Technical advances in cork processing

Presentation by António de Barros
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SLIDE 1 – TITLE

Good afternoon ladies and gentlemen, and thank you for coming.

The reason we are here today is to look at the progress Amorim is making towards achieving an assured supply of consistent highest quality corks for the wine industry.

In particular, I want to tell you about our efforts to date to eliminate the contaminants in cork that lead to wine taint, and what we hope to achieve in the near future.

I am not interested in debating whether the true incidence of taint is 2 per cent, five per cent or 10 per cent—I'm here to tell you what Amorim is doing to lower the incidence to close to zero.

It is now almost a year since I announced at the London International Wine Trade Fair that Amorim's highest priority was the elimination of TCA.

It remains our highest priority, but what have we achieved in the last 12 months?

In a moment I will show you details of changes we have made to our production processes and the preliminary results of tests on these new processes.

SLIDE 2 – WHAT HAS NOT CHANGED

But first, let me remind you what has <u>not</u> changed in the past year:

- Cork remains the best closure for wine. No synthetic product is yet able to match all of cork's attributes in terms of sealing the bottle, ease of extraction and contribution to ageing of the wine.

- Amorim buys the best raw materials available. With a rigorous trace-back system and 40 years of purchasing records, we are able to monitor cork quality within each property and ensure that only the best cork is used for our wine corks.

- Amorim seeks to stay closely in touch with the wine industry. With our developing worldwide network of wholly-owned distribution companies and a major commitment to communications and consultation, we are in a strong

position to understand what the industry requires and to customise our products to meet winemakers' specifications.

- Amorim invests heavily in R&D. We continue to invest around $US6 million a year into basic research and the development of new products. (That's over 10 million in Australian dollars, although given recent trends on the money markets it could be more by tomorrow!)

Now let us look at Amorim's new production process.

SLIDE 3 – ADVANCES AT EACH STAGE OF PRODUCTION

Amorim's philosophy is to avoid or eliminate contamination of cork at each step in the production chain. We start with the best quality cork, eliminate as many contaminants as possible at the outset, and then control the environment during subsequent phases to avoid the possibility of further contamination.

The reason for this approach is that TCA is sensorily such a powerful contaminant we do not believe there is an easy one-off solution you could apply at the end of the production process and completely destroy the compound *in situ*.

This flow chart summarises the processes that are being used now or are about to be installed at various Amorim plants around the world, including our new primary processing facility at Ponte de Sôr in the south of Portugal.

As the slide shows, the new process involves a new boiling system; stabilisation in a chamber with controlled humidity and ozone; mechanical processing, such as sorting, separating and punching; the INOS II processes for washing the discs used for Twin Top and SPARK corks; a cork washing stage that uses hydrogen peroxide; and final storage of finished corks in an atmosphere of ozone.

SLIDE 4 – SEASONING

Let's look at the production chain, one step at a time.

Our philosophy of prevention begins even before the bark enters the factory, with measures to minimise contact between the raw bark and the bare earth, where moulds can infect the cork.

Previously the bark was seasoned on the forest floor; now it is done in the factory yard.

The facility at Ponte de Sôr occupies 15 hectares, which gives us ample room to stack the bark during the seasoning stage on a sealed, well drained surface and on steel pallets.

Each batch of cork has a lot number, which gives us the ability to a trace a piece of bark back to the property where it was grown and to compare it with cork we obtained from that property up to 40 years ago.

SLIDE 5 – BOILING (OLD & NEW)—PHOTOGRAPH

The boiling stage has undergone dramatic change.

The old process, served to moisten the cork, clean it, flatten the curvature in the bark and make it workable for punching.

In contrast, the new boiling stage is a critical element in Amorim's approach to extracting contaminants.

Ponte de Sôr is currently processing about 20 tonnes of cork a day. When both plants are fully operational, they will process all of the cork that Amorim sources from within Portugal.

SLIDE 6 – BOILING II (OLD VS NEW)—SCHEMATIC

The old cast-iron boiling tanks processed the cork in 15-tonne batches, which restricted the circulation of water to the planks at the middle of the batch and so reduced the effectiveness of the boiler. It was also an unpumped and unfiltered process, and had uneven temperature distribution due to the method of heating.

The new stainless steel boiling tank holds just two tonnes of bark, which improves water circulation and boosts the extraction of contaminants and tannins.

The new process is dynamic: the water is pumped through the tank and passed through a filter to remove suspended solids. The entire volume of water in the tank is filtered every 20 minutes.

The water used in the new tanks is heated using a heat exchanger to ensure a consistent temperature throughout the process. (The furnace, incidentally, burns either cork dust or gas).

In addition to the filter, the new boiler also has a system known as a volatile compound trap (or V.C.T for short) for continuously removing volatile compounds dissolved in the washwater. More on this in a moment.

SLIDE 7 – GROUNDWATER

The water used in the boilers is high-quality, unchlorinated groundwater which is routinely tested by the independent laboratory CTCOR for the presence of

many chemicals, including organochlorines, chlorophenols, chloroanisoles and a long list of pesticides.

This slide shows that the water tested on this occasion contained little or no chlorine-based compounds.

SLIDE 8 – CONTINUOUS EXTRACTION OF VOLATILE COMPOUNDS (VCT PHOTO)

As I mentioned, the Ponte de Sôr plant has a system known as VCT that was developed by Amorim to remove volatile compounds from the washwater during the boiling stage.

This is a photograph of a prototype of the VCT unit operating on one of the four boiling tanks at Ponte de Sôr.

SLIDE 9 – CONTINUOUS EXTRACTION OF VOLATILE COMPOUNDS (VCT SCHEMATIC)

The unit uses a fast evaporative method to remove volatiles. Within the main chamber the hot washwater from the boiling tank is sprayed through nozzles to create a curtain of water just 0.4 mm thick.

Air is pumped through the chamber continuously.

Because the curtain of water has an enormous surface area, volatile compounds such as TCA in the water are quickly and efficiently evaporated out of the water, which then returns to the boiling tank.

Amorim has conducted preliminary research on the efficacy of the VCT to remove volatile compounds, including TCA.

In this test, a known concentration of 2,4,6-trichloroanisole (TCA) was injected into the inlet stream of the VCT – in this case, the concentration was 40 parts per trillion.

Samples taken from the outlet stream showed the concentration of TCA after 20 minutes (which is one cycle in a three-cycle boiling operation for each batch of corkwood) was just 0.5 parts per trillion.

SLIDE 10 – VCT TRIAL—TCA CUT BY 97 %

In fact this test showed that, after only 20 minutes, the VCT unit had removed 97 per cent of the TCA in the wastewater.

This leads us to believe that in the 60 minute boioling cycle, the removal of TCA would be further enhanced. The result gives us the confidence to believe we are on the right track to defeating TCA.

SLIDE 11 – SIGNIFICANT CUTS IN OTHER VOLATILE ORGANIC COMPOUNDS

Of course, TCA is not the only compound removed by the VCT.

Out of 21 volatile organic compounds detected in the washwater, five compounds disappeared altogether after 20 minutes.

The average reduction of all volatile organic compounds after 20 minutes was 67 per cent.

SLIDE 12 STABILISATION

Under the old process, cork was stored after boiling in a closed moist environment. This was an ideal environment for mould growth (a component in TCA formation).

In the new system, after boiling the bark processed at Ponte de Sôr is stored in a well ventilated chamber protected with ozone to prevent mould growth and further contamination.

A further stage is in development to replace what is known as the second boiling in the old production process.

The second boiling moistened the cork planks after a period of drying. However, to get exactly the correct moisture content, it was necessary to allow the planks to dry for a period, providing opportunity for moulds to grow.

The second boiling stage will be replaced with a chamber in which the planks are gradually brought back to the correct humidity in an atmosphere of ozone for protection. Under these conditions, the moisture level needed to make the cork workable can be achieved without allowing moulds to grow.

This new stabilisation chamber is still under development but we expect to see it in operation by June this year.

SLIDE 13 – THE INOS SYSTEM (PHOTO)

Following the separation, sorting and punching of the cork, some cork products are subjected to another process designed to clean the lenticels in the cork structure.

This is called INOS II, a process now in use for cork discs in several Amorim plants, including here at Amorim Cork Australia.

Some of you may already be familiar with the INOS II system for washing the natural cork discs used in Amorim's Twin Top and SPARK corks. If not, you will be able to see it here in the factory after this session.

We believe it is one of the most advanced processes for removing contaminants such as TCA from cork and ensuring that the cork that is in contact with the wine meets the highest possible standards.

It works this way.

SLIDE 14 – THE INOS SYSTEM (SCHEMATIC)

Purified water heated to 70°C is pumped into a stainless steel autoclave containing the discs.

As the pressure is increased and then reduced the lenticels contract and expand, causing them to completely fill with hot water and then empty—rather like squeezing a sponge under water.

The hot water and flushing action extract any contaminants that would otherwise be dissolved by the wine and affect its flavour.

At the end of the cycle, the water is removed from the autoclave, creating a vacuum, which extracts moisture and contaminants.

The cycle takes about 20 minutes and is repeated twice, with clean water used for each cycle.

SLIDE 15 – MICROSCOPIC ANALYSIS USED TO MONITOR CELL STRUCTURE

This process is quite vigorous, and so we carefully monitor the cell structure of the cork, using microscopic analysis, to ensure that the physical attributes of cork that are so beneficial—in particular, its resilience and impermeability—are not impaired.

The results of trials conducted by Amorim and 10 years' use in the production of our SPARK champagne corks give us confidence that this process is extremely effective in removing TCA and other volatile organic compounds from the cork discs.

SLIDE 16 – TANNIC ACID

One measure we use to test its effectiveness is the presence of tannic acid in the cork. Tannins contain phenols and other substances that can lead to the formation of TCA.

This diagram shows the results of High Press Liquid Chromatography analysis of tannic acid present in cork discs before and after the INOS II process. The area outlined in red measures the tannic acid before INOS II, the area in yellow after INOS II.

As you can see, in this test, the INOS II process reduced the tannins by almost half.

SLIDE 17 – BEFORE & AFTER INOS

Another series of tests measured the presence of individual volatile organic compounds, including TCA, before and after INOS II. All the other substances can lead to the formation of TCA in the right circumstances.

As this slide shows, the results are very encouraging, especially as they were conducted before the new boiling process was established.

For example:
- TCA was reduced from 18 nanograms per kilo—that is, parts per trillion— to 5 during the INOS II process. That's a reduction of 72 percent
- TCP was reduced from 16 parts per trillion to 7—down 56 percent
- and so on.

Overall, there was a significant percent reduction in volatile organic compounds during the INOS process.

With the introduction of the new boiling process and continuous volatile extraction, we expect the residual amounts of TCA and other volatile organic compounds to be reduced even further.

SLIDE 18 – OZONE TREATMENT

After mechanical processing, all corks are washed in a solution of hydrogen peroxide to disinfect them and whiten their appearance.

In line with the Code of Good Practice for the cork industry, it is has been some years since chlorine products were used to bleach corks.

Finally, at the Amorim & Irmãos plant in Portugal, at this plant here in Melbourne and at our plant in the Napa Valley, branded corks are stored for 24

hours in an ozone-enriched atmosphere to deodorise and protect the corks against microbiological contamination.

That basically summarises where Amorim is at the moment with its new production processes.

SLIDE 19 – USES OF OZONE

Now just a quick look at one area that is under active investigation.

Increasingly, ozone is being used in the wine industry to replace chemicals such as sulfur dioxide and potassium metabisulfate.

Because of the link between chlorinated products and TCA and because of ozone's powerful oxidising and disinfecting properties, Amorim is exploring the use of ozone at various stages in the production chain.

I have already mentioned the use of ozone in the stabilisation of cork planks and the treatment of finished corks. To that, we need to add the use of ozone in the treatment of washwaters, something we already do at Amorim.

In addition to these uses, we are conducting a number of trials in some of our factories, including Amorim Cork Australia, to establish how well ozone kills microorganisms and how well it eliminates contaminants in cork, including our least favourite compound, TCA.

SLIDE 20 – OZONE GENERATION

Ozone is a naturally-occurring form of oxygen which is typically made using an electrical discharge.

In nature, the gas is formed by the action of lightning or intense UV radiation on oxygen in the air. In industry, it is made using high-voltage plasma discharge units.

Ozone cannot be stored – it quickly combines with itself to form oxygen, so it has to be produced as it is needed.

In the past, ozone-making required large amounts of electricity but new technology has lowered the cost of production, making ozone competitive with traditional disinfectants and purifiers.

SLIDE 21 – OZONE AS AN OXIDANT

Ozone is a very powerful oxidant. It has 1.5 times the oxidising power of chlorine and it is especially effective at dismembering organic compounds.

This slide shows how the ozone molecule attacks the carbon rings in many organic molecules, breaking the double carbon bond and cleaving the ring.

In one of our early experiments, we bubbled ozonated air through a solution containing 15 parts per trillion TCA and found that, after 15 minutes, there was no TCA left. However, there is much work to be done yet before we can say what is happening and whether the process is effective against TCA.

SLIDE 22 – OZONE AS A DISINFECTANT

As a disinfectant, ozone acts very rapidly and effectively.

In these tests, conducted by Luengo and Casteastillo, water infected with E. coli was completely sterilised within 15 seconds, while water infected with Salmonella —a particular hardy and unpleasant bacterium—was completely sterilised within 20 minutes.

SLIDE 23 – EXPERIMENT 1

Amorim's new R&D department has begun a series of experiments looking at the effectiveness of ozone in disinfecting cork stoppers.

In this experiment, corks that were highly contaminated with microbes were quartered and then each quarter was either treated with ozone for 24 hours or not treated at all. (The reference in the slide to 2 hours is the time the corks were left after treatment to dispel residual ozone).

Each cork quarter was then analysed microbiologically. (The units being used here are colony-forming units or CPUs, which is a standard method for measuring the microbiological concentration in a sample.)

The result was that all the untreated cork quarters displayed high rates of contamination – over 50 CPUs per millilitre, whereas the majority of the treated cork quarters displayed levels below 10 CPUs per ml – which is very clean.

SLIDE 24 – EXPERIMENT 2

Then, of course, is the question of how effective ozone is in disinfecting whole corks.

In this experiment, untreated corks were contaminated over a range of values, centred on 30-40 CPUs per ml, whereas the treated corks were, once again, chiefly under 10 CPUs per ml.

The result was even more pronounced when we analysed the core of each cork. The untreated cork cores showed a very high level of contamination, whereas almost all of the treated cores displayed less than 20 CPUs per ml, and most were below 10 CPUs.

At this early stage, the results of the ozone research are very encouraging but the process remains to be proven at a commercial level.

SLIDE 25 – NEW PRODUCTION PROCESS

So, to recap on what we have seen so far:

Amorim is pursuing quality improvements at every stage of the production process, primarily to fulfill its commitment to eradicate cork contaminants.

To achieve its aim, Amorim has substantially remodeled the production process, incorporating a new boiling stage, introduced new steps to control mould growth and to thoroughly clean and disinfect our cork products.

We are building new plants in Portugal, which will eventually process all our Portuguese-sourced cork for wine stoppers, and we are trailing new techniques using ozone to disinfect corks and destroy organic contaminants.

The early results—and I stress, early results—of this enormous effort are very promising indeed.

I would love to say to you that we have beaten the TCA problem but I cannot at this stage. I can only say it appears we are on the right track and the prospects are very good.

SLIDE 26 – R&D SUMMARY TABLE

We believe we have made good progress in achieving our R&D objectives over the last 12 months, principal of which is the elimination of TCA.

With the developments I have described, most of the projects we announced 12 months ago have been achieved

- the new boiling process
- use of ozone for microbiological control

Other developments, such as rehumidification in a microbiologically controlled environment using ozone, are due to come on stream soon.

We are making steady progress in applying the INOS II system to natural corks. We are now using it with the small natural corks used in bar top corks. Once this process is proven on an industrial scale, we plan to extend it to other natural corks.

Our project for single unit colmatage is aimed at improving the quality of colmated corks. It is now being tested on an industrial scale and is progressing very well. We have set a target of September 2000 for its introduction.

To recap, we are making good progress on an ambitious R&D agenda.

But we are not resting there. We know that 98 or 99 percent of our corks perform extremely well in the bottle, but we won't rest until the remaining 1 or 2 percent perform to the same high standards.

SLIDE 27 – FOCUS OF INTERNAL R&D PROGRAM
That is why we established a dedicated R&D department late last year, comprising a microbiologist, chemist and an oenologist. They will add a strong winemaker perspective to our existing cork research capabilities.

Their main tasks will be to identify and solve problems in the cork production chain and test and support the development of new products and processes.

In this they will work very closely with our quality assurance and product development department.

Their priorities for the first year are:

- Development of a comprehensive database of all the scientific literature on cork, its problems and performance – to give us a thorough understanding of current issues and relevant developments
- Scientific validation of all existing processes and of new products and processes. We want firm scientific evidence to show that these processes produce the results we want on an industrial scale
- Development of a code of practice to advise wine makers and bottlers on correct corking procedures – to minimise the risk of closure-related problems once the product leaves our factory
- Cork flavours. We are using HACCP – that is, hazard analysis and critical control point – techniques to identify and eliminate critical risks in the cork production and distribution chain.

  Three areas are under investigation—the forest, the production process, and environmental contamination during transport and storage.

  The R&D team will research new technologies that can be applied to each critical area of risk.

- Finally, to assist in our quality assurance procedures, we are establishing an expert sensory panel that will establish and apply new standards for sensory analysis throughout the Amorim Group.

SLIDE 28-9 – COLLABORATIVE RESEARCH

So Amorim is making a very significant investment internally. The R&D department is also collaborating with a number of scientific research institutions around the world on a range of joint projects.

SLIDE 30 CONCLUSION

To conclude, let me say this:

Recently, problems have begun to emerge with synthetic closures and I expect you will hear more of these in the coming months.

Amorim is not comforted by the problems being encountered with plastics. They do not let us off the hook. The wine industry has said it wants to stay with cork but that we must improve its technical performance. We agree.

In the past, Amorim has emphasised repeatedly its commitment to the wine industry and to meeting winemakers' needs for consistent high-quality cork.

These were not just fine words. This company doesn't work that way.

I hope you would agree after today that Amorim is working hard to deal with the concerns of Australian winemakers and that our efforts are now beginning to bear fruit.

And we remain committed to dealing with any new problems as they emerge.

Thank you for your time.

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