AWRI Ferment Simulator

The AWRI Ferment Simulator is a spreadsheet-based tool designed to provide wine producers with the capability to monitor and predict wine fermentation performance, as well the ability to track important winery metrics such as refrigeration load, energy costs and fermentation throughput.

The AWRI Ferment Simulator has been developed based on field testing conducted through the AWRI Riverina Node during vintages 2011-13. The Simulator was 'trained' on commercial-scale fermentation data sourced from multiple sites across several vintages, and during development was found to reliably predict commercial fermentation performance under various different operating conditions including temperature, yeast strain, wine type, nutrient levels, and fermenter size.

Two versions of this tool are now available as unlocked Excel files – a Lite Version (compatible with Office 2003 onwards) which provides basic functionality and a Full Version (compatible with Office 2007 onwards) with more advanced features such as multiple ferments and refrigeration demand. Both version provide complete simulation and 'what if?' capability.

The two versions of the AWRI Ferment Simulator are now provided as unlocked Excel files (compatible with Office 2003 onwards for the Lite version , or with Office 2007 onwards for the Full version). A LibreOffice version (compatible with v3.5 onwards) is also available for Linux and Mac OSX operating systems. The source code is also unlocked, allowing wine producers to adapt the simulator functionality to interface directly with LIMS/PLC/SCADA systems for automatic data acquisition if desired.

Please feel free to contact the AWRI with any queries, comments, and suggestions regarding the Simulator, or for assistance in use of the package.

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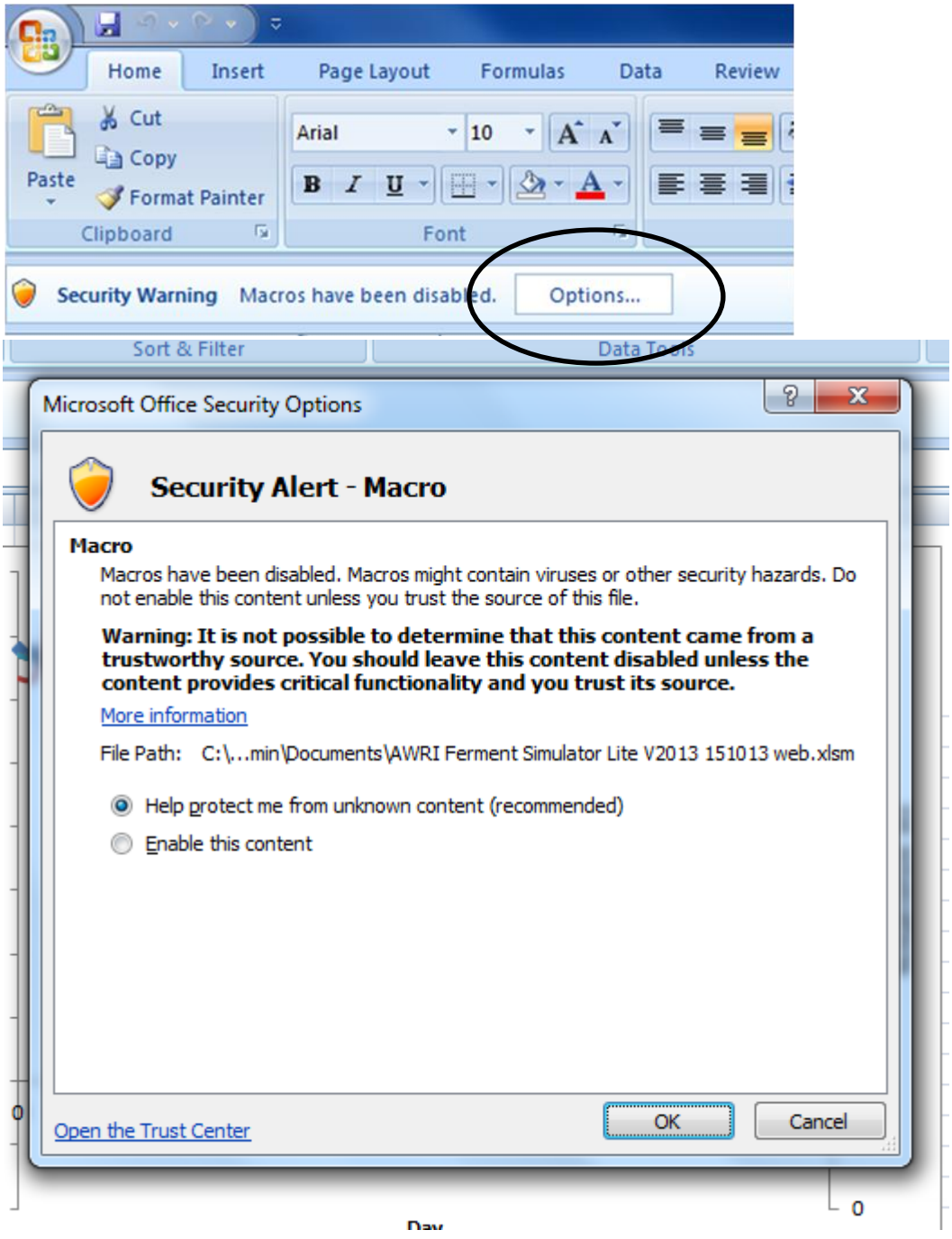
AWRI Ferment Simulator

Operating Procedure

1. Enable Macros

Upon opening the Simulator, please ensure that macros are enabled.



Click OK

2. Worksheets – Overview

Ferment 1 – The Lite version of the AWRI Ferment Simulator provides the facility to simulate three ferments at a time. Each ferment sheet is a simple screen that allows the user to enter in basic ferment data such as the fermenter start date and time, fill volume, initial yeast and nitrogen levels (if known), as well as regular baumé and temperature values collected throughout fermentation. This worksheet also provides fields to record tank additions and operations such as pump-overs and agitation – all of which will impact on the model predictions. A baumé and temperature chart of the current ferment is also shown, together with the ferment prediction.

Ferment 2 – as per the Ferment 1 worksheet

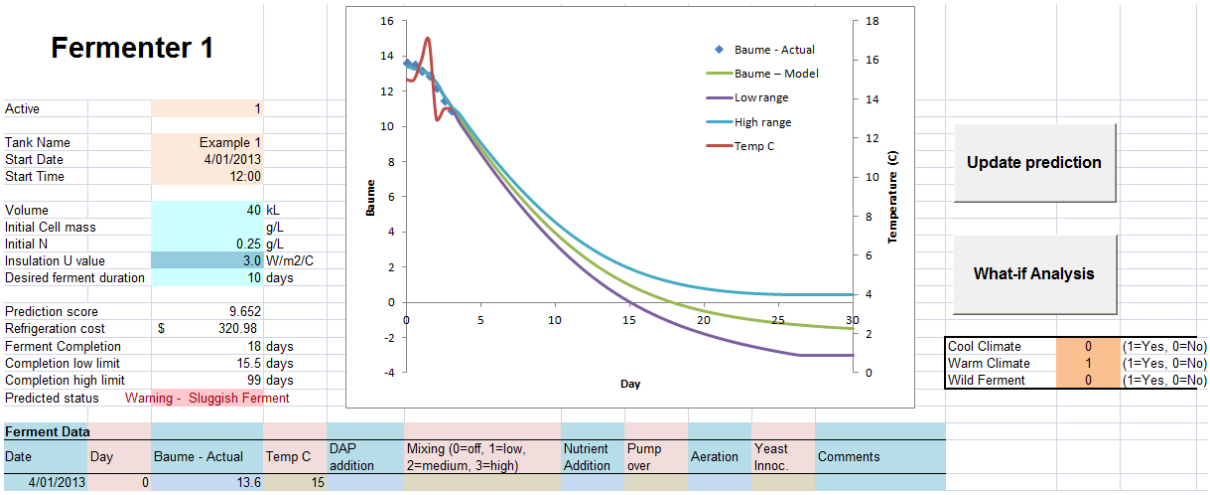
Ferment 3 – as per the Ferment 1 worksheet

Refrigeration & Weather –A table is provided on this worksheet for users to enter the max/min temperatures forecast (up to ten days) for the winery. This worksheet is also where the user provides details on their refrigeration plant, such as brine temperature and average electricity cost ($ per kWh).

What-if Analysis – this worksheet is used for 'what-if?' analysis

What-if Chart – this tab displays the detailed view of most recent fermentation simulation run. It is also used to show the results of 'what-if?' analysis.

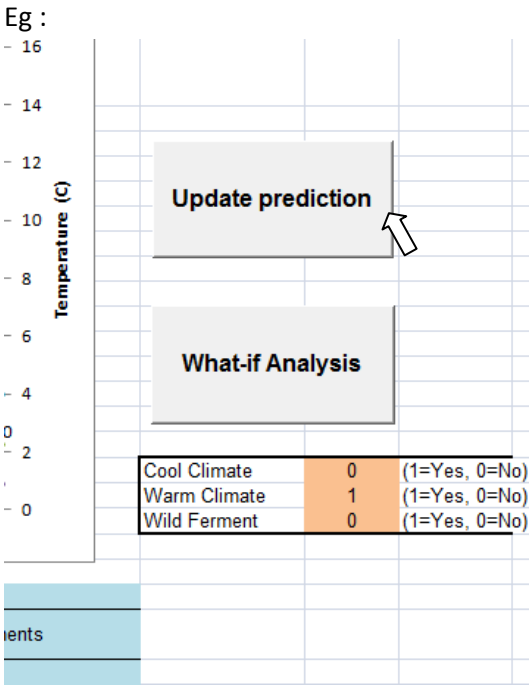
3. Getting Started – the Ferment screen



Go to the **Ferment 1** worksheet

1. Go to the Ferment 1 worksheet. This is one of three example ferments that are provided
2. New baumé and temperature data for a ferment can be added using this screen. Try adding some new values (hit enter after each value is entered), and then click on the "Update prediction" button on the worksheet.

Eg :



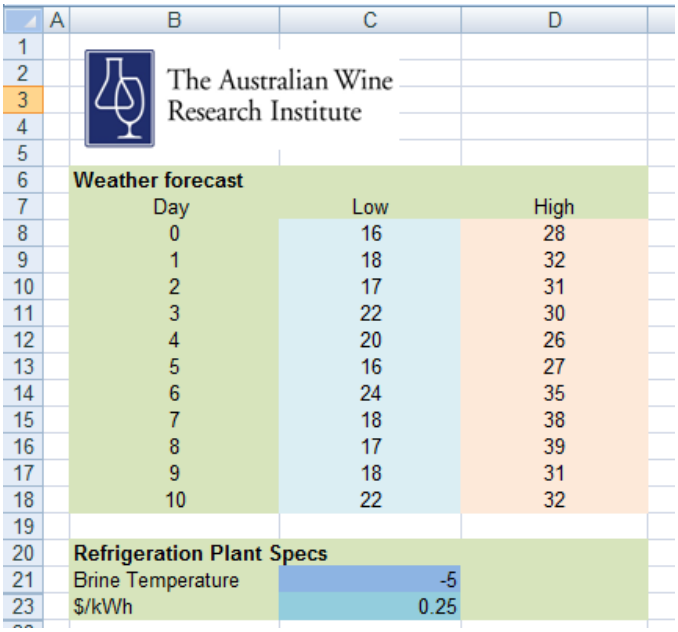
3. This will update the simulator with these new values. Note that for statistical reasons a minimum of 5 data points are required to calculate a prediction.
4. As described in **Section 2 – Worksheet Overview**, each worksheet contains the full details of each fermenter. This worksheet is designed to be similar in layout to the paper ferment record sheets used by many commercial wineries.
5. In addition to columns for baumé and temperature, this worksheet provides additional data fields for the ferment, such as initial yeast cell mass, tank additions and operations such as

pump-overs and agitation. All of these parameters, if used, will impact on the model predictions, however this information is optional and is not required for a prediction to be made (obviously the prediction will be more robust as more information about the ferment is supplied).

6. At the top of the ferment log there are fields to indicate whether a warm climate, cool climate or wild ferment is to be simulated. This is indicated by entering a 0 (zero) for "no" or a 1 for "yes" in the appropriate box. The prediction will be tailored based on the information that is entered here.
7. Throughout the ferment, DAP additions can be recorded in the appropriate column (in g/L) on the fermenter log as they occur.
8. Mixing and agitation are also recorded on the worksheet, with a numerical value used to simulate agitation and mixing operations. Suggested values are:
    0 = no mixing
    1 = low mixing (e.g. in-tank agitator)
    2 = moderate mixing
    3 = high mixing
9. When a mixing value is entered, that value is used in the simulation until another non-blank value is encountered on the fermenter log. A blank cell will not reset the mixing value back to zero; a zero value must be physically entered into the log.
10. To simulate an in-tank agitator which is switched on and then left on for a period of time, enter a mixing value of 1 or 2 at the time the agitator is switched on, and then a 0 (zero) value when it is again switched off. Mixing due to CO_2 production by the ferment is already accounted for in the model and so does not need to be entered here by the user.
11. To simulate a one-off mixing event (such as a pump-over , gas sparging), simply enter a 1 into the appropriate column at the time the mixing event is to occur.
12. To simulate a nutrient addition, enter a 1 into the appropriate column at the time addition is to occur.
13. After new data are entered on a ferment log, the ferment should be updated by double clicking in the grey "Update Ferment # Prediction" box (where # is fermenter in question)
14. If data are recorded on the ferment log before inoculation actually occurs, the time of inoculation should be indicated by entering a 1 into the appropriate column at the time inoculation is to occur. If the ferment is an uninoculated wild ferment, then this column can be left blank.
15. The user can enter the desired ferment duration (in row 12 of the ferment log). This value is used to determine if the ferment is trending on or off course. When a prediction is made, the simulator predicts the ferment duration (given in row 16 of the ferment log), as well as a predicted completion low limit and high limit. If the user's desired ferment duration is within two days of the predicted ferment duration, the predicted status will be "Good" (indicated with a green colour bar). If the user's desired ferment duration is within two days of the predicted high or low limit, the predicted status will be "High/Low range on spec" (indicated with a yellow colour bar). If the user's desired ferment duration is not within two days of the predicted high or low limit, the predicted status will be "Warning – Rapid/Sluggish ferment" (indicated with a red colour bar).
16. The Refrigeration cost (shown in row 15) is the predicted refrigeration energy cost for fermentation cooling for that ferment. This is calculated based on the refrigeration data provided on the "Refrigeration & Weather" worksheet. See **Section 4 - Refrigeration & Weather**

17. The refrigeration calculations will also take into account the weather forecast data entered on the "Refrigeration & Weather" worksheet. Again, see **Section 4 - Refrigeration & Weather**
18. The refrigeration calculations will further take into account the insulation used on the tank. This is indicated with the "Insulation U value" which is given in row 11. Suggested values are 0.8 for a completely insulated tank, 3.0- 5.0 for a partially insulated tank, and 10.0 – 12.0 for an uninsulated tank.
19. If the user wishes to record additional comments or notes (or other additions not already provided for on the ferment log), these can be entered into the "comments" column.

4. Refrigeration & Weather



Weather forecast		
Day	Low	High
0	16	28
1	18	32
2	17	31
3	22	30
4	20	26
5	16	27
6	24	35
7	18	38
8	17	39
9	18	31
10	22	32

Refrigeration Plant Specs	
Brine Temperature	-5
$/kWh	0.25

A table is provided for users to enter the max/min weather forecast (up to 10 days) for the winery. In future versions it is planned for these data to be automatically retrieved from www.bom.gov.au based on the user's location within Australia. However for this version, weather data must be entered manually.

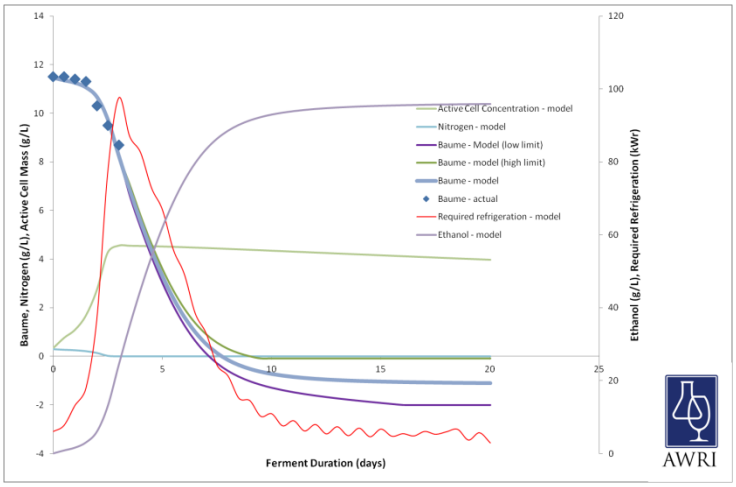
This worksheet is also where the user provides details on their refrigeration plant, such as brine temperature and average electricity cost.

Refrigeration Plant COP (Coefficient of Performance), which is an important metric in industrial refrigeration performance, is automatically estimated using the brine temperature.

5. ‘What-if?’ Analysis

	= user adjustable field								
Ferment start time		12:00					What-if ??		
Volume		40	kL						
Initial Cell mass			g/L						
Initial N		0.25	g/L						
Desired ferment time		9	days						
Prediction score		8.821					Fermenter Status		
Refrigeration cost		$ 299.21					Good		
Commercial Ferment									
Day	Baume – actu	Temp C	DAP addit	Mixing (0	Nutrient A	Pump ove	Aeration	Yeast Innoc	
0	13.6	15							
0.5	13.5	15							
1	13.2	16							
1.5	12.9	17							
2	12.2	13							
2.5	11.5	13.5							
3	10.9	13.5							
3.5	10.3	16	0.1			1			
4	8.4	16							
4.5	6.4	16							
5	4.6	16							
5.5	3.3	16							
6	2.5	16					1		
6.5									
7									

1. To run a ‘what if?’ analysis on a specific ferment, first go to the required ferment worksheet (eg **Ferment 1**)
2. Then click on the “What-if?” button on the worksheet.
3. This will take you to the **What-if Analysis** worksheet. The ferment log (eg Ferment 1) will be automatically copied to the what-if analysis worksheet, and the prediction recalculated.
4. Once this has completed, the user can make changes as desired to the temperature profile, initial N value, agitation etc. Click the “What if” button to see the effect of those changes. Click on the **What-if Chart** worksheet tab to see a graph of the current ‘what if?’ scenario.



5. Return to the **What if** Analysis worksheet. To see the impact of different agitation, or nutrient additions, or YAN addition, or pump over etc, enter those new parameters on the **What-if** worksheet and click on the “What if” button. The winemaker can then make their own assessment as to whether those new conditions should then be implemented in the winery

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