Ice Pigging In Wineries

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Introduction

- What is it?
- What is it good for?
- Where is its value to wineries?
- How is it different?
- What was done during vintage 2011?
- Did it work?
- Conclusions

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Ice Pigging - What is it?

Pigging

– insertion of a physical plug into a fluid pipeline. Usually foam or plastic pigs.

Ice

– Ultra high ice fraction (>80%) ice slurry.

– Needs a freezing point depressant ~1% (ethanol, potassium carbonate, caustic, acid, salt, etc.).

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Pumpable Ice Slurry

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What's it good for?

Cleaning

– High wall shear, physical scraping.

Clearing

– Efficiently sweeps out product in one pass; separates from push water.

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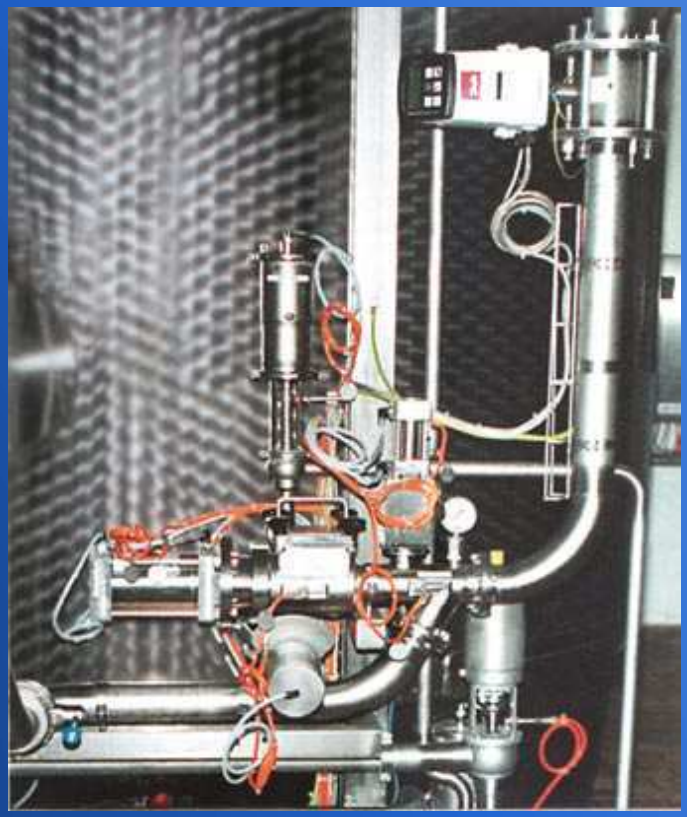
Conventional Pigging Systems

Pigs

Valves



Launchers / catchers

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Conventional Pigging Systems

Disadvantages:

Specially designed factories are necessary:

- Constant diameter pipework
- Specialist valves
- Pig launchers / receivers
- Pneumatic lines / valves for moving the pig

Equipment complexity results in high capital costs.

Very difficult to retrofit existing plants.

Requires expensive operational control and planning.

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ICE vs. Conventional Pigging

Cleans and clears like a solid

– high wall shear, clears grape must in one sweep. But cannot get stuck for long.

Flows like a fluid

– diameter changes, valves, thermowells, pumps, junctions, chillers, filling machines, etc.

Truly “retrofittable” in any plant and pigs the “unpiggable”. No enabling works at OLW.

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Value to wineries

Must-pushing

1. Product recovery ≡ reduced dilution.
2. Reduced BOD in push-water.
3. Reduced water use.

Cleaning

4. Reduced chemical load in cleaning.
5. Ability to scour inaccessible pipes.

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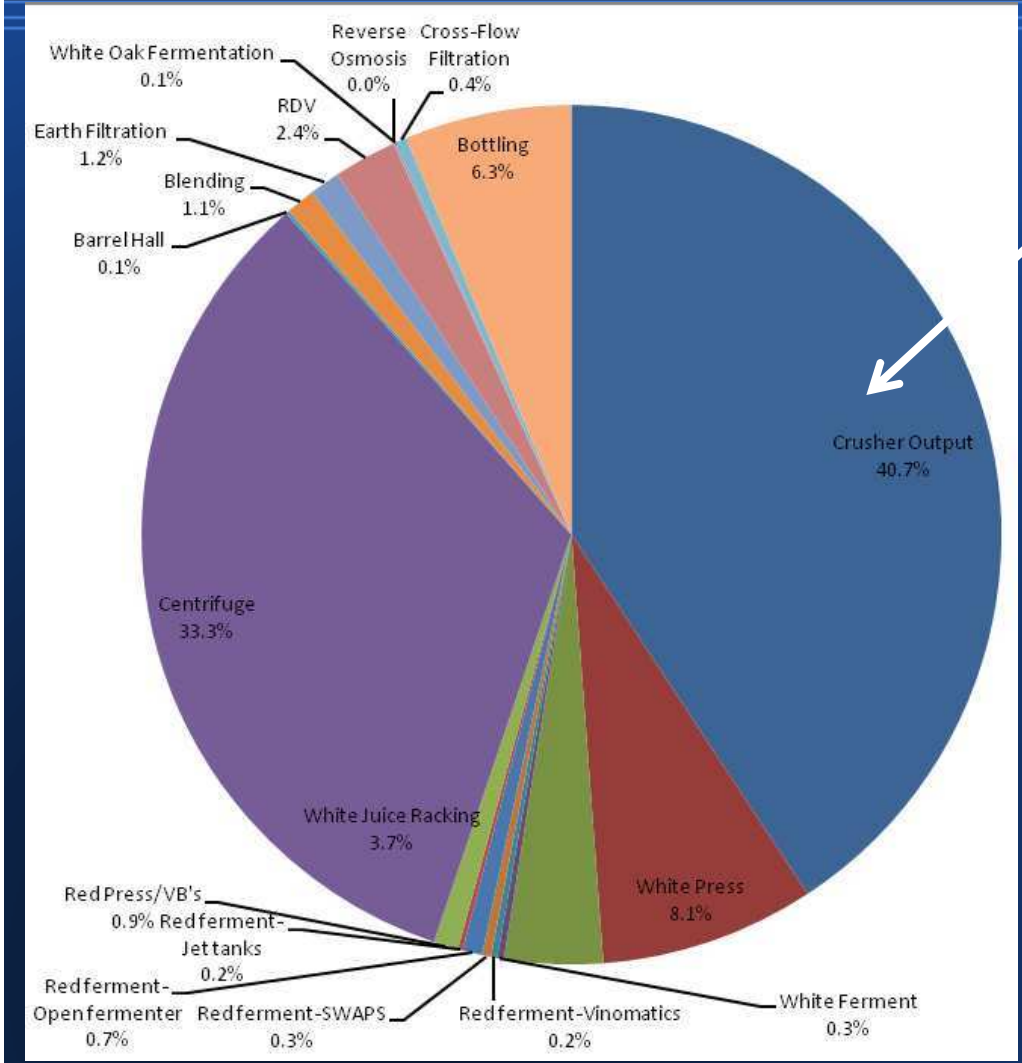
40.7% of COD from Crusher



The crusher output accounts for 40.7% of winery COD. Push water from large crushers account for 96.6% of this (39.3% of winery COD).

Figure 3.6 Relative COD Contribution by Process Unit. P.44

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Crusher output ≈ push water

Crusher Output	pH	EC (us/cm)	TSS (mg/L)	TSS %	COD (UF) (mg/L)	COD %	Na (mg/L)	Na %	K (mg/L)	K %	Volume (L)
Small Crusher push water whites	4.57	1,157	474	0.98%	10,781	0.51%	91	0.50%	168	0.50%	62,875
Large Crusher push water whites	**3.32**	**1,358**	**231**	**40.05%**	**10,903**	**43.04%**	**87**	**39.73%**	**142**	**35.69%**	**5,262,703**
Small Crusher push water reds	4.22	1,128	339	0.99%	10,204	0.68%	95	0.73%	147	0.62%	88,641
Large Crusher push water reds	**4.10**	**1,182**	**250**	**53.16%**	**11,066**	**53.58%**	**93**	**52.09%**	**195**	**60.11%**	**6,454,627**
Must line cleans-large crushers	8.83	1,333	49	0.40%	643	0.12%	251	5.39%	18	0.21%	247,605
Crusher cleans small crushers (RY1&2)	4.69	1,008	205	0.00%	5,560	0.00%	98	0.00%	91	0.00%	477
Crusher cleans large crushers (RY3&4)	3.79	1,198	661	1.50%	10,610	0.55%	91	0.55%	189	0.62%	69,041
Stalk conveyor spray	3.33	913	125	0.06%	2,843	0.03%	96	0.13%	78	0.06%	15,315
White Bin Wash	4.19	1,054	261	0.70%	8,591	0.52%	94	0.66%	145	0.56%	81,250
Red Bin Wash	3.96	1,766	1,235	2.13%	20,384	0.80%	91	0.41%	397	0.99%	52,286
Truck Wash	4.29	875	117	0.21%	3,973	0.17%	89	0.43%	75	0.20%	55,667
TOTAL	**3.86**	**1,259**	**245**	100.00%	**10,759**	100.00%	**93**	100.00%	**169**	100.00%	**12,390,486**

large crushers push water **TSS 93.2%** **COD 96.6%** **Na 91.8%** **K 95.8%**

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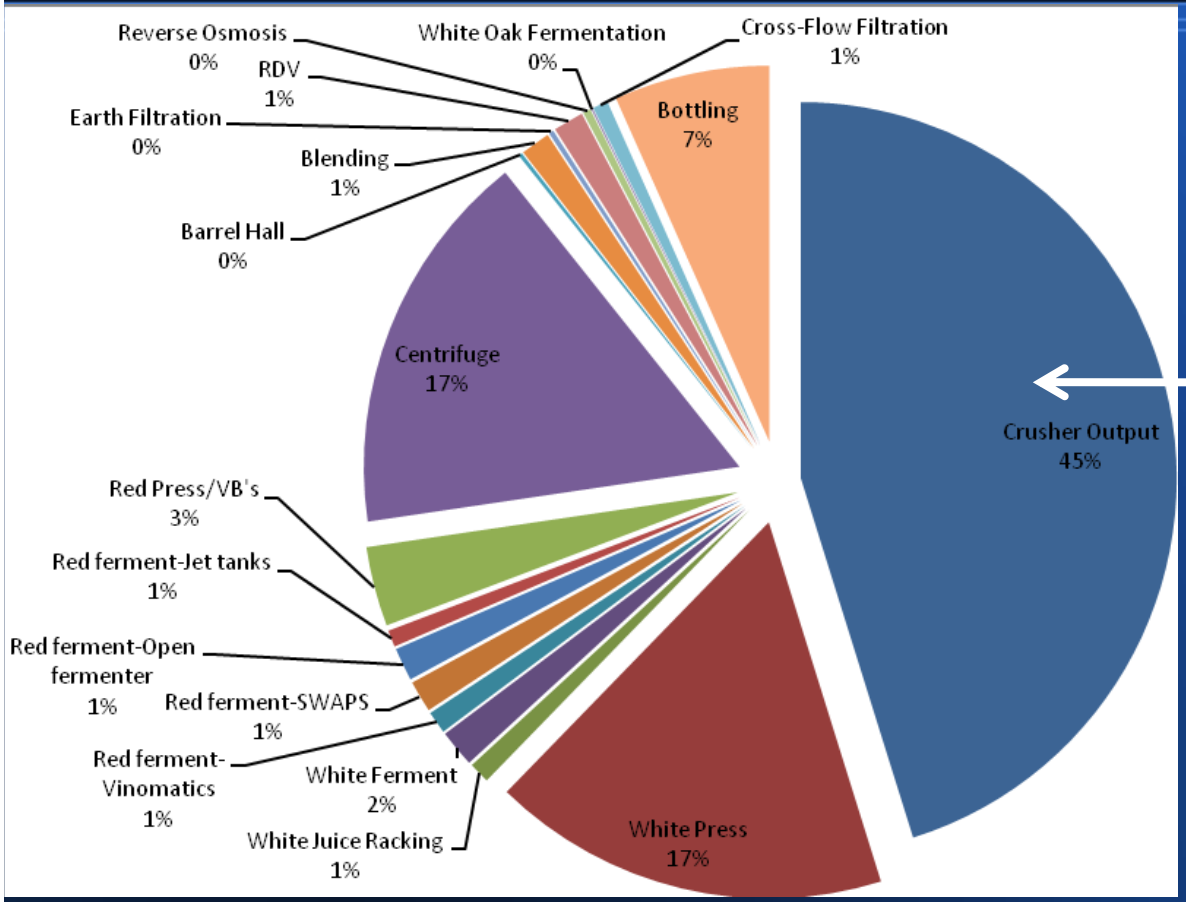
WATER USE



The crusher output accounts for 45% of winery water use.

Figure 3.4 Water Use by Process Unit. P.43

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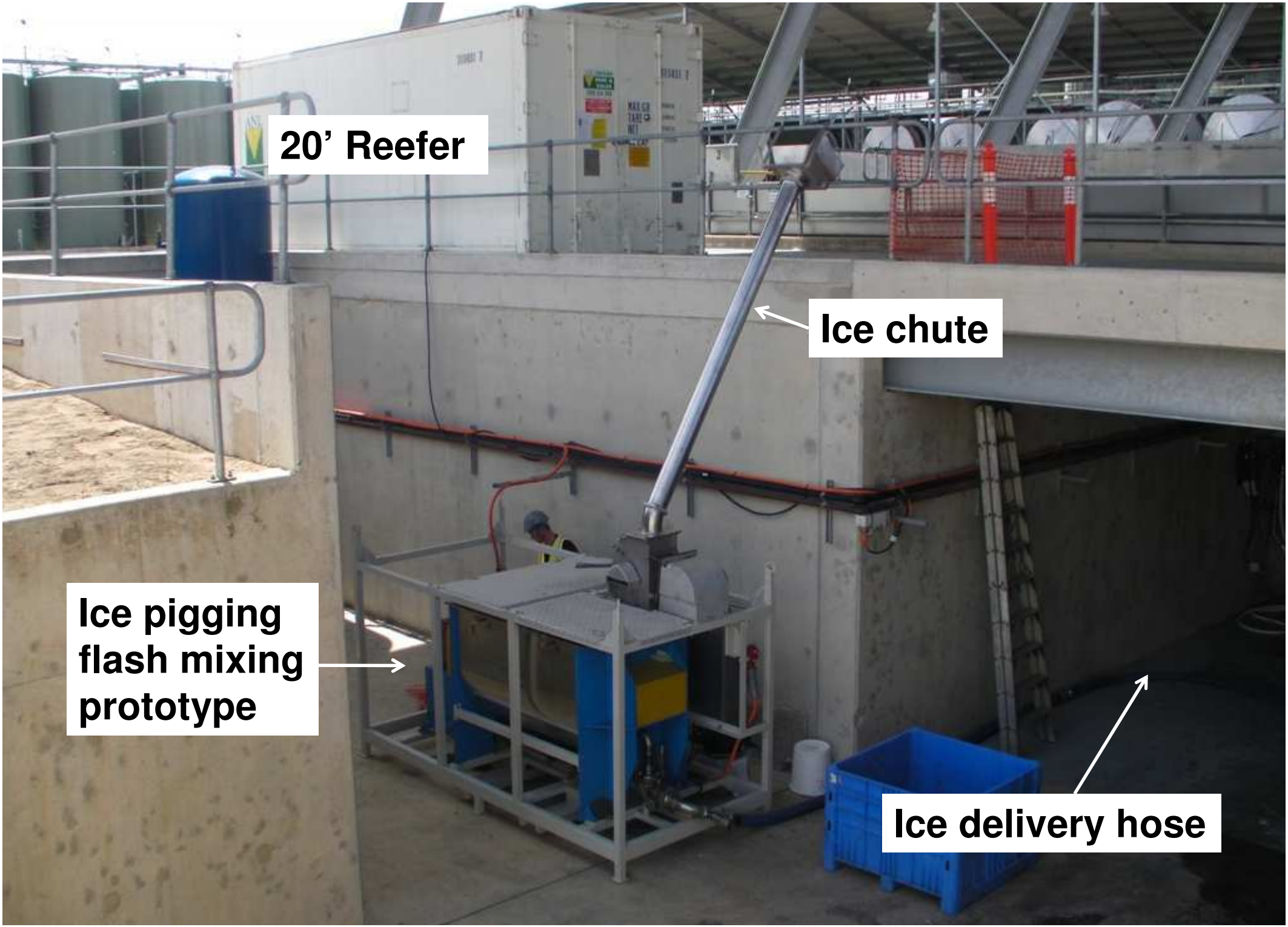
20’ Reefer
Ice chute
Ice pigging flash mixing prototype
Ice delivery hose

Procedure

1. Add water and freezing point depressant (about 1% mass) to mixing bowl.
2. Turn on agitator and crusher.
3. Gradually add ice cubes into the crusher until desired consistency / particle size distribution achieved.
4. Inject when ready (3” hose into must pump hopper).
5. If the ice fraction is too low (<70%) due to time delays, simply add a couple of extra bags of ice prior to injection.

It takes roughly 15 minutes to make a 250 litre ice pig.

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What was done Vintage 2011

Brought the ice pig making / delivery machine from HK to Oxford Landing Winery, Barossa Valley.

1. Measured mixing interfaces of wine transfers in 3” pipes.
2. Used ice pigs to push must from the crusher pumps to presses / tanks via 6” pipes x 220 metres and chillers (two of which are 5” diameter ~ “unpiggable”).
3. Made caustic ice pigs to clean pipework.

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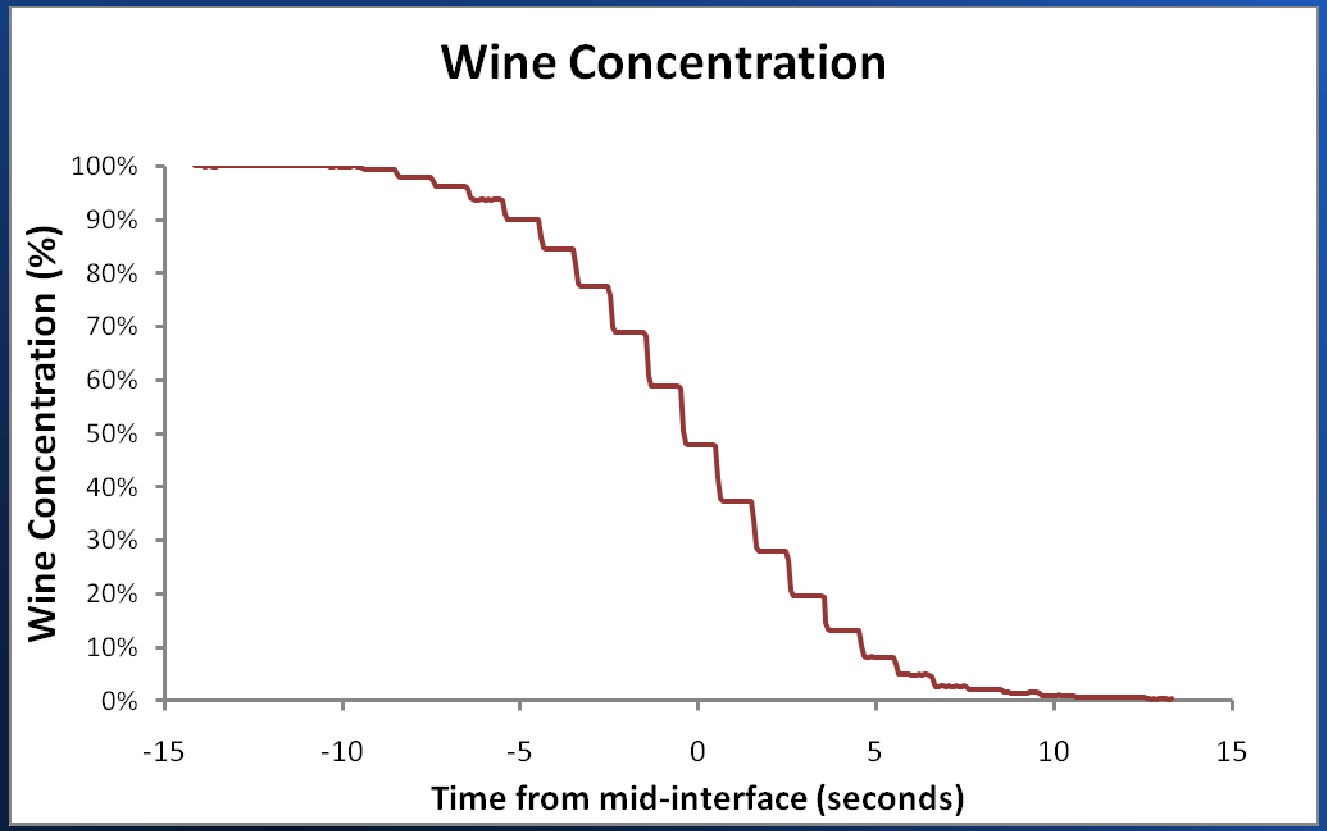
3” Transfer RTD



- 3” transfer
- Wine > water
- 440 metres long.
- 20 hL volume.
- Including tube in tube heatexchanger.
- 180 hL/hr
- 5 litres / second
- Measured conductivity @1Hz.

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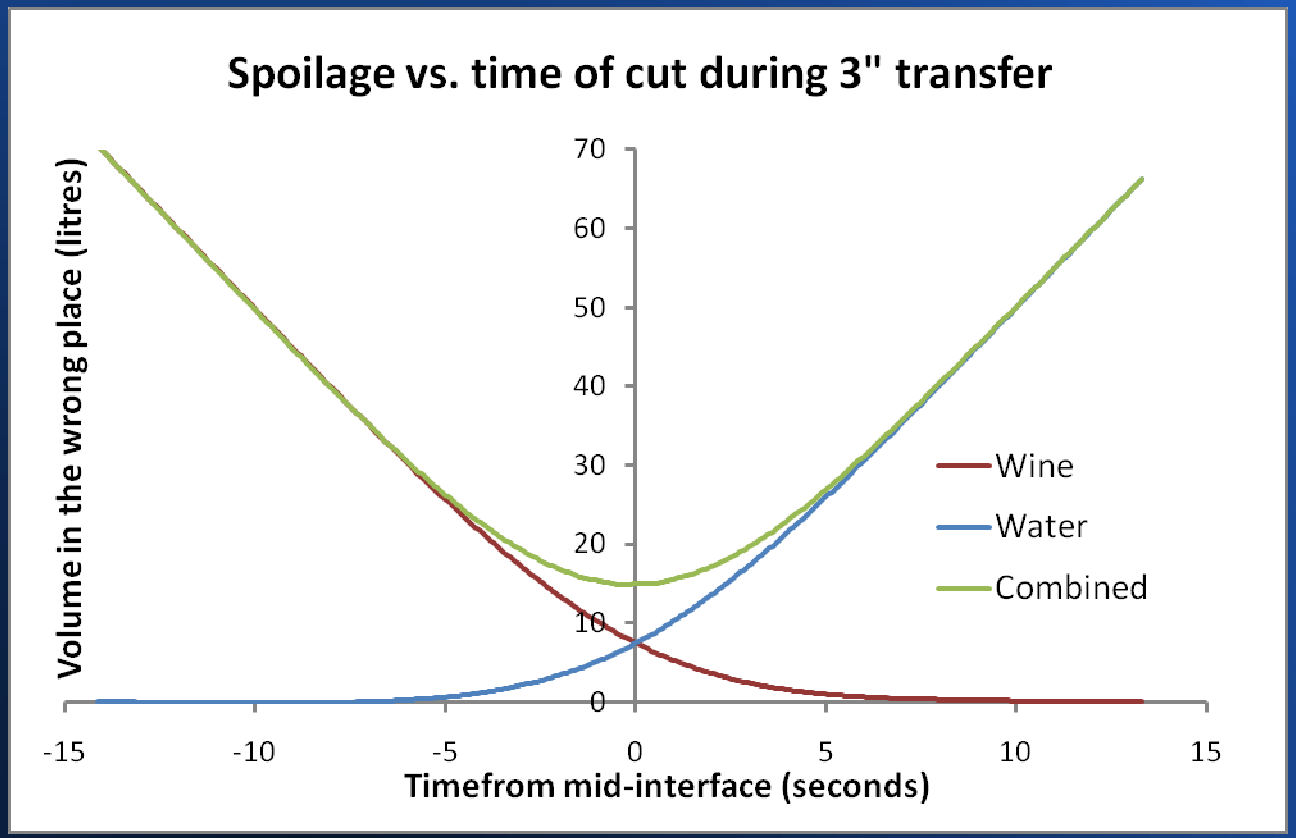
3” Transfer RTD



The interface lasts about 15 seconds.
If cut at 50% wine, about 8 litres of wine goes into waste and 8 litres of water into tank.

Not worth ice pigging.

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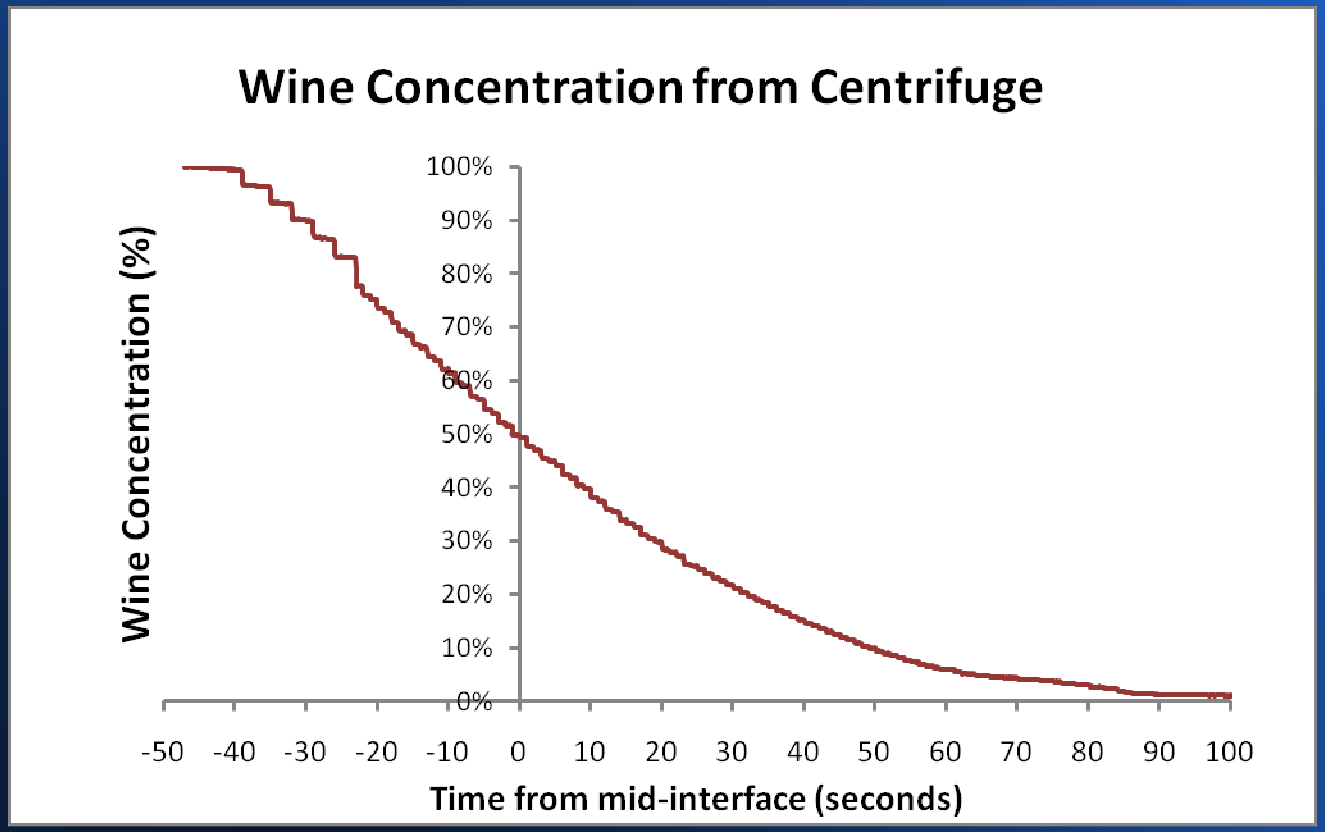
Centrifuge RTD



- Centrifuge mixing
- Wine > water
- 105 hL/hr
- 2.9 litres / second
- Measured conductivity @1Hz.

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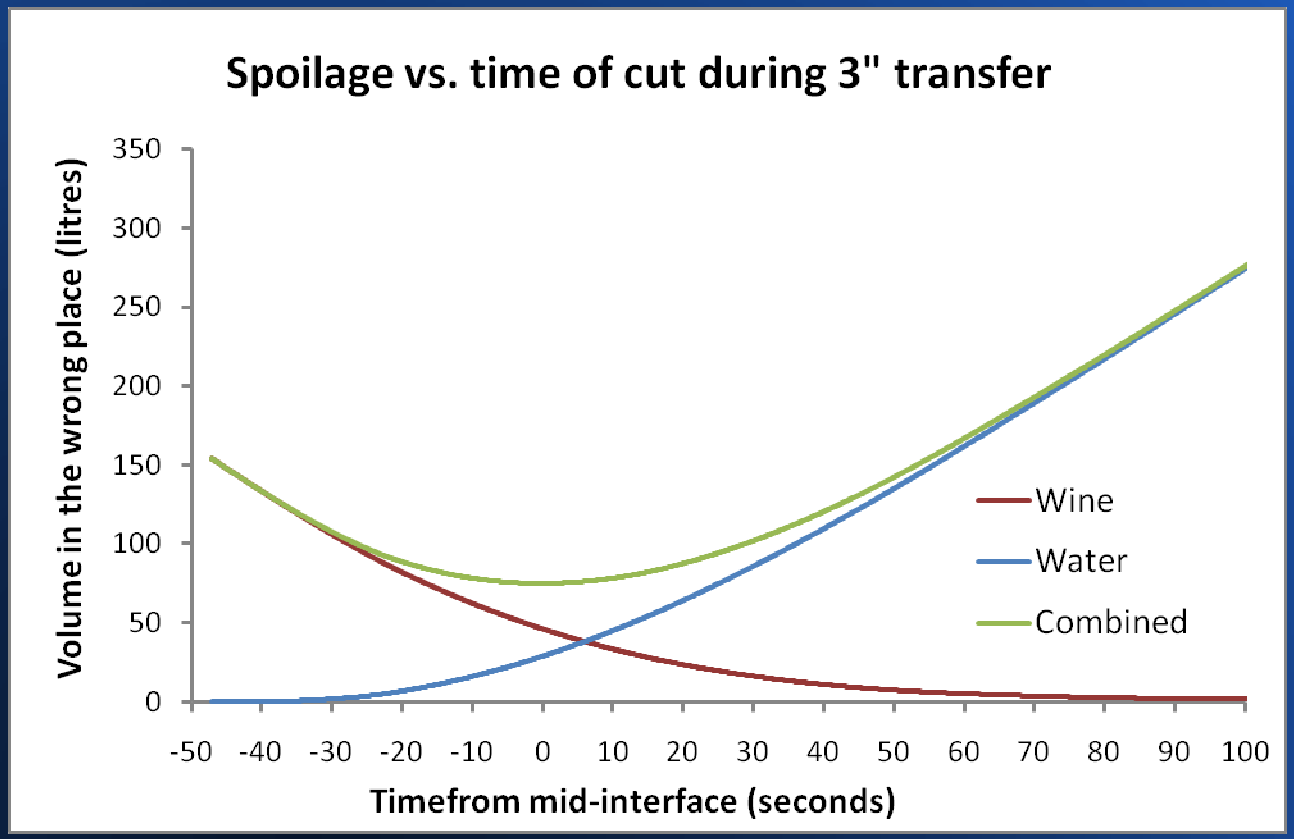
Centrifuge RTD



- Mixing interface lasts over 2 minutes
- 50%c cut 28 /46L water / wine.
- 44%c cut 38 / 38L water / wine.
- Not symmetrical – where do you cut?

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Videos

1. Water push of must. Long interface. 3” clear hose.
2. Water push in a 3” clear hose.
3. Making the ice, consistency at 83.7% solids.
4. Ice pigging must in 3” clear hose.
5. Clearing chiller.
6. Ice pigging must through 6” lines. Exit videos.
7. Side by side Comparison of water push and ice pig.

8. Biofilm removal from 3” hose – 1 pipe volume.
9. Caustic ice pig of 500m 3” pipe – 400 litres.
10. Pushing out the screw press -1000kg of ice cubes = $270.

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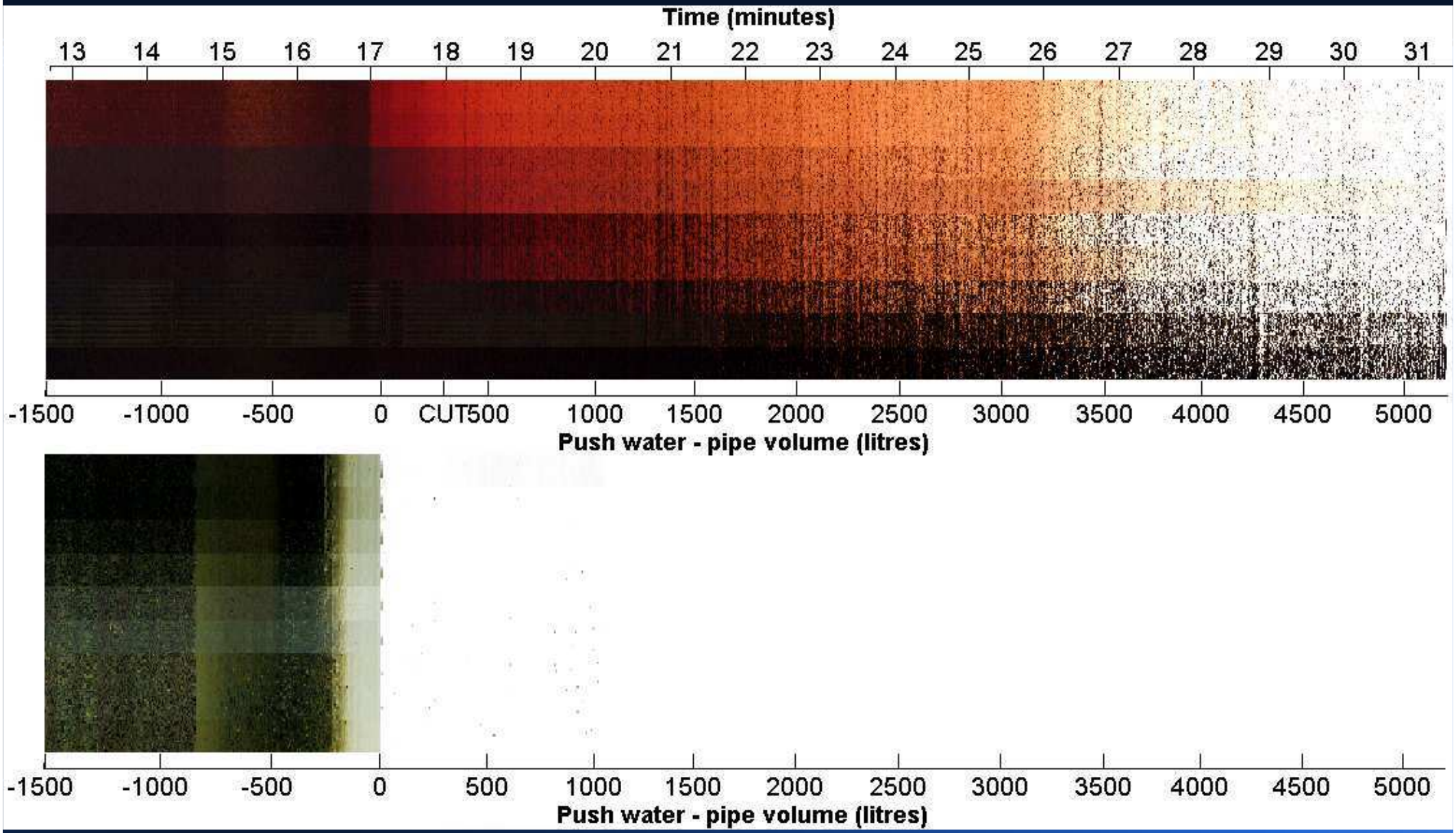
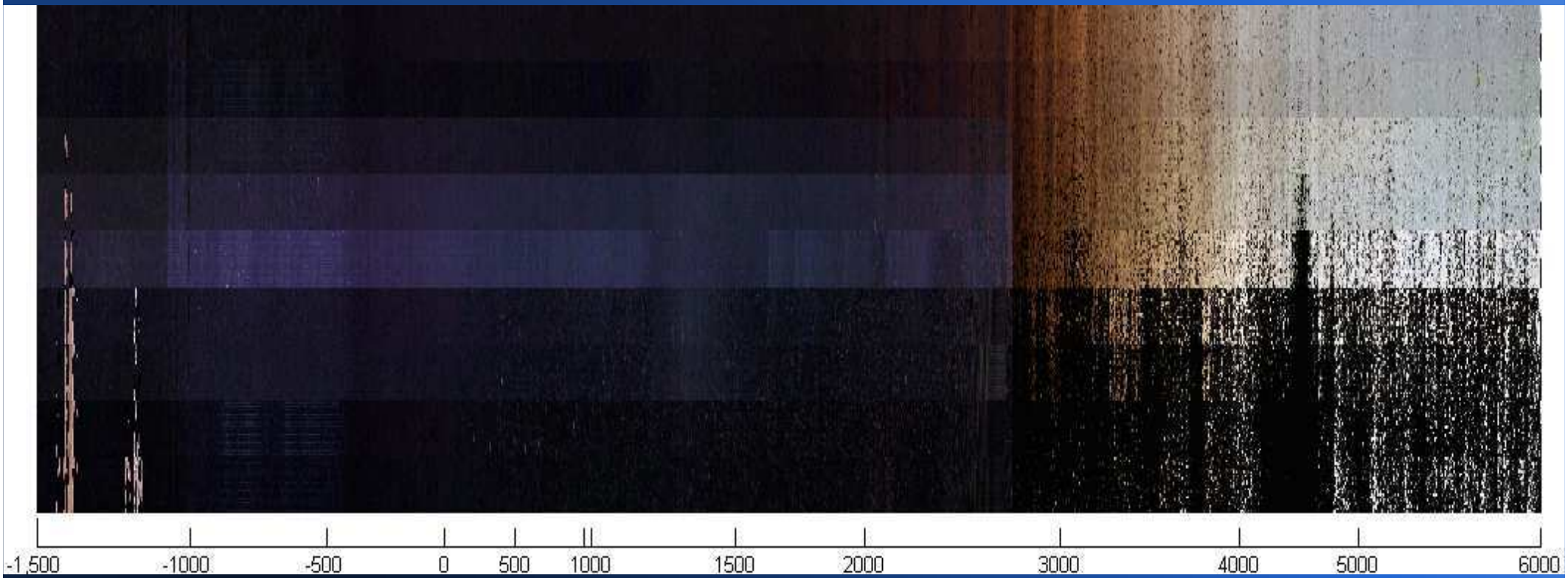
Must Push Comparisons



More Water Cuts



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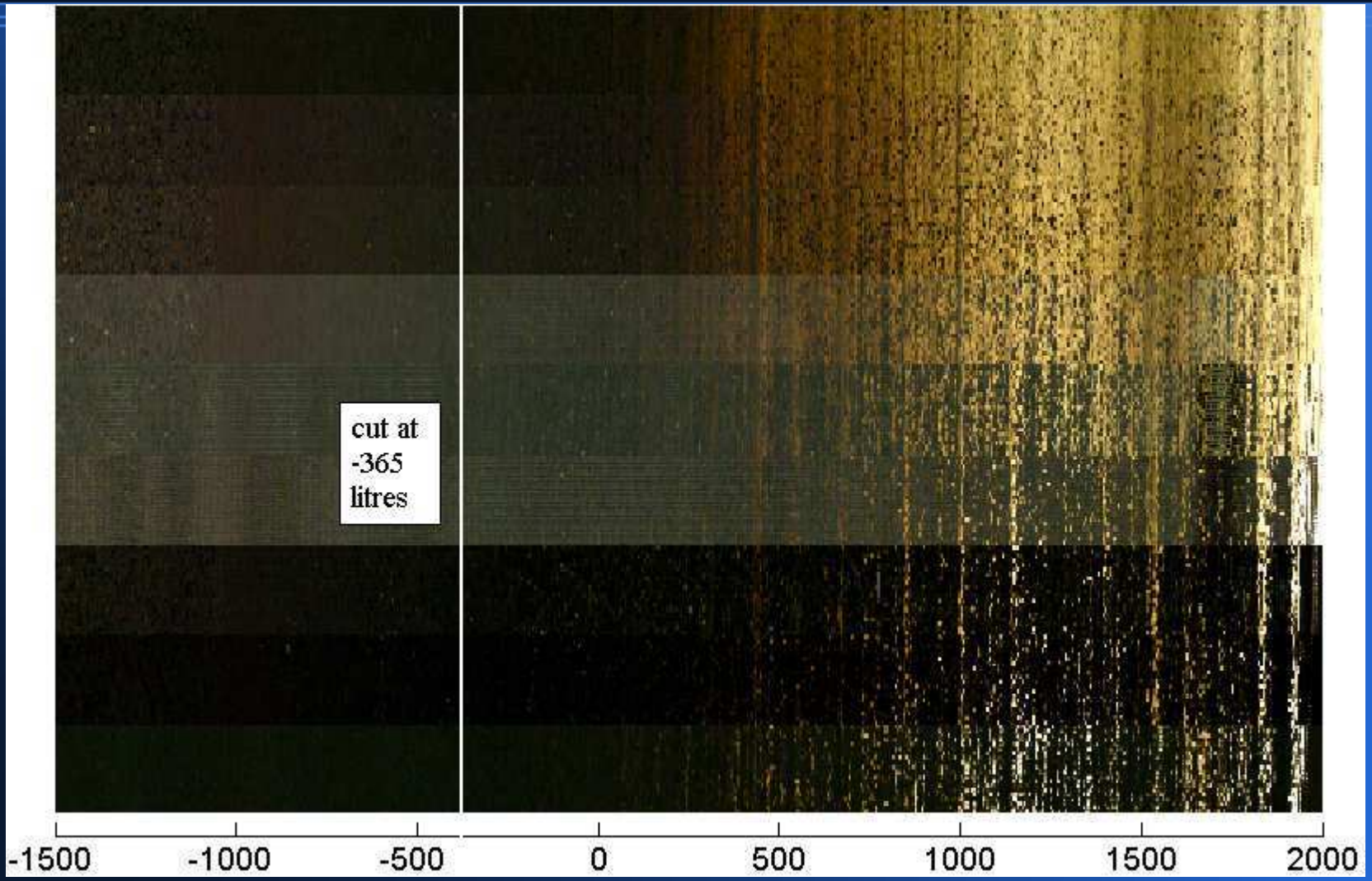

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More Ice Pig Cuts

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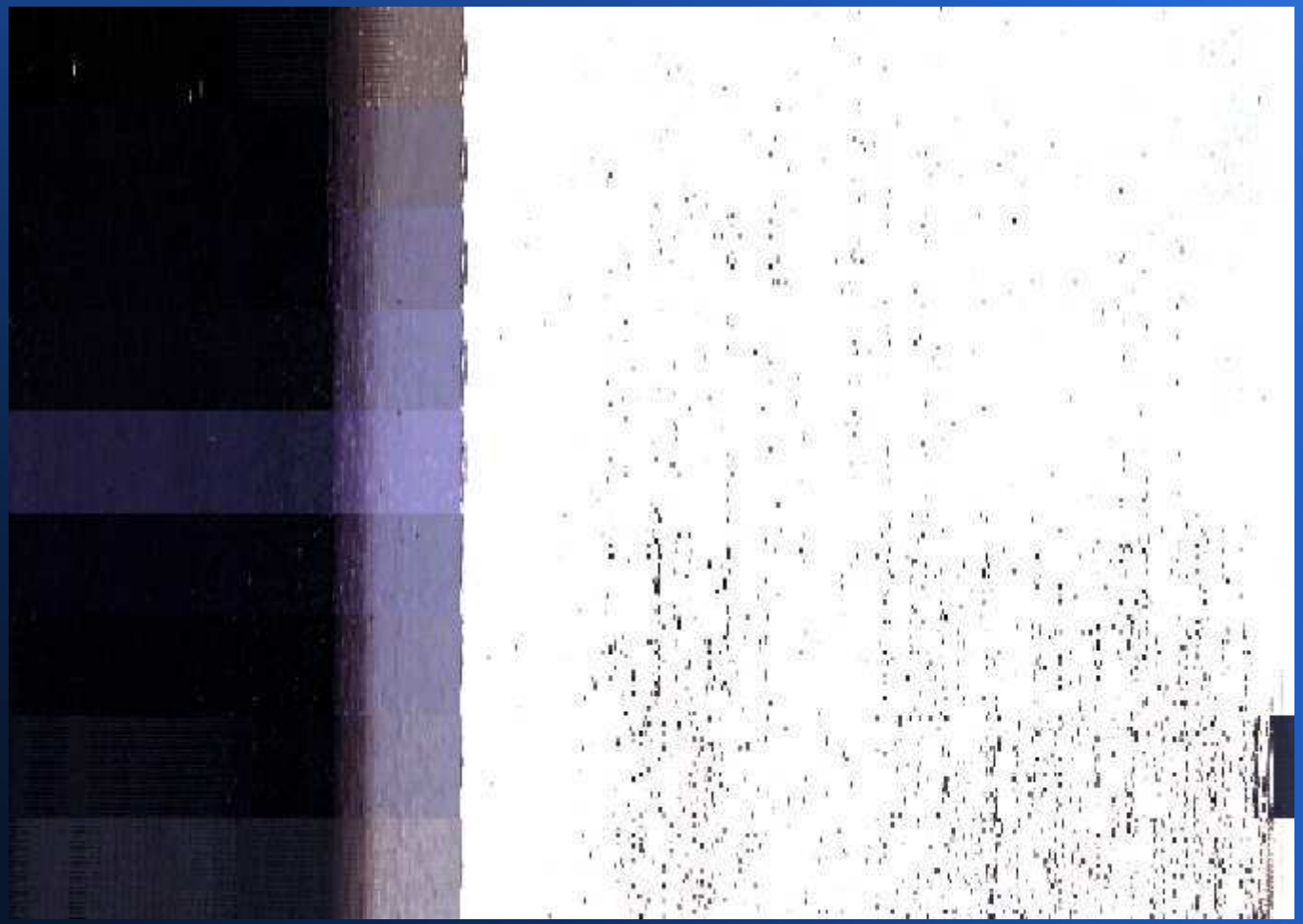
More Ice Pig Cuts



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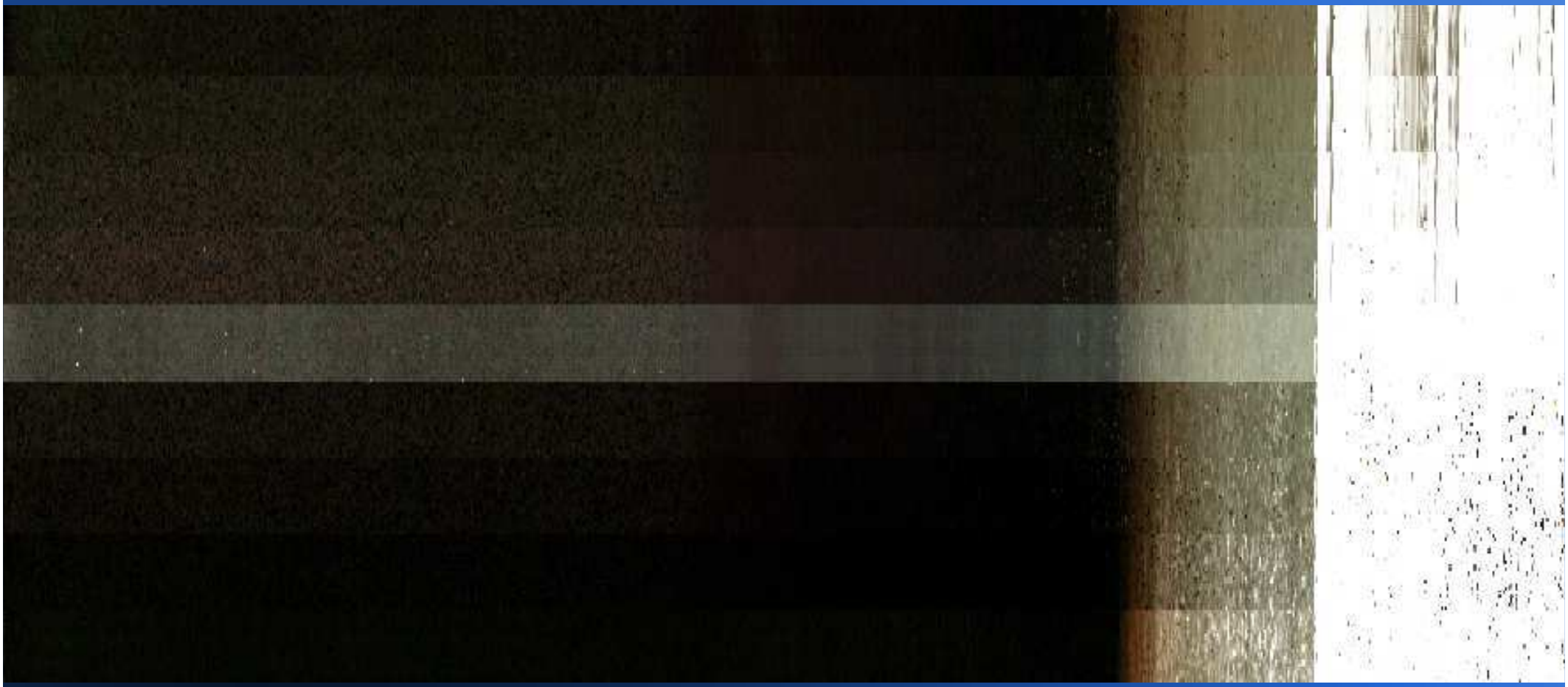
More Ice Pig Cuts



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Conclusions – Must pushing

1. Grape must is an excellent candidate for ice pigging – low adhesion, high solids.
2. 250 litres of 1% ethanol ice pig was good for a 220m 6”.
3. Went through 5” diameter chiller easily.
4. Turning the chillers on cold before the ice is beneficial.
5. All liquid and most solids swept by the ice; dead legs are still a problem. Product recovery near 100%.
6. Push water is reduced to 1 pipe volume and very clean.
7. With push water recycling, water use could be 0.
8. Successful in keeping COD, K etc. out of waste.

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Conclusions – Cleaning

1. High solids ice slurry can have exceptionally high wall shear, up to 0.3 bar per metre of 3” hose.
2. Easily clears out settled solids left in pipe – seeds, skins.
3. Ice pigs can be made with caustic as the FPD, for a chemical / physical clean (or acid, biocide etc.).
4. A 300 litre 1% caustic ice pig removed about 3x the solids from a fixed steel 3” pipe, than a 500 litre 2% caustic wash plus a scourer pig in the middle. 3x the performance with 1/3 the caustic loading.
5. Ice pigging can perform better than scourer pigging (with enough ice), AND can be done on “unpiggable” plant.

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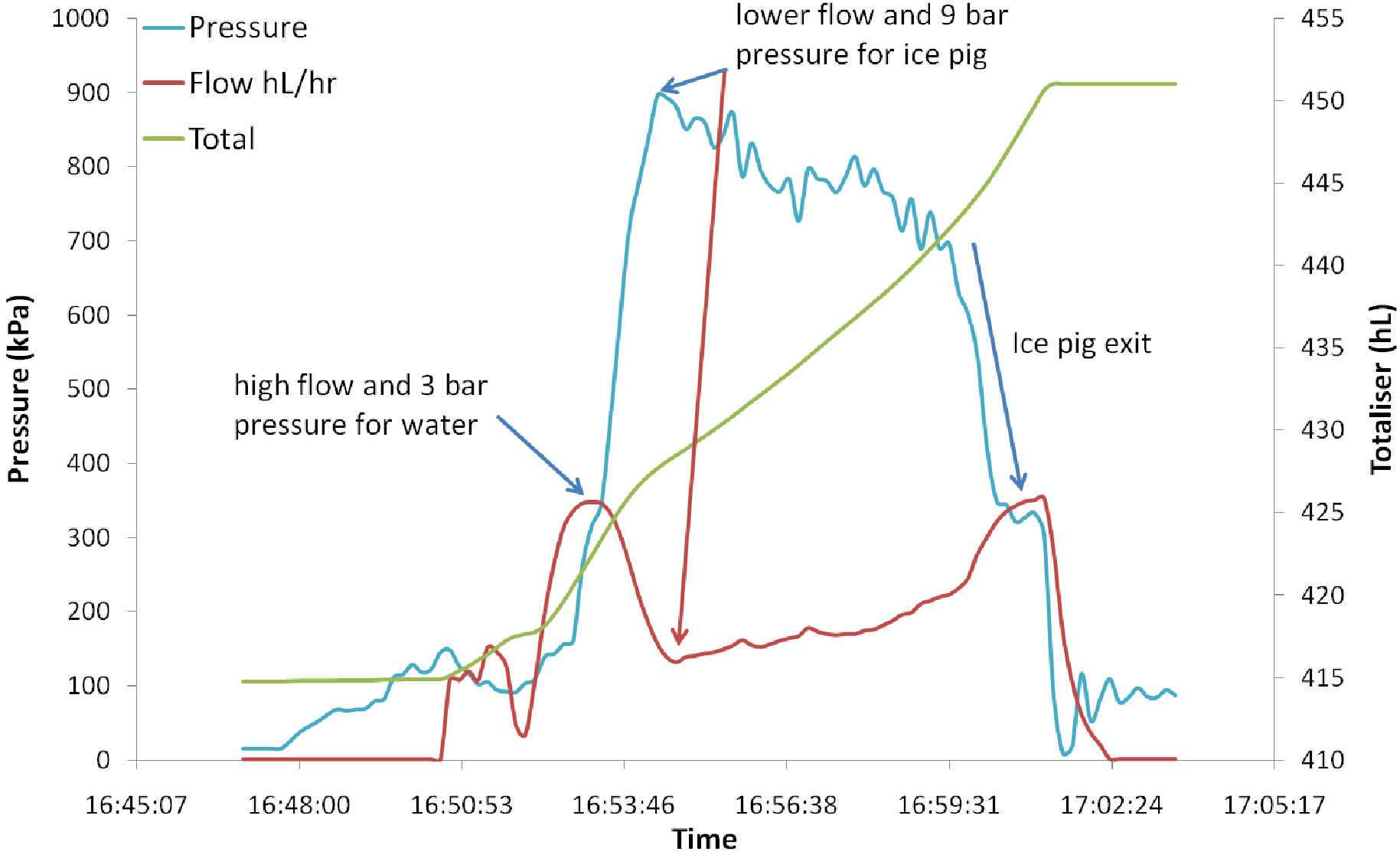
Pressure Drop across Caustic Ice Pig



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Value depends on Winery Economics

1. Reducing dilution – difficult to quantify, yield unaffected.

2. Reducing water consumption – depends on cost of water and value of treated water.

3. Reducing COD in waste water – no effect on the major fixed costs of treatment, but savings on variable costs (e.g. aeration, off-site treatment).

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Value depends on Winery Economics

4. Reducing salts in waste water - may enable vineyard irrigation with treated water; sustainable.

5. Reduced peak loads during vintage – delay, reduce or avoid large capital expenses on wwtp.

6. If crushing is restricted by water or waste design limits or legislative caps, reducing waste / water use will extend crushing capacity.

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