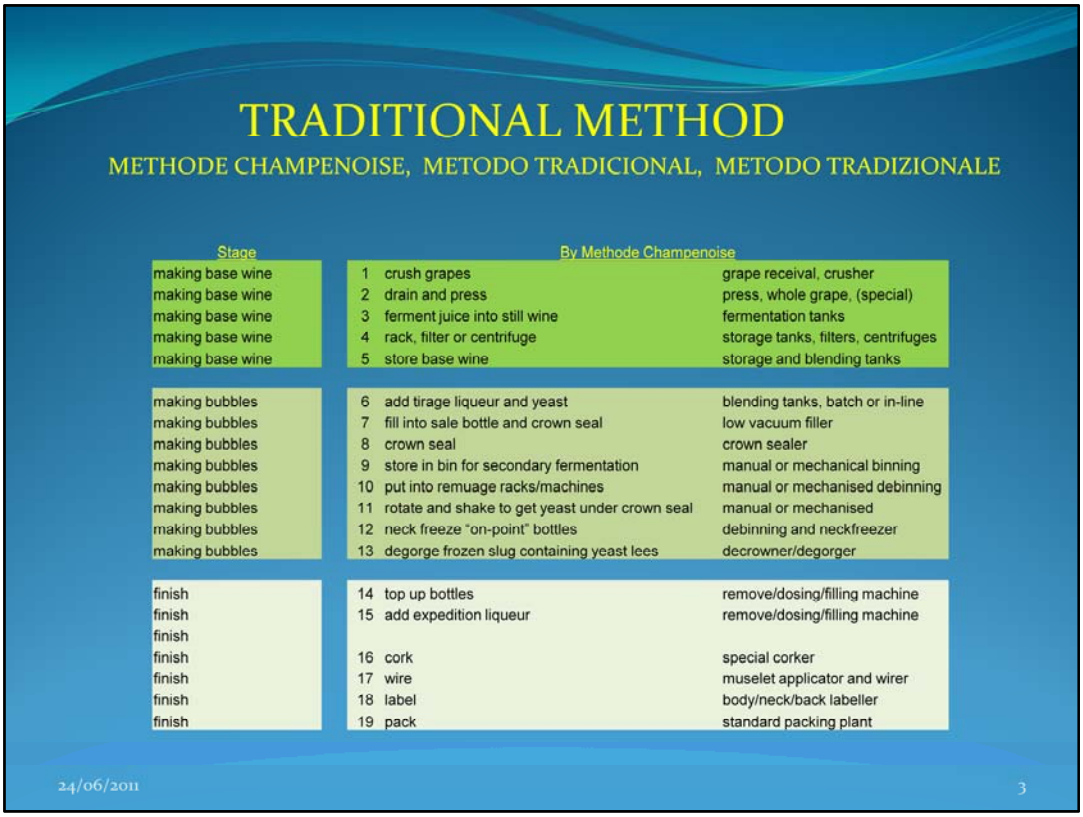
Sparkling wine – wine with bubbles in it. Requires specialist equipment. This paper will overview the four main methods of production and the plant and equipment used, concentrating on the plant specific to sparkling wine. It is all plant that must be purchased and then supported, in service, by operator training and maintenance.

The base wine preparation and some finishing steps are the same for all four methods.

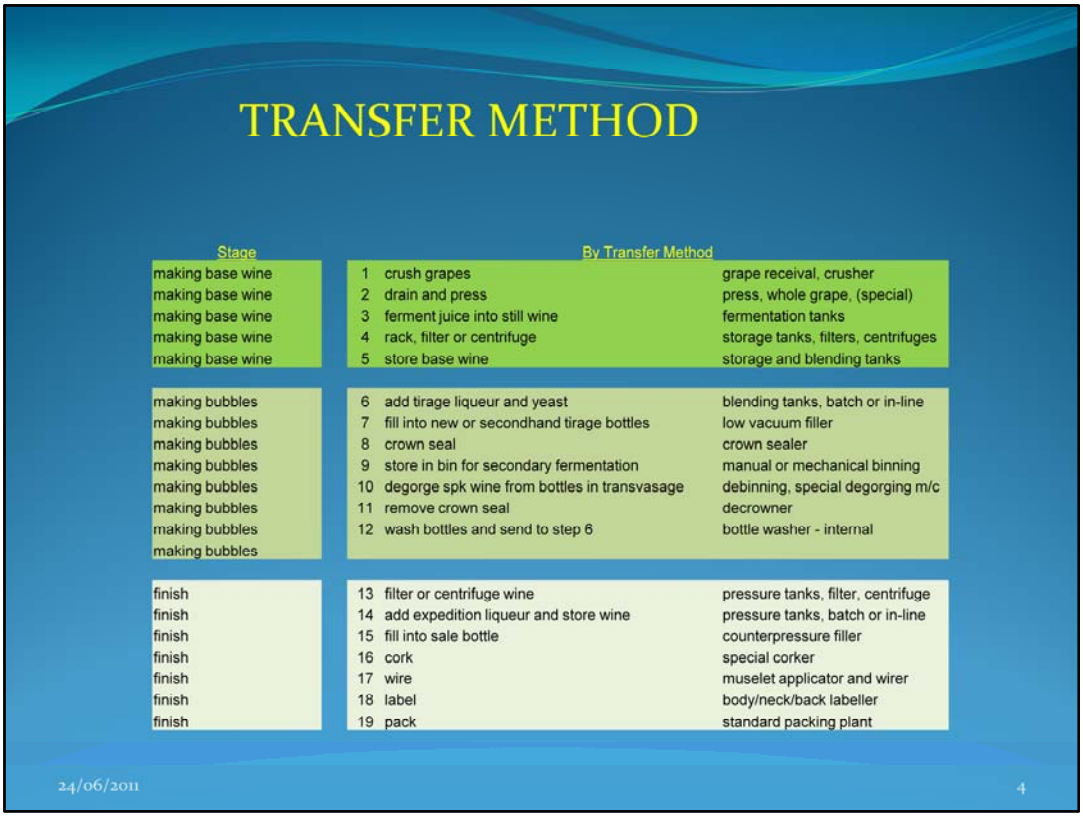
Sparkling wine is made to be drunk, according to James Halliday. This especially appeals to engineers – especially sparkling red wine!!

This slide is intended to provide a quick comparison of the four methods and the plant used that is peculiar to sparkling wine. Traditional and Transfer have the most steps – 19 each. Charmat and carbonation have 14 and 13 steps respectively. All but Carbonation require a second fermentation to produce the bubbles.

Note that blending and malo-lactic fermentation of the base wines have been omitted. These do not require any plant peculiar to sparkling winemaking, and are common to all four methods.

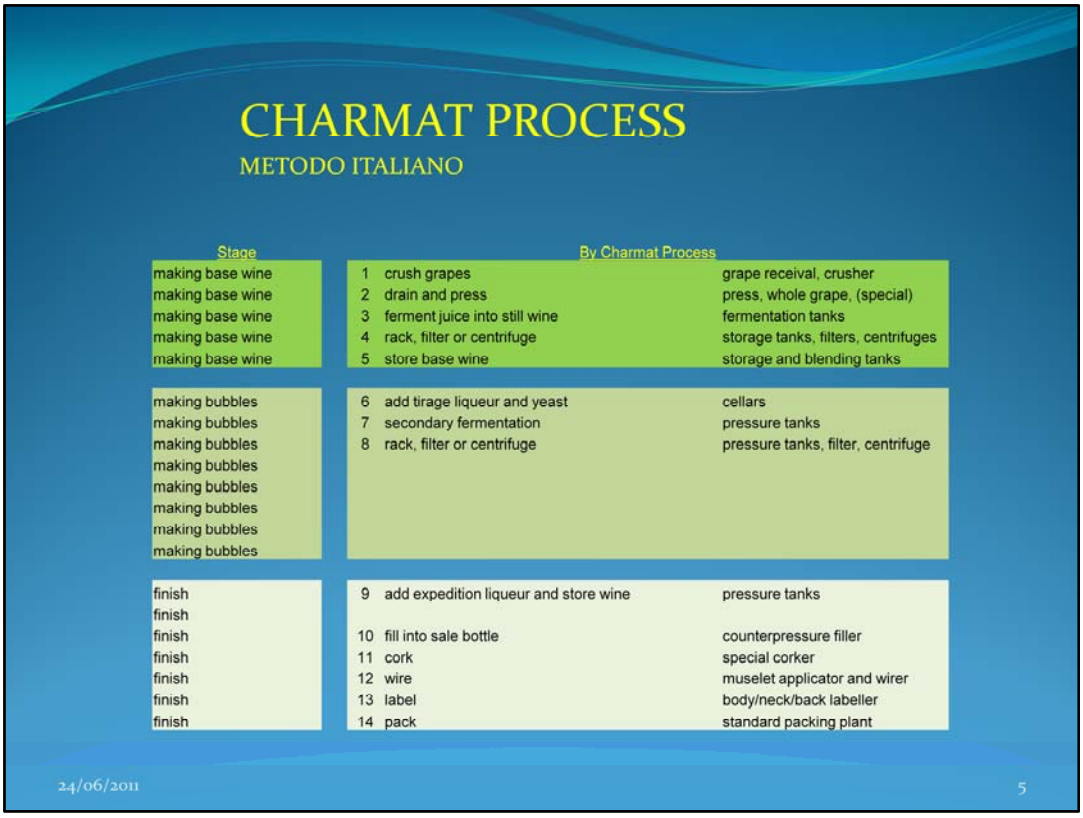


Traditional starts with a base wine preparation process common to all methods. It is the steps to make the bubbles of CO2 that define the process. Traditional is prevalent in France and Spain where it is largely mechanised. The main feature is that the second ferment happens in the bottle purchased, therefore steps are required to remove the lees from the bottle.

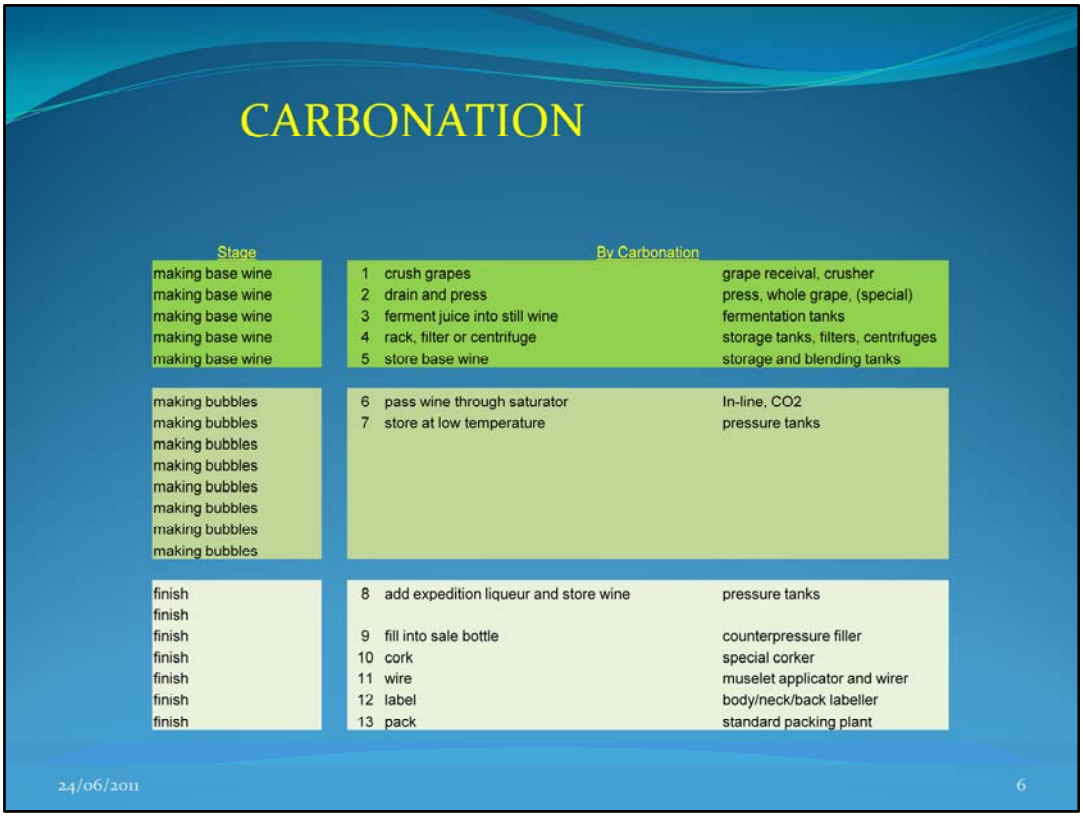


With Transfer, the second ferment happens in a bottle to obtain the characteristics of Traditional, but not the one the wine is purchased in. Flexibility is obtained by the ability to transfer the wine to larger or smaller bottles. After the second fermentation the wine is completely disgorged to pressure tanks hence there are no remuage steps. The clarification process takes place with the sparkling wine stored in, and transferred between, pressure tanks.

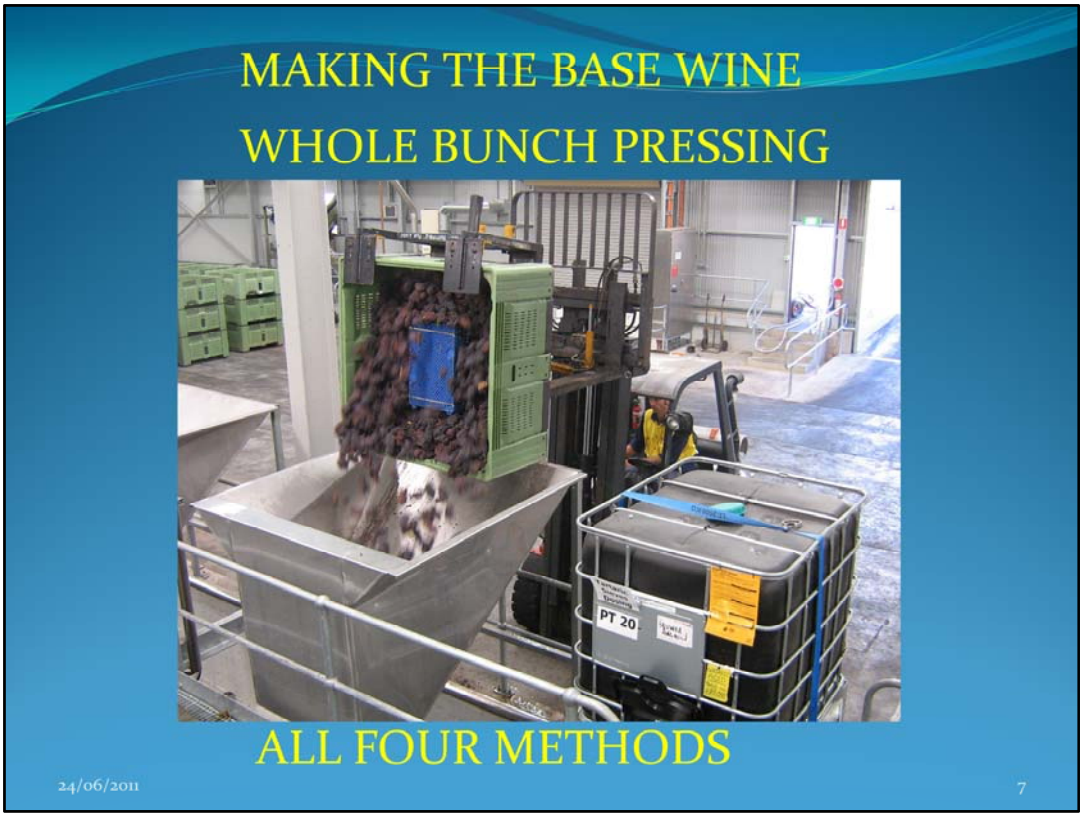
Both Transfer and Traditional have the advantage of maturing the sparkling wine on yeast lees for the required periods to gain desirable wine characteristics. Doing this however, requires more space in the tirage cellar.



Charmat, or bulk ferment, is popular in Italy, hence the other name, for producing prosecco and spumante. The second ferment happens in a pressure tank, then processes similar to Transfer are used to remove the lees. This method cannot mature wine on lees without tying up pressure tanks for long periods.



No second ferment takes place. The bubbles are formed by injecting CO2 into cold base wine under pressure, then storing the product in a pressure tank. This method consumes the most carbon dioxide so a ready supply of bulk food grade CO2 is required.



Base wine preparation uses normal table wine plant and equipment. An operation popular with sparkling wine production is whole grape pressing.

From this point during the presentation, the method using the plant or process shown, will be displayed at the bottom of each slide.

This slide shows pinot noir going into a tank press. It has been kept in a cool room and the blue crate in the centre of the green bin is to provide improved airflow around the grapes and hence better cooling.

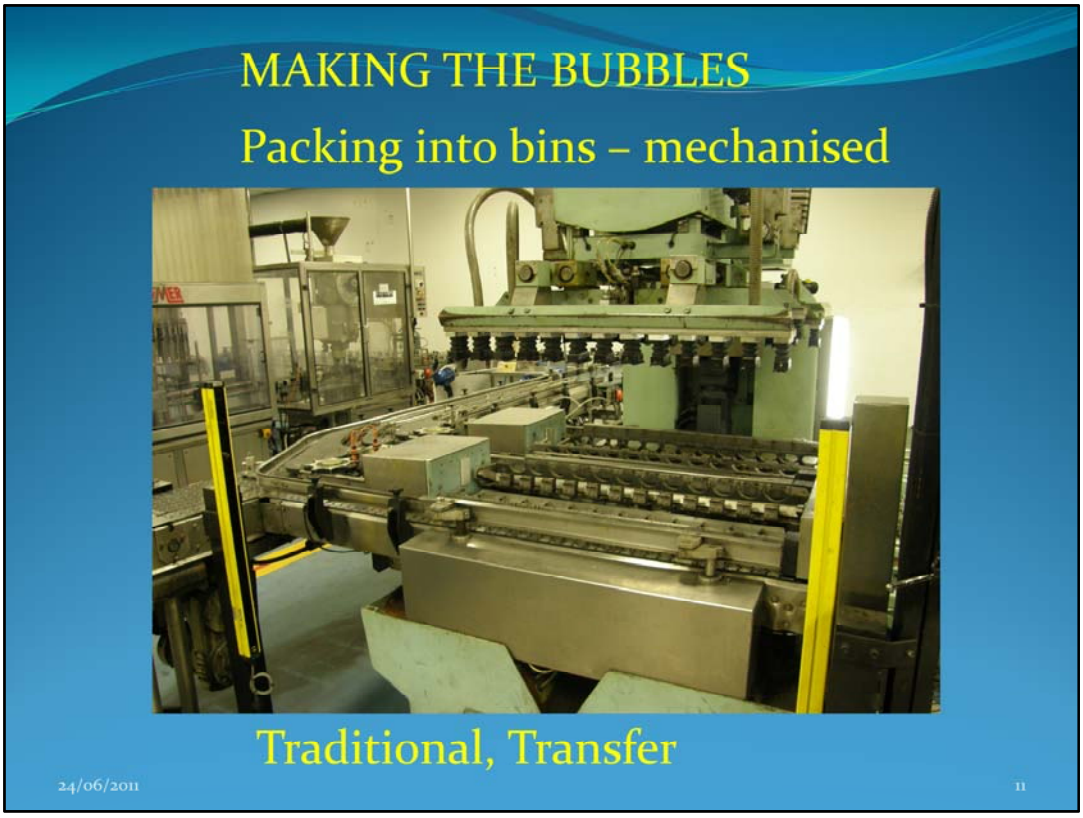
Whilst tank presses are popular, horizontal, double plate “basket” presses were once favoured due to their ability to rapidly separate juice from the grape skins, especially when pressing pinot noir.

For the second ferment, tirage liqueur, containing yeast, sugar and possibly a settling agent is added to the base wine. Generally batch wise for Charmat but can be in-line for Traditional and Transfer.

The slide shows an in-line tirage dosing plant for wine on the way to the tirage filler. The two larger tanks contain the yeast and the smaller tank contains the settling agent. The dosing is flow meter controlled with dosing of yeast and settling agent by the two blue diaphragm pumps.

Filling tirage dosed wine uses low technology, low vacuum fillers followed by sealing bottles with stainless steel crown caps.

Tirage bottles can then be packed manually – the bottles and bins can have some variation.



Or the bottles can be packed by machine. On this machine the bottles are laid down with their necks “interwoven” to get the closest packing, and then the whole layer picked up by suction cups and placed into the bin.

Tirage bottles can be packed into metal bins. These bins are in Spain. Bins made from steel rods and wire mesh are also available.

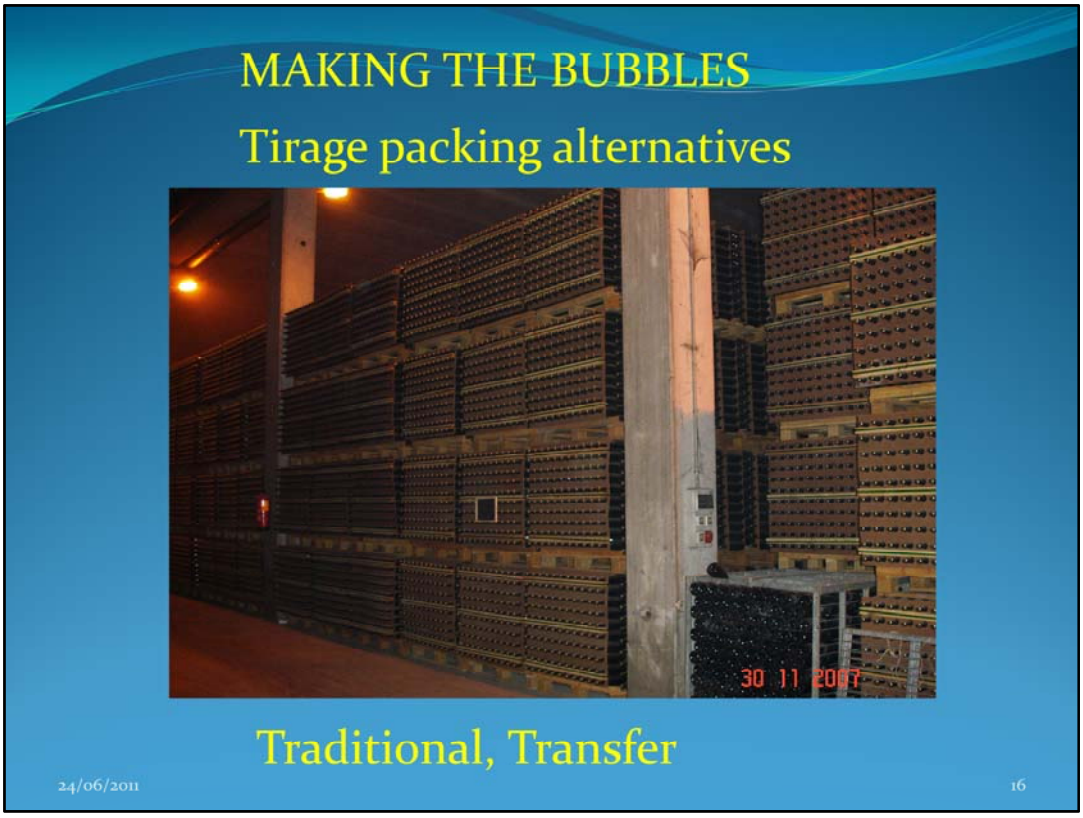
Tirage can also be packed into wooden bins. The bins shown are double bins which can be stacked higher. Each “side” contains 500 bottles.

Mechanical packing requires consistent bottle shape and more precise bins so that this does not happen. The robot cannot un-pack this!

An alternative to bins for tirage are “bottle packs” seen in Spain, for tirage stage and then also ready for the remuage stage. These were developed by Codorniu but also seen at smaller wineries in the Penedes.

A semi-mechanical process assembled the pack on pallets placed by the operator, then upright bottles “palletised” using layers of thin boards with holes for the bottle necks.

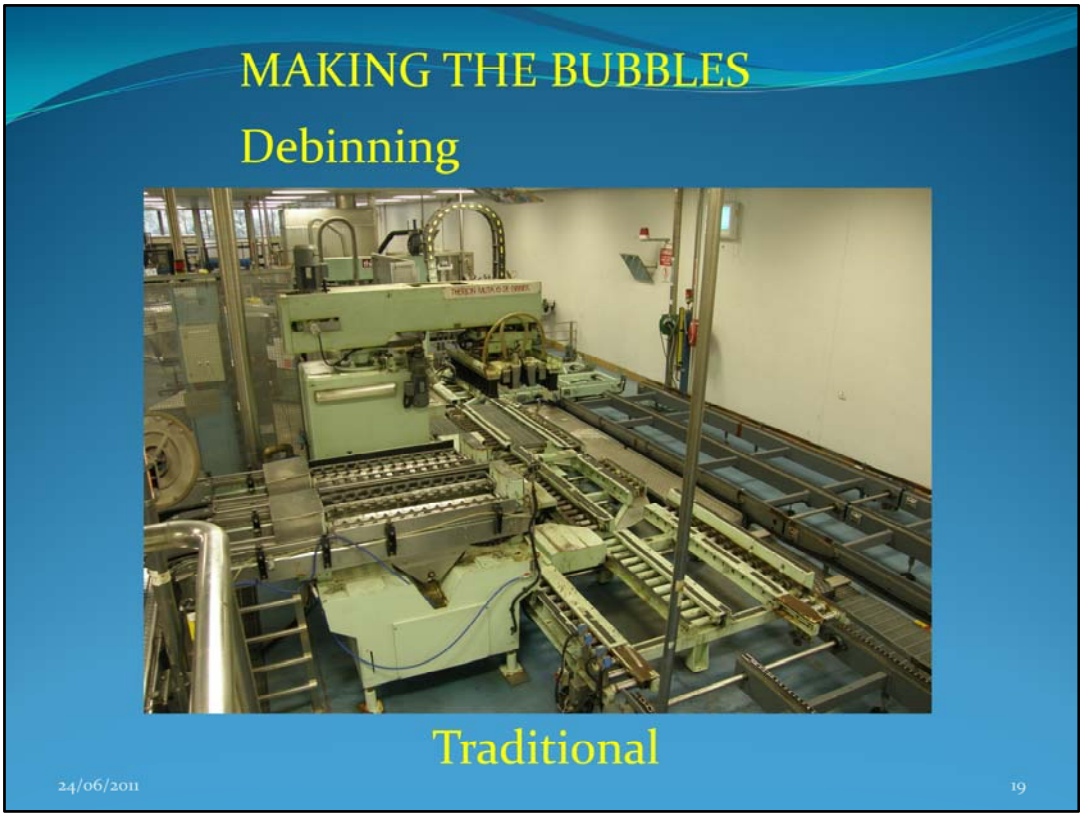
A similar machine, with suction cups to the bottle bottoms, unstacked the pack and placed the bottles into the neck freezer.



Bottle packs in the tirage cellar with 500 bottles in each pack.

Another alternative is stacking tunnels with bottles. This machine can stack and un-stack tunnels. Double handled however; packed into bin for transport to the robot, although when unstacking the tunnel, the robot placed the bottles into remuage bins with the bottles all pointing the same way. This is at Freixenet.

Traditional and Transfer are similar up to the blue arrow. From this point we will look at the remaining steps of Traditional only, and pick up Transfer later.



Debinning can be manual or mechanised depending on the scale of the operation.

This slide actually shows the debinning section of a transfer method tirage line, but could be a traditional debinner. This particular machine was originally used to debin traditional method tirage in the Seaview Cellars at Nuriootpa.

If “burgundy” stacking is used where the bottle necks are interwoven, a stage of emptying the tirage bins and placing the bottles into bins all pointing the same way is required before remuage. It is typical to also mix the bottle contents to suspend the yeast lees when this is done.

Whilst the bottle packs shown earlier do not need this stage, they are not the most dense pack and take up a bit more tirage cellar space.

Moving the lees to the top of the bottle is the first stage in removing them from the bottle. Remuage can be by manual rotating and tilting, called “riddling”, in “tables” holding 120 bottles each as shown in this slide.

Mechanised remuage on a moderate scale can be done in single bin or pack machines called “gyropallettes” holding 504 bottles each.

Mechanised remuage on a large scale can be done in a remuage machine which handles 4032 bottles at once, or eight 504 bins, as shown. In addition to a tirage cellar, Traditional requires a space to do the remuage operation.

The bottles are rotated and tilted either manually, or by machine, until upside down, or on-point with the lees against the cap.

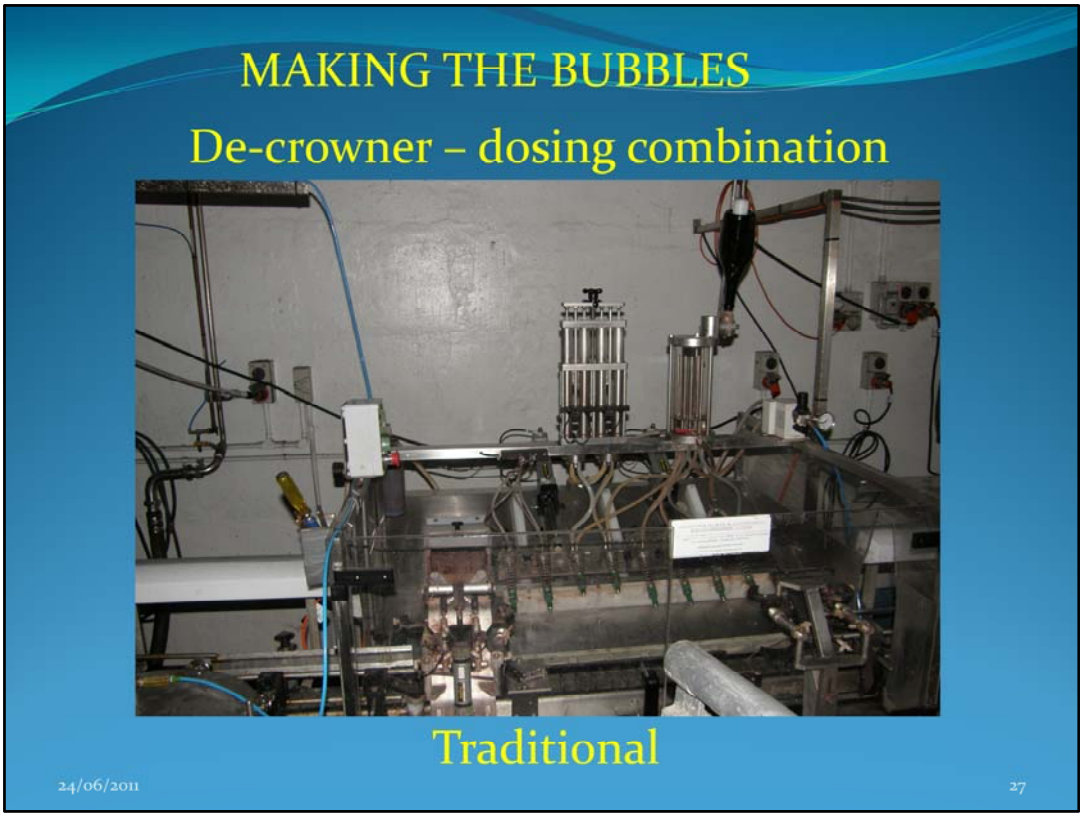
Another useful plant item is a cool room to get the on-point bottle to the right temperature for disgorging.

The next task is freezing the slug of lees that is against the cap. Bottles can be placed manually into small neck freezers with brine at -27 degC.

The brine can be calcium chloride in water, ethanol in water, or a mixture of both.

The refrigeration unit for a small neck freezer is usually in the base of the machine.

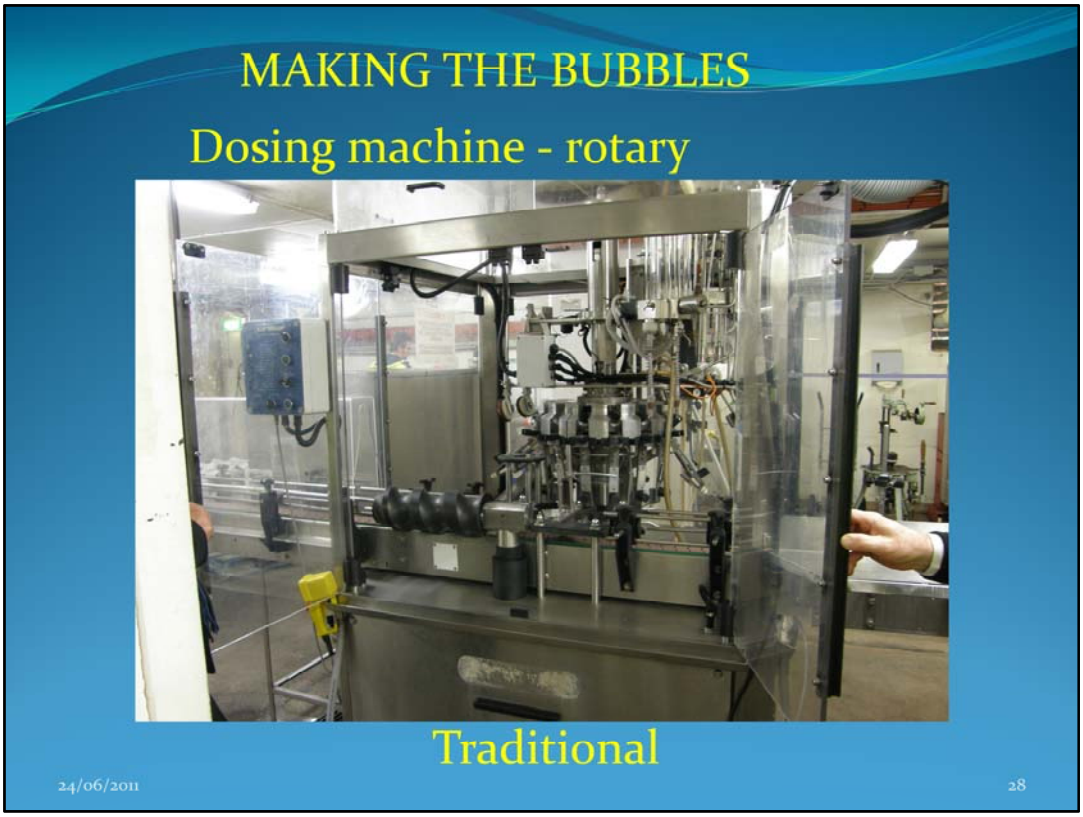
This shows a large neck freezer. Large neck freezers are usually fed with bottles mechanically. All neck freezers require a refrigeration plant to get and keep the brine cold. For a small neck freezer it is in the base of the unit, and for a large neck freezer can be a separate system connected by pipes for the brine.



After the liquid containing the lees is frozen, bottles pass to a device to remove the crown cap. At the right temperature, the slug of lees is pushed from the bottle with out being followed by the rest of the wine!

The slide shows a decrowner and doser in one small in-line unit. The first stage at the left is the de-crowner. The bottle is tilted against a half-collar which flips the crown cap off. Pressure inside the bottle pushes the frozen slug of wine containing the lees out of the bottle.

The two dosing stages to the right, add expedition liqueur and top up the bottle to replace the volume lost in the frozen slug. Topping up is done from a bottle of wine from the same batch, clamped into the holder at the top right.



This slide shows a rotary de-crowner and doser wich does the same steps as the linear machine in the previous slide but with the bottles in a carousel.

This slide shows an inline de-crowner and doser combined with the neckfreezer. The dosing at this stage is for topping the bottles and to add expedition liqueur. The bottles leave the doser upright and individual on a conveyor for movement to the corker.

At this stage, Traditional has clear wine ready for corking. We shall leave that now and look at Transfer……

Transfer uses re-usable bottles. They are a single purpose bottle; the finish only requires ability to take a crown cap – not a cork as well, so the bottles can be cheaper.

Each bottle will do several ferments. Some sites have a policy of a set number of ferments for a bottle before it is culled. This is usually in sites with manual handling of bottles after the second ferment to guard against bottles exploding in the operators hands.

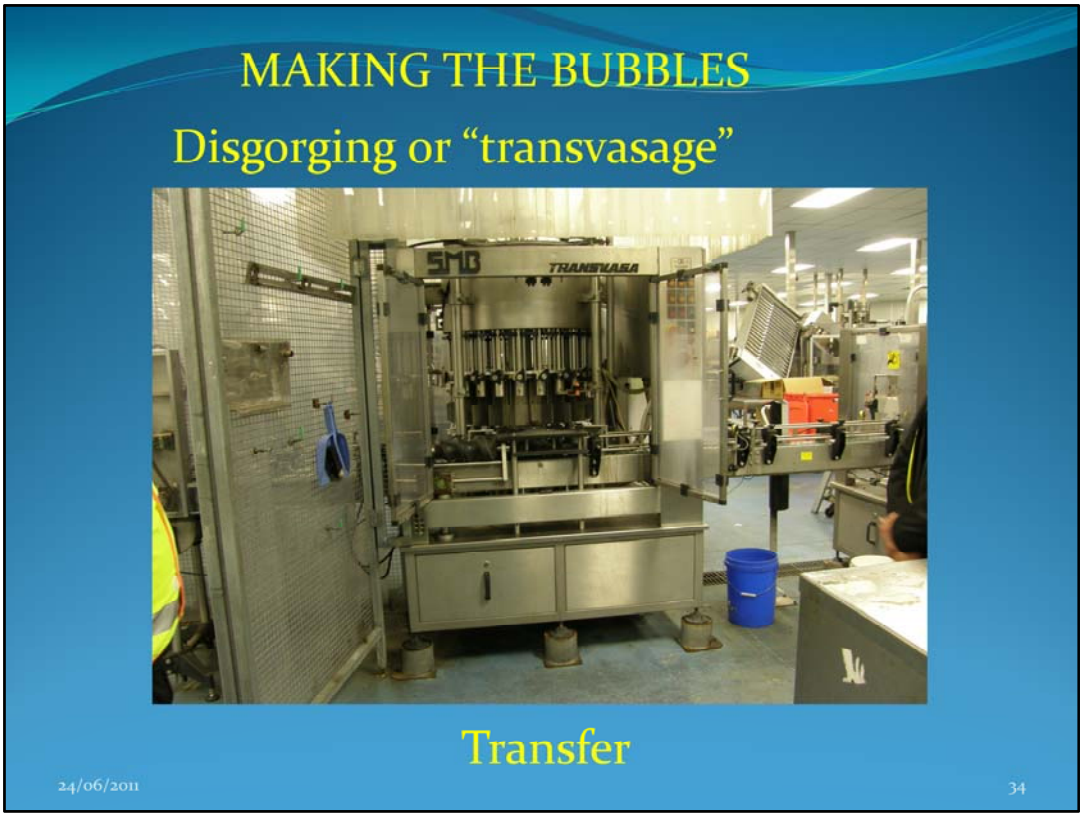
Note that for this section, “Transfer” is shown at the bottom of the slides.

Transfer tirage can be laid down in bins as with Traditional, but here is an alternative where they are palletised upright for fermentation.

Palletising and depalletising of the bottles is more easily mechanised.

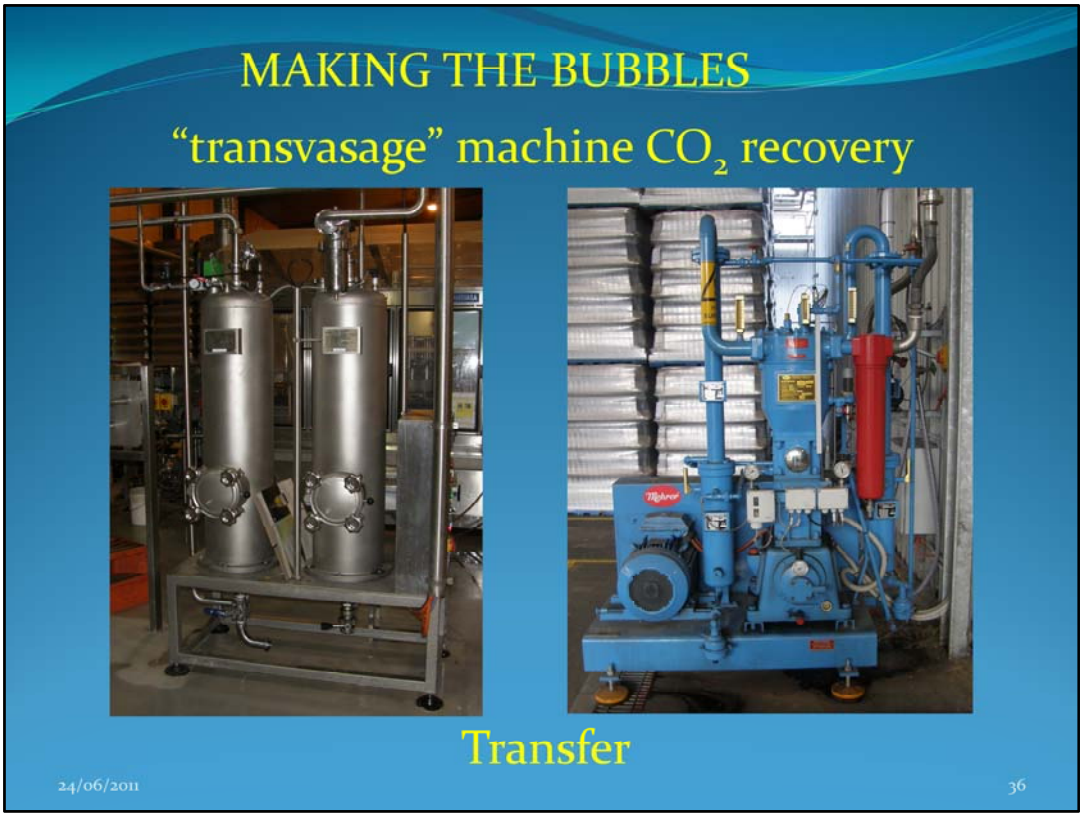
After debinning, the bottles are mixed to suspend the lees, as during disgorging the entire contents will be removed.

The machines are AVE mixers which oscillate the bottles.



Disgorging takes place in the transvasage machine. The machine pierces the crown cap of each bottle and uses CO2 under pressure to push the wine from the bottle.

Pierced crown caps from a transvasage process. The piercing enables the disgorging to happen without any loss of carbon dioxide bubbles from the wine by keeping it under pressure.



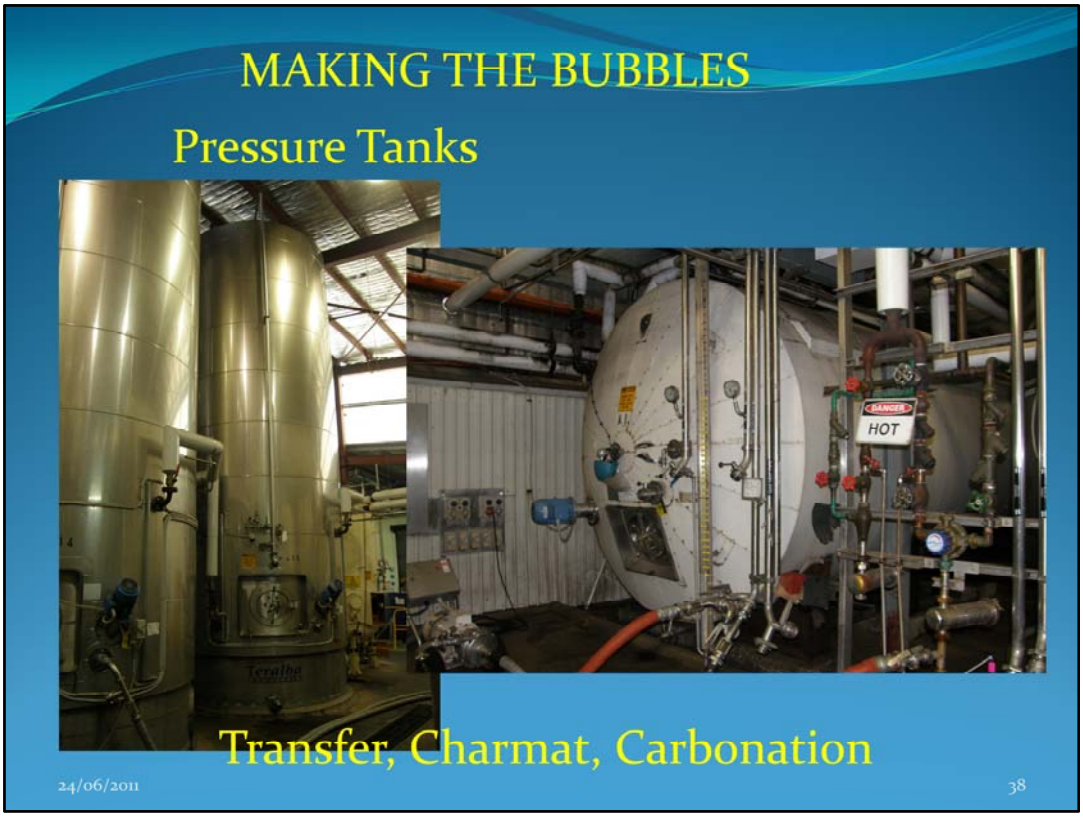
The transvasage machine uses a system that includes an oil-free compressor to recover 85% of the carbon dioxide.

After the wine is pushed from the bottle, the bottle is left full of CO2 under pressure. The CO2 is then allowed to pass to a vessel where it expands as the bottle depressurises to atmospheric pressure to exit the machine. The compressor then recompresses the CO2 to use it for the next push.

The Transfer method requires a bulk CO2 supply at the winery, but the CO2 recovery system keeps consumption to a minimum.

After disgorging, the re-usable bottles are washed and typically go to the filler for another fill of tirage dosed wine.

The machines shown wash with water and some have the ability to recycle some of the water, for example, final rinse water is collected to become initial wash water before it is released to the drain.



The disgorged wine is transferred to pressure tanks for storage under pressure of 500 to 600 kPa, and controlled temperature. The tanks are vertical or horizontal, and older ones are made from mild steel with an epoxy lining whilst newer ones are made from stainless steel.

Transfer of wine between pressure tanks requires headspace connection pipes between the tanks. Whilst these methods do not require the space for remuage to take place, they require the space and infrastructure for pressure tanks.

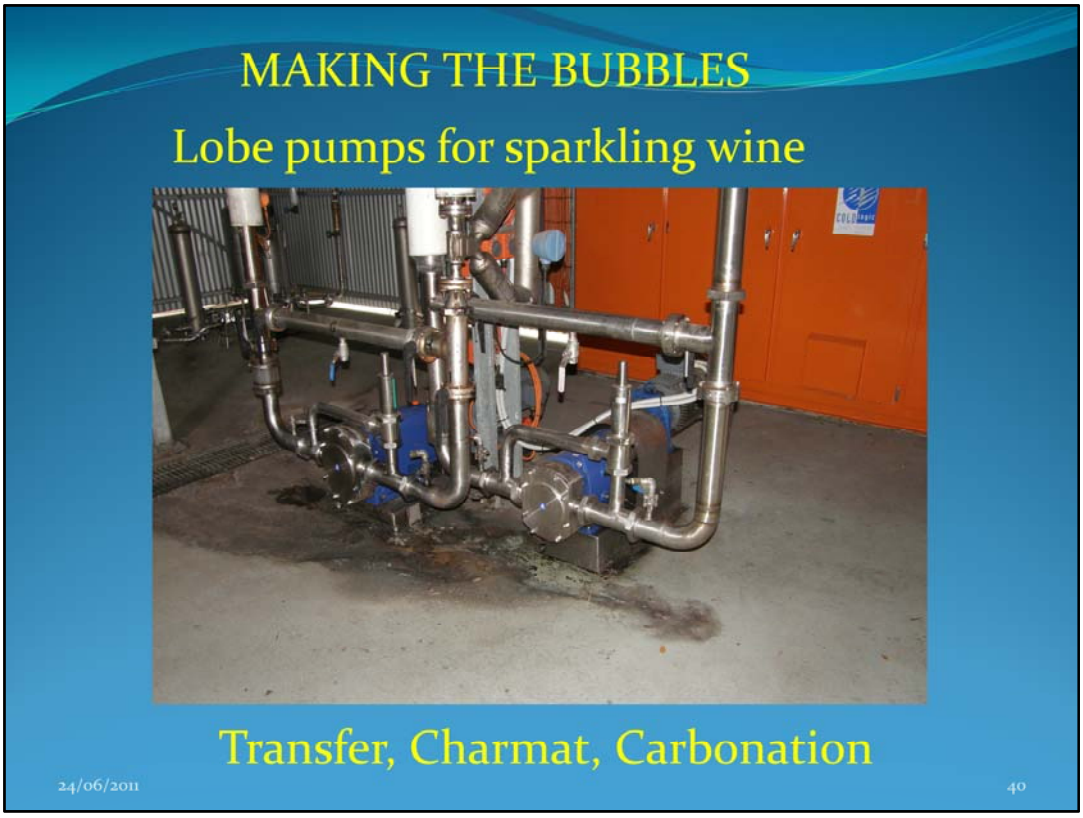
Pressure tank operations require a bulk CO2 facility for pre-gassing destination tanks to same pressure as the source tank.

Charmat is added to the bottom list now as pressure tanks are where the second ferment for these wines occurs rather than in bottles.

Carbonation is also added because the wines are stored here after they…….

……..are passed through a carbonator cold and under pressure to dissolve CO2 into the wine.

Carbonation consumes the most CO2 per litre of wine produced because none is produced by a second fermentation.



Traditional method sparkling wines do not need to be pumped anywhere, but the other types do.

Lobe pumps are the preferred types due to their low shear action on the product.

From pressure tanks, the wine is transferred to cross flow filters with head space connection to maintain pressures whilst the sparkling wine is filtered.

A ceramic element cross flow filter is shown.

Hermetically sealed centrifuge separators are also used to remove lees from Transfer and Charmat process wines.

After storage and treatment in pressure tanks, the bulk sparkling wines are filled into new bottles using counterpressure fillers.

Sparkling wines have special corks for the pressure and need a special corker, or special corker jaws for the table wine corker.

Note that we have all four method wines included now as Traditional method wines are corked straight after expedition liqueur dosing.

These days, some sparkling wines, as specified by the marketing package designers, are sealed with a crown cap as the final closure.

The corks go into the bottle one way so they must be orientated and fed to the corker that way.

Discs of solid cork on one end of the otherwise aglomerate cork are to go against the product. The orientator balances each cork on a knife edge and the cork falls toward the aglomerate end to be correctly fed into the corker.

The corks are held in by a muselet due to the 5.5 to 6.0 bar pressure.

The muselets are applied and tensioned in a wirer machine.

This slide shows a corker and wirer combination machine.

Another step after corking and wiring may be to use an AVE type mixer again to mix the expedition liqueur evenly throughout the bottle before labelling.

A lot of sparkling wine filling is done cold. The bottles then get wet with condensation making labelling difficult. This shows a bottle warmer to heat up the bottles for better labelling.

Foil capsules are more peculiar to sparkling wines. The slides shows a capsule dispenser placing foil capsules. This particular machine can place tin capsules and heat shrink capsules onto table wine bottles with the appropriate change parts fitted.

A capsule pleater follows to compress the foil capsule against the top of the bottle by creating four pleats and then folding and smoothing the pleats against the bottle.

Some pleaters feature bottle orientation to ensure that the pleats do not occur where some lettering is printed onto the capsule.

A capsule dispenser and pleater all in one unit.

After pleating the capsules, the bottles pass to labellers for body, back and neck labels, but these downstream machines are not necessarily peculiar to sparkling wine.

In summary the machinery list down the left side, and the methods that use them, show Transfer as requiring the most.

Other considerations covered during this presentation are:

Traditional Method requires:
- a temperature controlled cellar or warehouse for tirage or second fermentation
- no pressure tanks
- a space for remuage with an on point cool room
- no counter pressure filler, just a vacuum filler for tirage
- no bulk CO2 facility at all

Transfer Method requires:
- a temperature controlled cellar or warehouse for tirage or second fermentation
- no space for remuage but space and services for pressure tanks
- a bulk CO2 supply
- both a vacuum filler and a counterpressure filler

Charmat process requires:
- no tirage cellar
- pressure tanks and their infrastructure
- a counterpressure filler

Carbonation requires:
- pressure tanks and their infrastructure
- a carbonator
- a counterpressure filler

Whichever method is chosen, it is all about making plenty of these in the most cost effective way.

I wish to thank:

Ed Carr from Accolade for when we both worked together on the Seaview Cellar all those years ago,
Andrew Byles from Accolade, and Peter Policki from orlando, for sharing their sparkling wine facilites and processes, and
The bottling line people, especially those in the Tirage Room at Yalumba Angsaton,

….when I was preparing this talk.