EARTH LISTENER

Focus

Wine materials: concrete

The use of uncoated "natural" concrete tanks, and its effects in winemaking and wine refining

Research and development Wine consultancy

Abstract

The last few years have seen in the cellars of the whole world the return of a material that in the 50s and 60s of the last century was the undisputed king of oenological tanks: **concrete**.

Today the increasing demand, moved primarily by organic and biodynamic companies (but not only), is to have tanks in “natural” concrete not coated with epoxy resins, capable of enhancing the quality of the wines and at the same time resulting in inert against possible cession to wine during winemaking and storage. The choice to prefer the tanks in “natural concrete” over vitrified ones has always been based on personal experience rather than on the result of real scientific research.

From these assumptions, our **Research and Development department,** in collaboration with the concrete tank manufacturer *Nico Velo*, has launched a study focused on the following aspects:
– evaluation of **possible cation transfer in wine** by cement subjected to different degrees of surface finishing and different mixing of cementitious compounds;
– the **role of the correct internal passivation procedure** of the cement tank with tartaric acid solutions;
– evaluation of the **differences** between passivated “natural concrete”, vitrified concrete and steel tests **on the chemical and sensorial evolution of wine**.

Below there is the complete technical focus with the article “The new life of concrete” published in the number 2 of March of the magazine VVQ Vigne, Vini & Qualità.

EARTH LISTENER

“THE NEW LIFE OF CONCRETE”

Article published in the n° 2 of March of the Magazine VVQ Vigne, Vini e Qualità

Federico Giotto
Fabrizio Minute
GiottoConsulting

The last few years have seen in the cellars of the whole world the return of a material that in the 50s and 60s of the last century was the undisputed king of oenological tanks: concrete.

Despite the undoubted qualities, such as mechanical resistance, good thermal inertia and poor electrical conductivity, the concrete tanks were progressively abandoned by winemakers and replaced by stainless steel tanks for their easier sanitization and above all because concrete conglomerates, if not properly treated, could compromise the stability and quality of the wine following conspicuous cation sales, in particular of calcium and iron.

However, many winemakers have never stopped using cement, suitably treated or coated with epoxy resins, as it is considered superior to steel especially in the prolonged storage of wines, which tend to remain more intact and less prone to redox phenomena.

Today the increasing demand, moved primarily by organic and biodynamic companies (but not only), is to have tanks in "natural" concrete not coated with epoxy resins, capable of enhancing the quality of the wines and at the same time resulting in inert against possible transfers to wine during vinification and storage.

Natural or vitrified concrete

The reasons that lead many producers to prefer tanks in "natural concrete" over "vitrified" ones, despite the possible problems mentioned above, have always been the result of a personal experience rather than the result of a true scientific research. Starting from these assumptions, the Research and Development department of the consulting firm GiottoConsulting, in collaboration with the leading company in the production of concrete tanks Nico Velo, started a research activity that would allow a use aware of cement in modern enology. In particular, the study focused on the following aspects:

• evaluation of the possible transfer of cations to wine by concrete subjected to different grades of surface finishing and different mixing of cementitious compounds;

• the role of the correct internal passivation procedure of the concrete tank with tartaric acid solutions;

• evaluation of the differences between passivated "natural concrete", vitrified concrete and stainless steel test on the chemical and sensorial evolution of a wine.

Materials and methods

Comparison of transfers of various cementitious mixtures and the role of passivation

The characterization tests of the metal supplies were carried out using cubes (10x10 cm) of different concrete mixtures, object of study by Nico Velo, immersed in a known volume of wine red in order to maximize the cement surface / wine volume ratio, compared to what would occur under normal operating conditions. The cubes were then passivated with a solution of tartaric acid so as to make the calcium insoluble, with relative formation of calcium tartrate on the surface. The passivation protocol was defined by studying the various execution variables such as: concrete humidity, tartaric acid dosages for surface and application methods. The certainty of the success of the treatment was tested by determining the pH of the solution of water and tartaric acid and by analyzing the rinsing water. To avoid possible external contamination, all the tests were performed using non-toxic containers suitable for food contact. Periodically the samples to be used for the chemical analysis of the main analytical parameters of the wine (FTIR analysis) and for the screening of metals by ICP (*Inductively coupled plasma*) were taken.

Vinification and storage tests

Following the analysis carried out on the cubes in laboratory conditions, winemaking and storage tests were carried out on wine in vitrified cement tanks and "natural cement" passivated at l'Azienda Agricola Corte Sant'Alda, in Mezzane di Sotto (VR). In detail, 3000 kg of grapes used to give Amarone della Valpolicella were vinified separately in two pyramidal concrete tanks coated with epoxy resins and in two pyramidal tanks in natural passivated cement, with a capacity of 750 l. The winemaking technique adopted was the same for each type of container (number of pumping over, pumping over time, etc.), in order to standardize operations and eliminate potential sources of differentiation. When the fermentation was completed, the four masses were drawn off and two masses were created, respectively of vinification in tanks inerted with epoxy resins and vinification in passivated natural concrete tanks. From the two new masses created, representative of the two theses, the samples to be used for chemical analysis (FTIR analysis) were periodically taken. Part of the mass has also been vinified in a 10 hl steel tank and used as a test. The possible effect of micro-oxygenation of the wine was assessed by the Nomasense O2 P6000 analyzer. After 9 months of storage, to complete the test, a sensorial analysis was carried out comparing the three masses of wine using a tasting panel.

Results

Comparison of metal transfers of various cementitious mixtures tested.

The migration tests carried out using different cement mixtures have shown in all cases more or less marked transfers of cations in wine, with the exception of iron which shows a decrease over time probably due to precipitation phenomena. As shown in Figure 1, the composition of the mixture and the degree of surface finish of the cement can have a considerable influence on the extent of the transfers. This preliminary study allowed us to identify the most suitable mixture for contact with wine, and in which passivation with tartaric acid was more effective. Once identified, the cement mixture was sent to two certification institutes to test its suitability for contact with food. Today this cement mixture has obtained the certificates of suitability for food contact both from the Excell Vert laboratories in France and meet the requirements of FDA (Food and Drug Administration) for the United States.

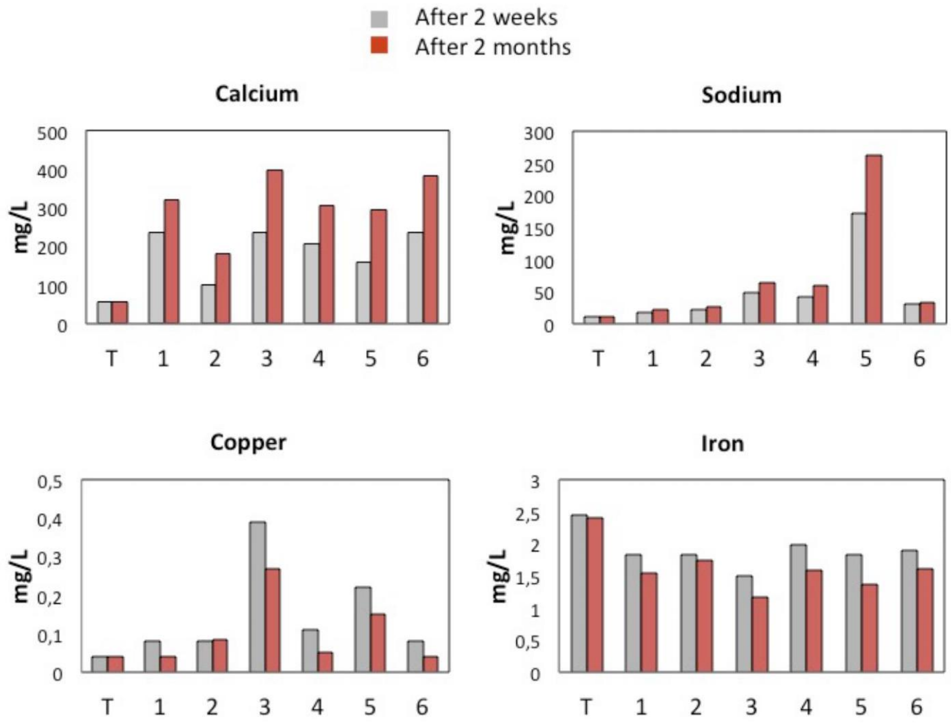

FIG.1 – Transfer of calcium, sodium, copper and iron of six different cement mixtures (1-6) after 2 weeks and after 2 months of contact with a red wine. T = wine test

The importance of correct passivation

In order to avoid cession to the wine, it becomes therefore fundamental to passivate the walls of the tank with tartaric acid before its use and possibly in case of washing for tartaric salts removal. Also in this case, various tests were carried out aimed at developing a passivation protocol that would guarantee the effectiveness of the treatment. The wine in contact with the passivated cement cube presents, after two weeks, pH values and total acidity very similar to those of the witness wine, demonstrating that the passivation technique using concentrated tartaric acid solutions, if performed correctly , is a valid tool for controlling the transfer of metals (Table 1). This data is also confirmed by the analysis of the cations carried out by evaluating the transfers over a five-month period (Table 2). Also in this case the concentration of cations found in the wine in contact with the passivated cement is completely similar to that of the test wine.

PARAMETERS	*u.m.*	TEST	NON-PASSIVATED	PASSIVATED
Density	a 20°C	0,994	0,994	0,994
Total Alcohol	% vol a 20°C	12,40	12,33	12,39
Actual Alcohol	% vol a 20°C	12,38	12,32	12,37
Glucose + fructose	g/l	0,36	0,22	0,37
Reducing substance	g/l	3,03	2,28	3,02
Total dry extract	g/l	27,04	26,97	27,23
Non reducing dry extract	g/l	27,40	27,19	27,60
Net dry extract	g/l	25,37	25,91	25,58
TA	g/l	4,95	3,39	4,80
pH	g/l	3,59	4,00	3,65
VA	g/l	0,43	0,44	0,44
Malic Acid	g/l	0,13	0,53	0,18
Lactic Acid	g/l	1,65	1,83	1,63
Tartaric Acid	g/l	1,88	0,52	1,74
Glycerine	g/l	7,85	7,54	7,84

Table 1. Analytical values of the test wine and of the red wine in contact for two weeks with natural passivated concrete and natural non-passivated concrete cubes.

				TEST			NON-PASSIVATED CONCRETE			PASSIVATED CONCRETE		
PARAMETERS	u.m.	L.o.D.	L.o.Q.	15 days	2 months	5 months	15 days	2 months	5 months	15 days	2 months	5 months
Aluminium	ug/l	30	100	429,0	424,0	455,0	1262,0	1293,0	1410,0	511,0	528,0	521,0
Silver	ug/l	0,7	2	2,3	2,3	2,4	6,9	10,1	15,6	2,4	2,7	2,7
Arsenic	ug/l	5	15	N.D.	0,0	N.D.	N.D.	0,0	N.D.	N.D.	0,0	N.D.
Boron	mg/l	0,3	1	5,7	5,4	5,5	5,5	5,1	5,6	5,1	5,4	5,5
Barium	ug/l	3	10	73,0	69,0	63,0	56,0	46,0	40,0	74,0	73,0	77,0
Beryllium	ug/l	2	5	N.D.	0,0	N.D.	N.D.	0,0	N.D.	N.D.	0,0	N.D.
Calcium	mg/l	5	15	67,4	66,7	70,6	100,0	180,0	250,0	71,7	87,2	87,1
Cadmiim	ug/l	2	5	N.D.	0,0	N.D.	N.D.	0,0	N.D.	N.D.	0,0	N.D.
Cobalt	ug/l	2	5	4,6	3,4	3,3	9,9	11,1	18,8	3,6	3,6	3,3
Chrome	ug/l	2	5	19,6	18,5	20,2	34,6	33,6	39,8	18,5	19,4	19,7
Copper	mg/l	0,02	0,05	0,04	0,04	0,04	0,08	0,04	0,04	0,05	0,04	0,04
Iron	mg/l	0,07	0,2	2,4	2,4	2,4	1,8	1,6	1,4	2,4	2,4	2,6
Gallium	ug/l	2	5	7,2	7,5	7,1	7,3	7,8	8,4	7,4	7,9	6,9
Germanium	ug/l	0,7	2	N.D.	0,0	N.D.	N.D.	0,0	N.D.	N.D.	0,0	N.D.
Indium	ug/l	2	5	10,1	10,8	10,5	17,6	17,9	20,8	10,4	10,7	11,4
Potassium	mg/l	70	200	1244,0	1178,0	1220,0	1225,0	1114,0	1258,0	1212,0	1181,0	1271,0
Lithium	ug/l	2	5	11,2	11,0	11,2	34,5	44,8	68,9	11,9	18,0	18,6
Magnesium	mg/l	5	15	103,0	104,0	105,0	109,0	111,0	124,0	100,0	100,0	109,0
Manganese	mg/l	0,02	0,05	1,7	1,6	1,6	1,7	1,7	1,8	1,6	1,6	1,7
Sodium	mg/l	2	5	11,0	11,0	15,0	18,0	21,0	35,0	14,0	16,0	18,0
Lead	ug/l	5	15	25,0	26,0	29,0	24,0	25,0	27,0	28,0	21,0	20,0
Rubidium	mg/l	0,3	1	5,2	4,6	4,2	5,2	4,8	4,4	4,7	4,6	4,3
Sulfur	mg/l	10	30	438,0	370,0	247,0	425,0	349,0	270,0	512,0	444,0	252,0
Silicon	mg/l	0,3	1	11,2	10,5	10,3	24,5	28,5	35,8	10,8	11,2	11,4
Strontium	ug/l	7	20	709,0	690,0	672,0	855,0	878,0	986,0	710,0	720,0	737,0
Titanium	ug/l	0,7	2	16,1	16,1	16,2	214,2	216,3	220,9	16,4	18,0	18,5
Thallium	ug/l	2	5	23,0	22,8	22,5	23,6	23,7	24,2	24,1	21,6	22,4
Vanadium	ug/l	2	5	10,6	7,7	7,5	23,2	23,4	23,7	11,4	8,2	8,4
Zinc	mg/l	0,02	0,05	0,6	0,6	0,9	0,5	0,6	0,6	0,6	0,6	0,9

Table 2. Transfer of metals from passivated and non-passivated cement cubes after 2 weeks, 2 and 5 months of contact with a wine.

Chemical and sensorial evolution: comparison between steel, vitrified cement and natural passivated cement

As witnessed by various producers, one of the main advantages of concrete tanks lies in the absence of the reductive effect typical of many vinifications carried out in stainless steel tanks, with wines characterized by greater integrity of the fruity notes. In this work we wanted to extend the comparison by going to evaluate the differences existing between tanks in passivated cement with tartaric acid and tanks in vitrified cement. Also in this case, the pH and acidity differences found during the drawing off are minimal and due to the different malolactic fermentation pattern (Table 3). The analyzes performed after 9 months of storage and with completed malolactic fermentation (Table 4) confirm that there are no significant differences in the wines stored in the different tanks.

VINIFICATION TESTS

PARAMETERS	*u.m.*	STEEL	VITRIFIED CONCRETE	NON-VITRIFIED PASSIVATED CONCRETE
Denisty	a 20°C	0,9912	0,9912	0,9912
Total Alcohol	% vol a 20°C	15,95	15,86	15,99
Actual alcohol	% vol a 20°C	15,87	15,62	15,83
Glucose + fructose	g/l	1,35	3,98	2,60
Reducing substance	g/l	2,84	5,09	3,97
Total dry extract	g/l	26,6	28,9	27,9
Non reducing dryl extract	g/l	25,2	24,9	25,3
Net dry extract	g/l	26,21	25,87	26,25
TA	g/l	4,91	4,67	4,98
pH	g/l	3,48	3,49	3,42
VA	g/l	0,41	0,47	0,47
Malic Acid	g/l	0,92	0,72	0,82
Lactic Acid	g/l	0,3	0,34	0,27
Tartaric Acid	g/l	1,39	1,58	1,74
Glycerine	g/l	10,63	9,89	10,14

Table 3. FTIR analysis of Amarone wine vinified in steel, vitrified concrete and passivated concrete with tartaric acid. In the non-vitrified thesis, the slight increase in tartaric acid and therefore the titratable acidity of the wine is probably attributable to a remainder of non-salified tartaric acid inside the tank after its reclamation.

STORAGE TESTS

PARAMETERS	*u.m.*	VITRIFIED CONCRETE	NON-VITRIFIED PASSIVATED CONCRETE
Relative Density 20°C/20°C		0,991	0,991
Total alcoholic strength by volume	% vol a 20°C	15,91	15,79
Actual Alcohol	% vol a 20°C	15,81	15,68
Glucose + fructose	g/l	1,68	1,79
Reducing substance	g/l	3,04	3,01
Total dry extract	g/l	26,8	27,3
Non-reducing dry extract	g/l	25,1	25,5
Net dry extract	g/l	26,9	26,52
TA	g/l	4,07	4,12
pH	g/l	3,57	3,60
VA	g/l	0,64	0,67
Malic Acid	g/l	< 0,20	< 0,20
Lactic Acid	g/l	0,99	0,95
Tartaric Acid	g/l	1,60	1,81
Glycerine	g/l	10,04	9,88

Tab. 4 - FTIR analysis after 9 months of storage of Amarone wine in glass-lined cement and tartaric acid passivated cement.

During this period the content of dissolved oxygen in the various containers was periodically analyzed, but there were no significant differences probably due to the small size of the containers. In this regard, other tests are already underway aimed at testing the oxygen porosity of these materials through more specific tests, as well as evaluating the phenolic evolution in wines by comparing cement also with other materials such as ceramic and wood materials. If from a purely analytical point of view the chemical evolution of the wines is the same, from the sensory point of view more substantial differences have been found (Figure 2). Differences that, for this type of wine, have definitely rewarded non-vitrified cement compared to steel and cement internally coated with epoxy resins.

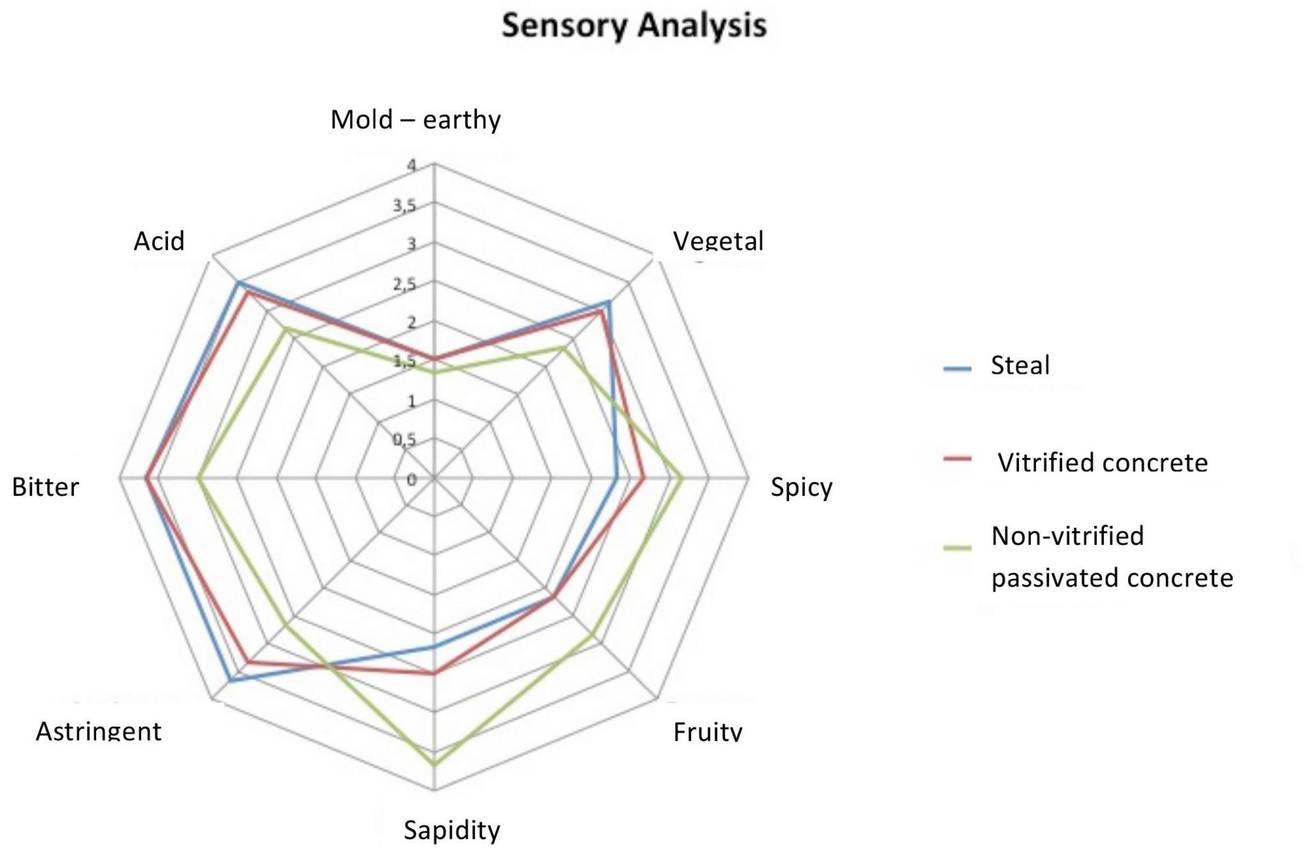

Fig. 2 - Results of the panel test carried out on wines capable of giving Amarone after 9 months of storage in three different tanks (steel, vitrified cement and passivated “natural” cement).

Conclusions

The attention of many wine producers, thanks also to the intense research activity promoted by manufacturers of concrete tanks such as Nico Velo, is making it possible to reaffirm themselves on the market of cement tanks characterized by the qualities recognized by the most attentive producers, without the limitations that had led to its abandonment in favor of steel in the early 1980s. Through a careful selection of the starting cement material, in particular the internal one used for contact with the wine, and with careful passivation, the transfers of metals are to be considered negligible as well as the original composition of the wine remains unchanged. However, research has shown that different materials significantly affect the organoleptic qualities of the product and that uncoated "natural" cement can be a very interesting material for the vinification and refining of many wines. It will be the winemaker's duty to go and choose the most suitable material for the exaltation of one's own vine and terroir.

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