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OXYGEN PERMEABLE WINE TANKS

Winery Engineering Association
National Conference, 2008
"Improving Winery Performance"

HDPE Maturation Vessels; Australian & International Trial Updates

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Refresher; Barrels, Oxygen & Wine Maturation

- Closed, full barrels diffuse O_2 into wine at a restricted rate, a lot slower than the wine could otherwise "use it up"
- This "oxygen starved" environment promotes beneficial rather than harmful chemical reactions, acting preferentially on wine & oak phenolic compounds & anthocyanins
- These complex, slow, sequential oxidation, polymerisation & condensation reactions soften "harshness" & tannins, aid the development of wine stability & colour, remove/reduce sulfides, add complexity to flavour & aroma
- HDPE vessels are O_2 permeable and simulate the natural, in-barrel, passive oxygenation process at rates typical of 2nd to 3rd fill barriques
- These vessels typically do not evaporate liquid components nor lose flavour & aroma volatiles

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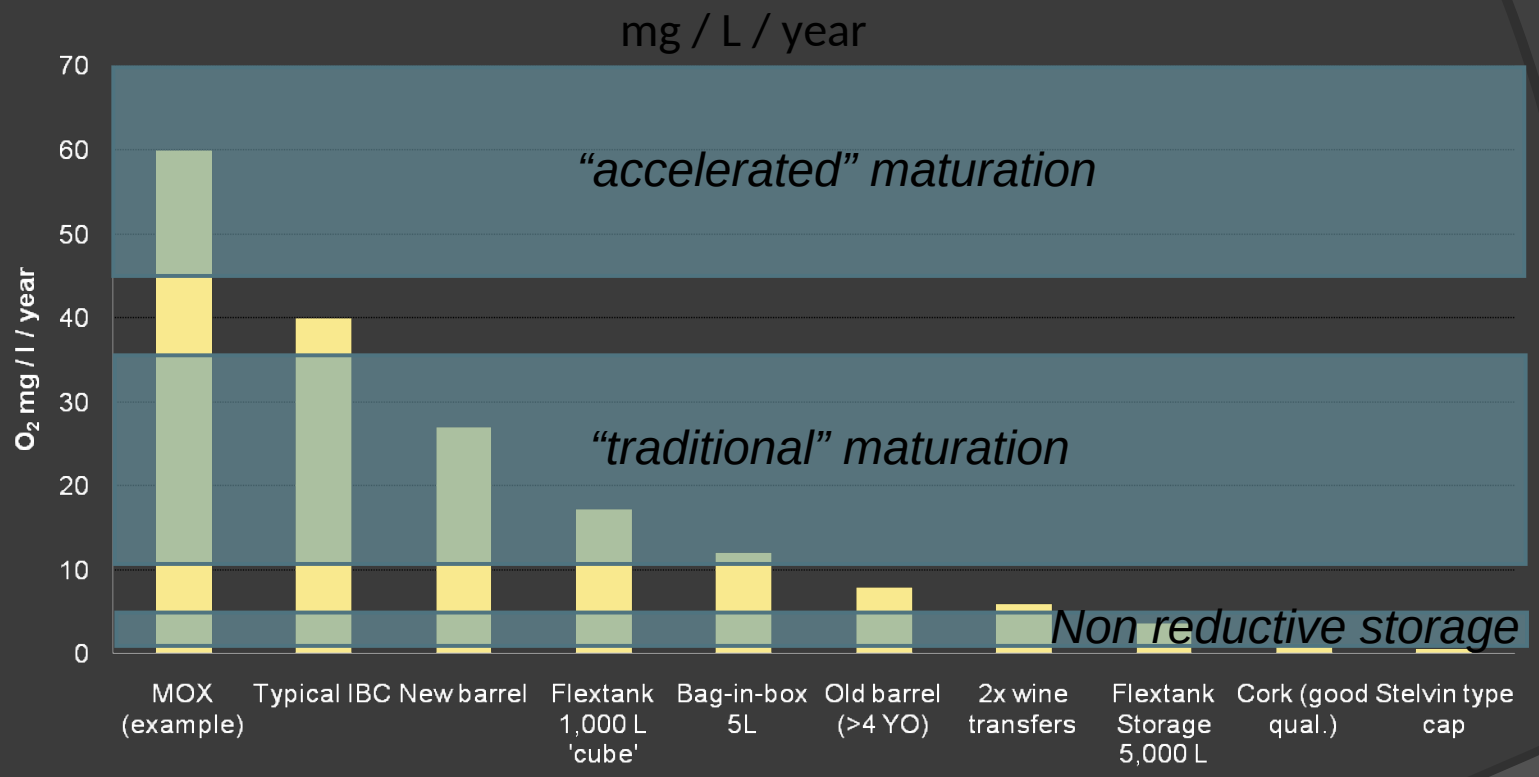
Oxygen Uptake in Wine Storage



Sources: Ribereau-Gayon, Moutounet et al, AWRI, Flextank

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Traditional Polyethylene Vessels Unsuitable for storing wine:

Poly Drums and IBC's are :

- too thin walled for their volume, i.e. too oxidative - wine spoils relatively quickly
- unsuitable shapes, i.e. have ullage traps
- difficult to clean internally, small openings
- incorrect material types and grades
- incorrect way of making - extrusion blow moulding 'overworks' polymer - 'burnt wax' taint common

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Flextank HDPE Vessels, engineered to mature wine:

Oxygen take-up (all sizes) ~17.3 mg/L/yr, and can be varied to suit wine type or maturation requirements

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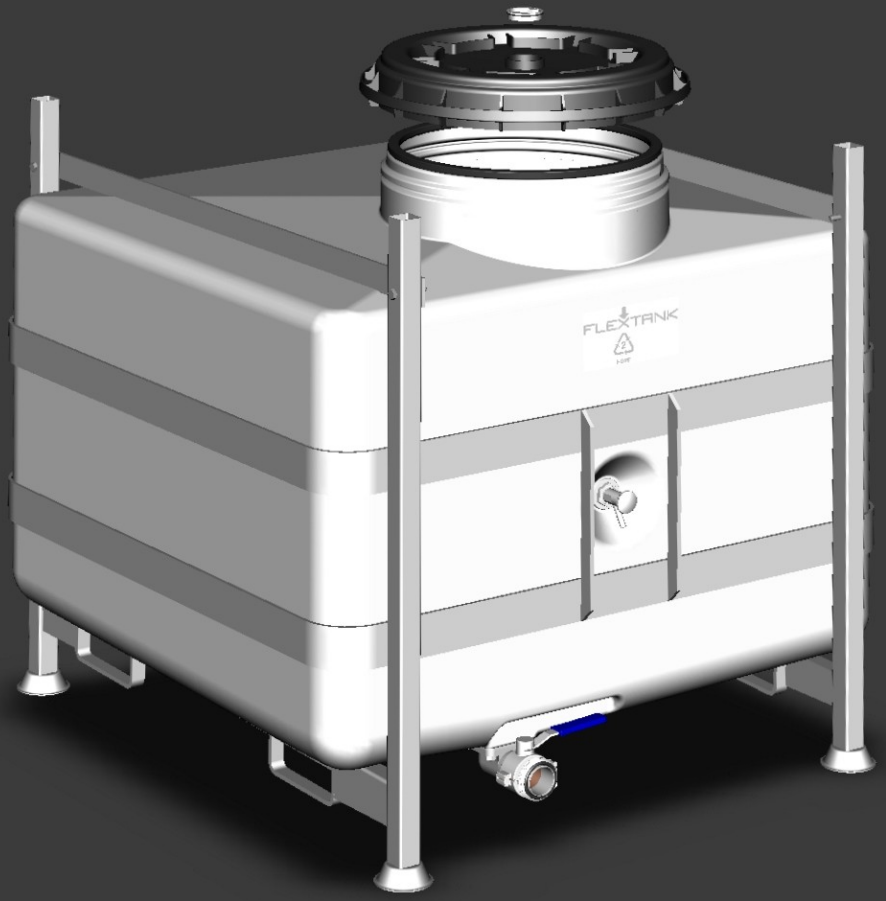
Flextank - 1,000 L Maturation 'Cubes' are:



- completely taint-free
- self-draining & ullage free
- can be tipped to remove solids
- accessible & easy to clean inside
- hygienic and sterilizable
- do not require topping
- stack 4 high, more than doubling cellar capacity
- can be transported full
- easily fitted with oak planks
- long-lived & non-corrodible

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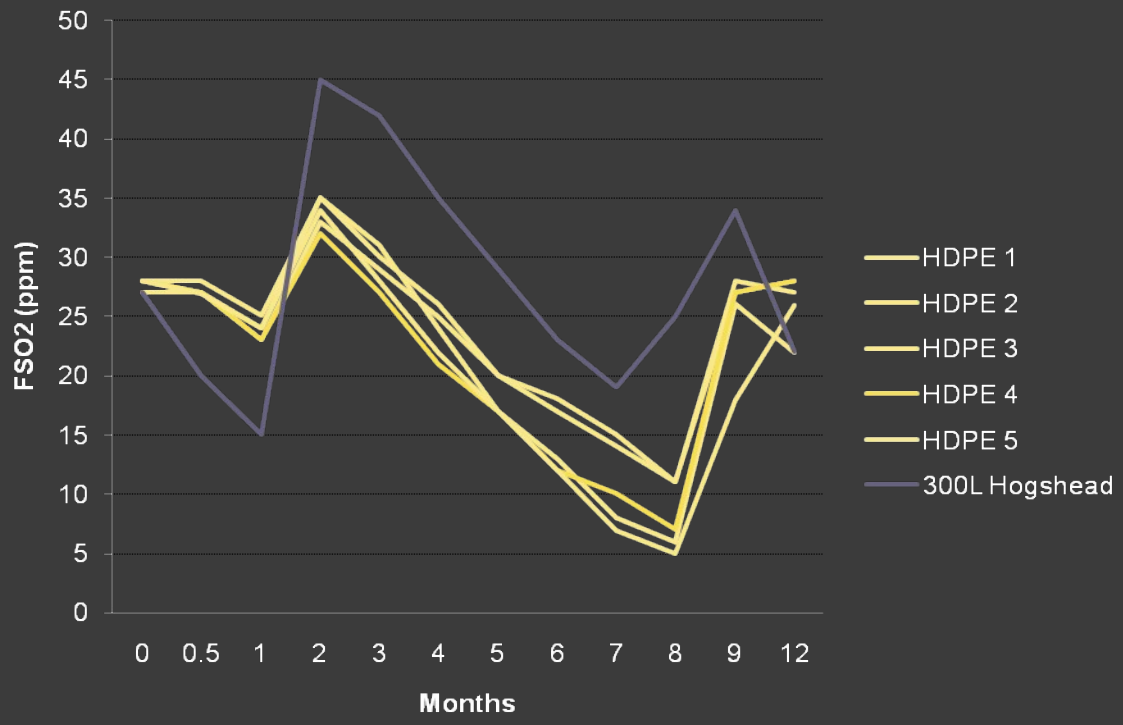
Chemistry during maturation in HDPE: FSO_2



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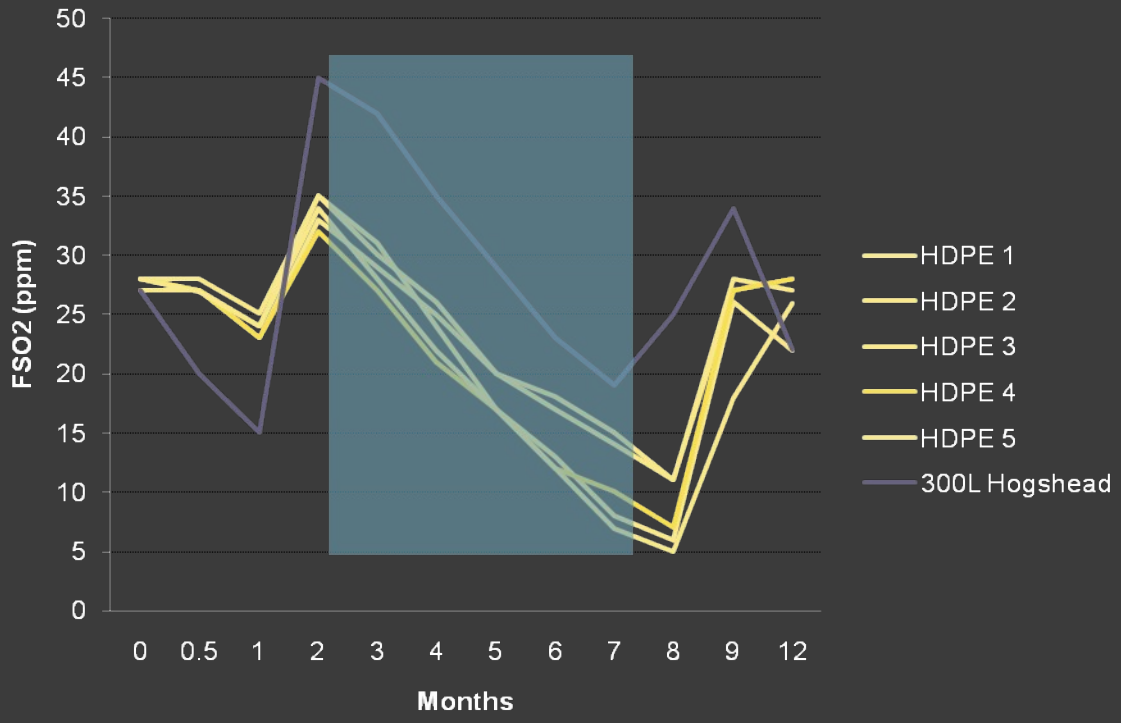
Chemistry during maturation in HDPE: FSO_2



Slope of FSO_2 decline in barrel and HDPE is effectively identical. Theoretical O_2 permeability calculations for the HDPE vessels are in fact correct, and are the same as the 1st fill hogshead permeability

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Chemistry: VA, sulphides and aromatic compounds

	Volatile Acidity	H_2S	FDMS
HDPE 1	0.41	2	10
HDPE 2	0.6	2	9
HDPE 3	0.41	2	8
HDPE 4	0.39	3	10
HDPE 5	0.41	2	9
300L Hogshead	0.57	3	6

VA, H_2S and FDMS in barrel and HDPE are very similar

Anecdotal evidence suggests HDPE retains volatile aromatic compounds to a significantly higher degree than barrel

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EXAMPLE
WINE
TRIALS

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Wine: 3x Shiraz 2007 (2x $40 rrp, 1x $15 rrp)

Trial type: Maturation

Time Period: 7 months

Replicates: Barrel (2nd fill French oak hogsheads)
5kl oak foudre
HDPE with oak staves
Stakvat
Stainless steel (staves?)

Tastings: 5 Winemakers, blind, scored 1-4 least-most preferred, max poss 20 pts

Results: Trial 1 $15 rrp shiraz; HDPE 18, stainless steel 14, barrels 13.
Trial 2 $40 rrp shiraz #1; HDPE 18, stackvat 17, barrels 9, stainless steel 6 .
Trial 3 $40 rrp shiraz #2; HDPE 16, barrels 14, foudre 11, stackvat 9

Comment:

This trial is notable for the performance of the HDPE with high value wine. Note that while Stakvat performed well in at least one trial, it's cost per litre did not suggest it as an economic choice compared to HDPE

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Wine:		Shiraz 2008
Trial type:		Fermentation (from near-end-of-ferment) & maturation
Time Period:	4 months	
Replicates:	Barrel (2nd fill Francois Freres barrique)	
		HDPE with oak staves
		Stainless steel (no staves)
Tastings:		5 Winemakers, blind, allocation tasting, Aust. wine show system scoring
Results:		HDPE "gold", barrel "silver", stainless steel "bronze". HDPE wine had deeper colour, improved palate weight and enhanced fruit flavours

Comment:

This was the 2nd year of HDPE trials for this winery and HDPE achieved an even higher quality result than previous year - where the HDPE wine was rated as "equal to barrel". Skill and experience in selecting the right oak staves and using them along with further experience with the HDPE vessels appears to be an important factor in achieving high wine quality

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Wine:	Cabernet Sauvignon 2007
Trial type:	Maturation
Time Period:	8 months
Replicates:	Barrel (barrique)
	HDPE with oak staves
Tastings:	5 Winemakers, blind, allocation tasting, multiple tastings over 2 days
Results:	HDPE wines “blew away” barrels, aromatics really different

Comment:

Winemakers have regularly identified HDPE wines as having “greater fruit...fresher...more typicity” than wines matured in barrel. This is usually combined with similar oak flavour / tannin / structure from oak staves, coupled with similar development and softness from polymerisation of tannins and phenols as seen in barrel and has often been so noticeable that HDPE wines have been preferred over barrel for this reason. Similarly to the previous trial, this winery has extensive experience with oak adjuncts and high confidence in handling them to achieve outstanding results

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Wine: Cabernet Dorsa 2007 (Cabernet Sauvignon x Dornfelder)

Trial type: Maturation

Time Period: 5 months

Replicates: 2x Barrel (3rd fill, 1x with additional oak chips and 1x w/o)

3x HDPE (2x different sizes w/o oak chips, 1x with oak chips)

4x Stainless steel (1x plain, 1x MOX @ 3mg/L/month, 1x plain with oak chips, 1x oak chips & MOX)

Tastings: Monthly, multiple winemakers, not blind

Results: Only broad inferences should be drawn at this preliminary stage. The O_2 wines (barrel, MOX & HDPE) all performed better than the non-oxygenated control wines in stainless steel

Comment:

This trial was run at a German State Govt run wine teaching school .Cabernet Dorsa is deeply coloured and quite tannic, and was deliberately chosen to highlight the impact of oxygen. Wine will be bottled in 4 weeks and formally assessed at regional winemaker forums. Legal use of oak chips and adjuncts is very new in Europe (last 12 months)

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Wine: Gamaret 2007 *(gamay beaujolais [red] x reichensteiner [white])*

Trial type: Maturation

Time Period: 5 months

Replicates: Barrel (2nd fill Vicard barrique, ex Ch. Lynch-Bages)

HDPE (no oak staves)

Stainless steel (no staves)

Tastings: 2 Winemakers, not blind

Results: HDPE wine soft, integrated and "complete", structurally similar to the barrel although the barrel had more advanced colour (seen as a negative) and was dominated by oak flavours. S/S was "hard, tight, not developed, with less richness" - almost thin by comparison

Comment:

Switzerland. This was a surprisingly unambiguous tasting result although note that it was not conducted blind. Winemaker did not want noticeable oak in final wine, a typical style requirement in Switzerland. With lighter, less phenolic grape varieties,Swiss winemakers have responded to the 17mg/L/year permeability of current HDPE vessels by using them for shorter time periods than commonly used in Australia. Excellent results for chasselas have been achieved in 5 weeks for example

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Wine: Chardonnay 2008

Trial type: Fermentation

Time Period: 1 month

Replicates: 4YO Barrel with new oak inserts

HDPE (with staves)

Stainless steel (with staves)

Tastings: 6 Winemakers, blind, allocation tasting

Results: Order of preference; barrel, then HDPE, finally S/S tank as least preferred. Barrel rated sl. higher (was "more complete") than HDPE although both barrel & HDPE were allocated to the same final blend. S/S allocated to lower grade wine

Comment:

Oxygen ingress / absorption rates from lees stirring may account for some or all of the variation between barrel & HDPE. With equivalent O_2 absorption rates, difference between barrel and HDPE should probably have been nil

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Wine:	Pinot Gris 2008
Trial type:	Fermentation , informal
Time Period: 1 month	
Replicates: Barrel	
	HDPE (no oak staves)
Tastings:	3 Winemakers, not blind

Results: Ferment sl. slower rate than oak barrel, remained clean (w/o use of DAP), retained v.good aromatic characters ("at least as good as had been achieved with [old] oak in previous years"), structure was "surprisingly rounded, giving excellent mouthfeel", the wine retained an "excellent degree of varietal character"

Comment:

Pinot gris winemakers typically want oxygen with negligible oak influence, difficult to achieve with old barrels. Another 2008 pinot gris ferment has reported possible differences in fermentation rate between barrel and HDPE - possibly due to temperature variation (HDPE is less insulating than barrel)

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Summary of Trial Outcomes

- Results are robust and consistent, across different wineries, grape varieties, countries and wine regions
- Wine quality produced by HDPE maturation technology is consistently rated as either "*similar to, but not quite as good as barrels*", "*equal to barrels*" or "*better than barrels*" and unambiguously as "*far better than [both] stainless steel and older [4-5 yr] barrels*"
- Experience with oak staves/adjuncts and winemaking skill are important in achieving "barrel" quality – "barrel" quality is being achieved today by many winemakers
- Trials are being undertaken with varying levels of oxygen permeability in HDPE vessels. Varying O_2 permeability will probably have noticeable effects on wine maturation and give winemakers additional tools and flexibility
- Anecdotal evidence suggests lower levels of oxygen permeability has substantially beneficial effects on reducing or eliminating "reduced" characters ("tankiness") typically associated with storage in stainless steel

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Made using 50% HDPE & oak chips / 50% barrel

Robert Parker, Wine Advocate;

93 points

Who needs barrels anyway…?

Pagos del Moncayo Garnacha 2006 (Spain)

BF T 2
BF T 1

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Economics: French Barrique vs. 1,000 l. Flextank

French Oak Barrique

CAPITAL COSTS:	Capacity L.	Cost / Unit $	Useful Life, years	$ / year	Cost: $ / L / yr
French Oak Barrique	225	$1,200	5	$240	$ 1.067
MAIN OPERATING COSTS:	Capacity L.	No. Vessels per Man Yr.	Cost / Year $	L. / year	-
Labour	225	500	$40,000	112500	$ 0.356
Space	225	-	$40		$ 0.178
Wine Lost by Evap.	225	$3/l	-	20	$ 0.267
				TOTAL:	$ 1.867

Flextank 1,000 l. Matn. Cube

CAPITAL COSTS:	Capacity L.	Cost / Unit $	Useful Life, years	$ / year	Cost: $ / L / yr
Flextank 1kl. Cube	1000	$1,610	20	$81	$ 0.081
Fr. Oak Plank Pack	1000	$105	1	$105	$ 0.105
MAIN OPERATING COSTS:	Capacity L.	No. Vessels per Man Yr.	Cost / Year $	L. / year	-
Labour	1000	1500	$40,000	1500000	$ 0.027
Space	1000	-	$80	-	$ 0.080
Wine Lost by Evap.	1000	-	-	-	-
				TOTAL:	$ 0.292

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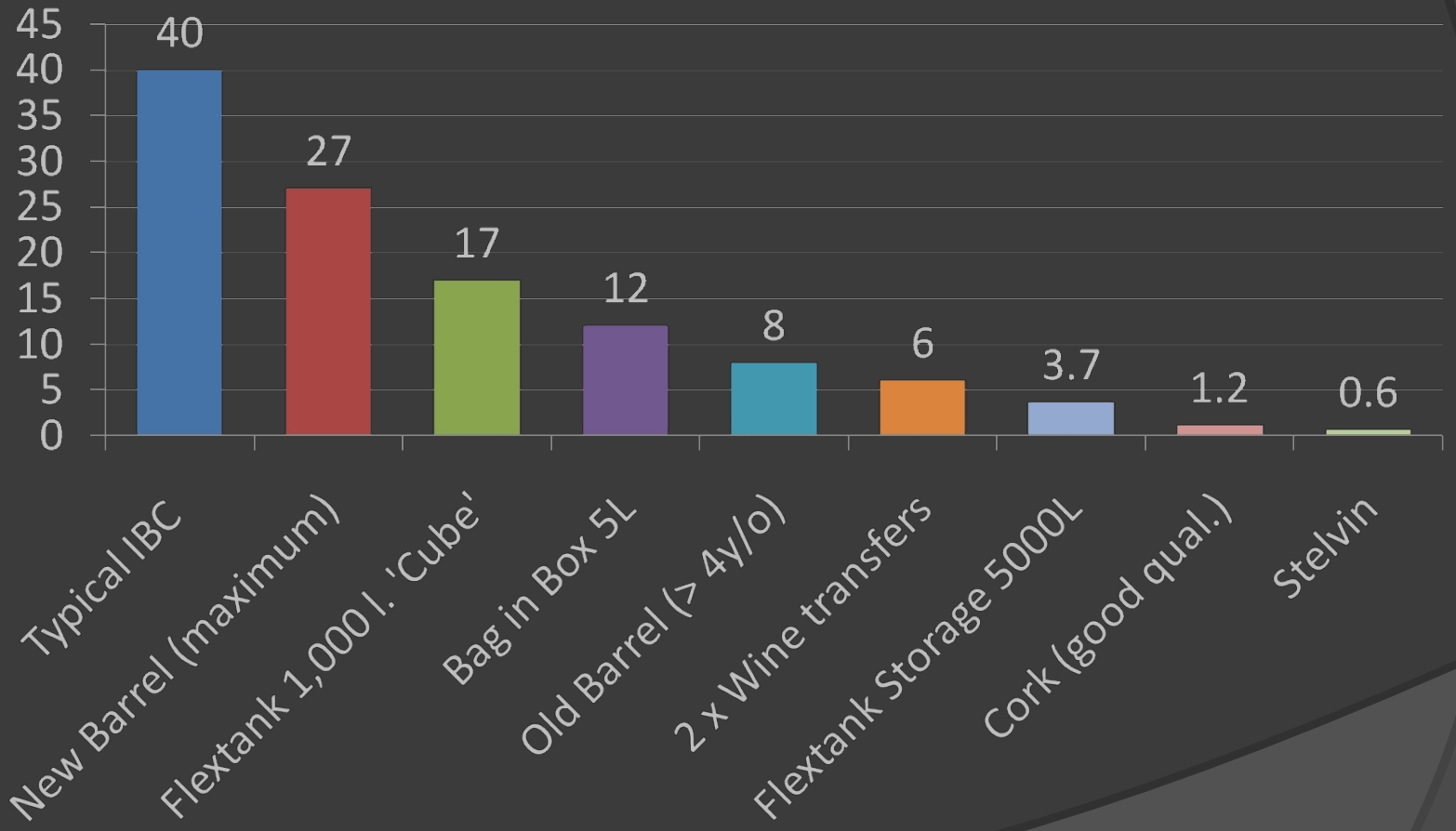
mg/L/year



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