process, to the final drying of the malt in the kiln. From the kiln, the final product, malt-in-culm, is normally transferred from the kiln to a holding bin, and this is a logical point for the transfer of control from the production area back to the silo system. After transfer of the malt-in-culm to the silo complex, all malt weighing, dressing, cleaning, and dispatch can be carried out as part of the silo operation.

In most cases, PLC/SCADA systems have been adopted, which can readily be operated by semi-skilled staff. There is normally a facility for building in various menus and recipes, to allow a wide range of programmes to be incorporated, depending on the type of barley being processed, and the final malt specification required.

In addition to his ability to control the process completely, the Maltster can also extract much useful information for management and auditing purposes, such as stock control, and tabulating of data relating to electricity, fuel, water and effluent.

With the advent of comprehensive control systems, the output of malt per man has risen dramatically, although perhaps the art of malting is being lost forever. Nowadays, there is much less need for the Maltster to process the grain in a ‘hands-on’ manner, as much of his time is spent in an area remote from the

process. This aspect is further exacerbated by the ease of locating terminals in offices remote from the process itself.

9.9 The future of the malting industry

In Section 9.2, the current picture described was one of rather depressed trading and low profit margins. At the end of 1998, the Maltsters Association of Great Britain recorded that year as being the worst in the memory of those in the industry, with European Maltsters on minimal profit margins, and instances of malt being sold below cost to maintain a customer base. This has been the result of, among other factors, an over-capacity in the European market, with UK Maltsters further pressurised by the high value of sterling. Total production in the UK continues to fall slightly, although a small increase in exports is evident. The UK Maltster will need to rely heavily on export markets for some time.

It is difficult to foresee what events worldwide will lead to a healthier environment, encouraging a substantial increase in malt production within the United Kingdom, and promoting selling prices which would allow major investment in new plant. It is unlikely that any Maltster will find it financially attractive to develop a new greenfield site, due to the high cost of the necessary infrastructure, including such elements as the supply of water, gas, electricity, new roads, effluent treatment, offices, storage, etc. As a guideline, the cost of developing a greenfield site might be in the order of £400/£500 per tonne of malt produced per annum. This figure will vary considerably, as a multitude of parameters can affect the final cost. Of the above figure, perhaps £250/£300 per tonne of malt per annum might be invested in the production plant itself, the remainder covering storage, site ancillaries, services, etc.[3]

Any investment in the mid-term is therefore likely to be restricted to the renovation or upgrading of existing plant, particularly where more efficient production can be achieved at relatively low cost. In the past few years, there have been efforts to increase the 'tonnes of malt produced per employee' in major firms, and this attitude is likely to prevail.

With only five major Sales Maltsters in the UK at present, there is little room for further consolidation or amalgamation.

Recently, in the UK, there have been instances of Maltings being sold, on the basis that the new owners (Sales Maltsters) would continue to provide malt on contract to the vendor (Brewer or Distiller). Worldwide also, brewers are looking closely at the function of malting within their core business, with a view to possible disposal, due to the current lack of profitability in producing malt. If this trend were to continue, it is possible that the Sales Maltster might, in due course, find himself producing a higher proportion of global malt requirements. Whether this would be advantageous in terms of profitability remains to be seen.

9.10 Further reading

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