FILTER

version 4.3

User Manual

Innovative Winery Solutions Napa, CA 94559 www.winerysolutions.com

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INTRODUCTION

IWS

Over the years there have been three IWS products, FERMENT, ACID, and FILTER. Each is a computer application designed to shed light on a separate area of winemaking. FERMENT is a system which monitors the progress of fermentations, ACID forecasts changes in wine acidity, and FILTER predicts the performance of filtrations. They were all created from a single perspective: that there are aspects of winemaking which can be assessed more precisely than is possible with traditional methods. The IWS perspective is that tools built with this in mind will lead to a greater understanding of the nature of wine, to a reduction in the level of processing of wines, and to making the winery cellar a nicer and more efficient place to work.

FILTER

Filterability testing is in place at some wineries. Where it is in place it is typically used to assess whether or not a wine is ready for bottling (i.e. ready to pass a membrane filter). FILTER was created with this use in mind and it does allow production managers to make that assessment quickly and confidently. However the data analysis employed by FILTER is a step up dynamically and, as a result, it also allows for much more complex questions to be answered.

Existing filterability procedures generate a fouling constant from laboratory data which is then used directly as a rating of how filterable the wine is. FILTER uses the same laboratory data as well as production scale information to graphically show how well the data fits the fouling curve and calculate the volume of wine which may be expected to pass the filter full scale. This makes FILTER a tool which can not only answer the most obvious of filterability questions, but allow a winemaker to assess a winery=s entire filtration regime. A tool which will answer questions which would otherwise not even be asked.

GETTING STARTED

The Models

The equations which are the core of all of the calculations performed in FILTER are described in an article from 1984, *The Modeling of Wine Filtrations*, by Federico de la Garza and Roger Boulton in The American Journal of Enology and Viticulture, volume 35(4). The article outlines two mathematical models which describe the fouling of filter media. In FILTER those two models are named the Surface and Depth fouling models.

Both models relate the resistance of the filter medium to the volume of filtrate which has passed the filter. The resistance is calculated, from data collected in the laboratory, by using the following equation:

$$R = \frac{dt}{dV}\left(\frac{PA}{\mu}\right)$$

where: R = resistance of the filter medium (meters^{-1})
$\frac{dt}{dV}$ = reciprocal of the rate of filtration (seconds per cubic meter)
P = pressure drop across filter (Pascals)
A = area of filter (meters^2)
μ = viscosity of filtrate (Pascal▪Seconds)

The surface model is described by the following equation:

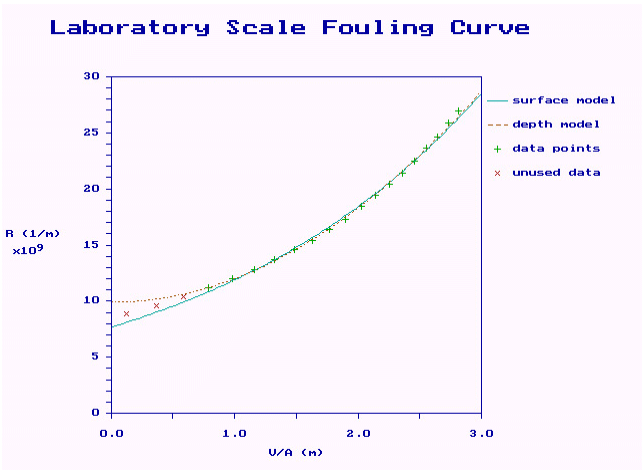
$$R = R_m \bullet exp\left(b\frac{V}{A}\right)$$

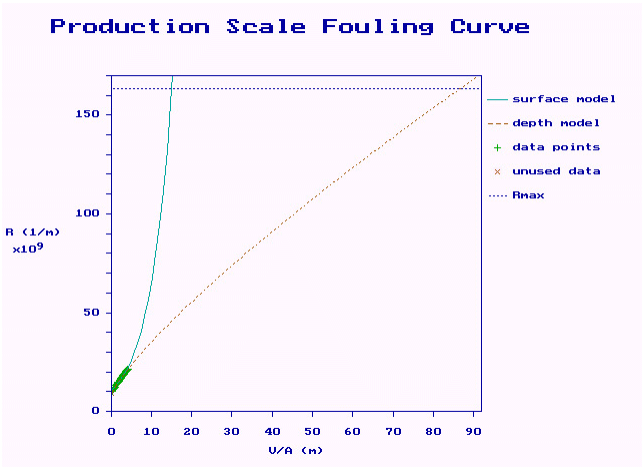
where: R_m = initial resistance of filter medium (meters^{-1})
b = fouling coefficient
V = volume of wine filtered (meters^3)
A = area of filter media (meters^2)

The depth model is described by the following equation:

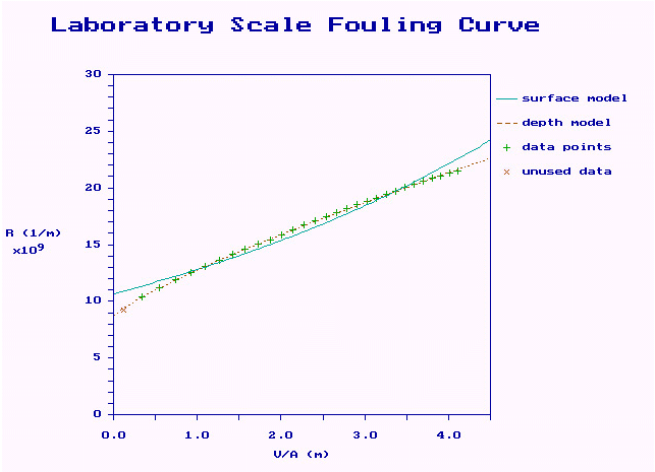
$$R = R_m + a\left(\frac{V}{A}\right)^b$$

where: a = fouling coefficient
b = fouling constant





Figures 1, 2 and 3 are images from computer screens of graphs drawn by FILTER. The volume of wine filtered is plotted along the x-axis while the resistance experienced by the wine as it passes the filter is plotted on the y-axis.



It is typical to think of fouling as an accelerating process. This is shown in Figure 1 where the lines curve upwards. In cases like this both models may describe the fouling quite well. By its nature the surface model must continually accelerate so it is suited to this sort of pattern. In many cases however fouling does not progress with constant acceleration. The depth

model can describe a much wider array of scenarios. Figure 2 shows a common occurrence: while the resistance does increase throughout the filtration, the rate of increase actually falls. This results in a downward curve, a phenomenon which the depth model can handle.

Once FILTER has fit the models into the observed data the next task is to extrapolate the fouling curve to its full scale conclusion. This is accomplished simply by continuing the model curves until each reaches the maximum tolerable full scale resistance. Figure 3 shows the data from Figure 2 extrapolated in that way.

Looking at Figure 2 it is not hard to imagine that the two models would diverge dramatically as they are extrapolated beyond the collected data. One also gets the sense that the depth model is a better match for the data set. This wine was a 1999 Pinot Grigio being prepared for bottling and the full scale filtration performance during bottling matched the prediction made by the depth model much more closely than the surface.

There are many cases where choosing which model is the better description of the filtration is a difficult task. In many of those the divergence of the models still occurs. The question of which model will be used to make production decisions then becomes an important one. This is discussed further in the section called *LIMITATIONS*.

The Basics

This section contains a brief orientation to the organization of FILTER. Reading this section, *The Basics*, and the next two, *Commands and Controls* and *Your First Wine*, will allow a person to navigate the program. For a detailed description of each command see *Appendix 3*.

Each wine being considered by the user is represented by a window. These windows can be moved by clicking on and dragging the top bar and resized by dragging their lower right corner. Windows have a close icon in the upper left corner which will close the window when clicked on with the left mouse button. There is also a zoom icon in the upper right corner which will cause the window to fill the screen. If clicked again the zoom icon will return the window to its previous size. In addition, FILTER can arrange all open windows in a tiled or cascaded arrangement, making them easier to view.

Table Wine: 1994 Sauv Blanc
Filter: 0.7um cel pads

Surface Fouling Constants			Depth Fouling Constants			
Rm: 66.29	b:0.590	r:0.980	Rm: 78.36	a: 40.718	b:1.969	r:0.993

Estimated full scale volume: 5488 gallons
Based on the Depth Fouling model
(Surface predicts 5155 gallons)

Laboratory Conditions		Full Scale Conditions	
pressure:	5 psi	maximum pressure:	30 psi
area:	10.0 cm2	area:	4.21 m2
equivalent volume passed:	1400 gal	rate:	9.00 gpm
average face velocity:	3.3 gpm/m2	face velocity:	2.1 gpm/m2

	V ml	Time min sec	V/A m	R 1/m	Rsurface 1/m	Rdepth 1/m	Rmax 1/m
0	na	00	0.000	na	66.29	78.36	1022.4
1	70.0	10 49	0.035	213.29	67.67	78.42	
2	170.0	19 18	0.120	117.10	71.16	78.99	
3	300.0	27 29	0.235	86.89	76.15	80.72	
4	400.0	33 31	0.350	83.28	81.50	83.52	
5	560.0	43 46	0.480	88.43	88.00	87.96	
6	650.0	49 53	0.604	93.81	94.68	93.45	
7	790.0	60 09	0.719	101.22	101.34	99.63	
8	890.0	67 45	0.839	104.90	108.77	107.18	
9	1000.0	76 28	0.944	109.38	115.73	114.71	
10	1090.0	84 56	1.044	129.85	122.76	122.69	
11	1170.0	92 42	1.129	134.01	129.08	130.07	
12	1260.0	101 24	1.214	133.43	135.72	138.02	
13							
14							
15							

Figure 4 shows such a window, though on a computer monitor a smaller portion would have to be viewed at a time. At the bottom of the window is a table. The first two columns show the data as collected in the laboratory. The next two columns are the volume and resistance values calculated from the laboratory data. The models are fit to the numbers in these two columns generating the fouling constants, R_m, a and b, which are reported at the top of the window. Those constants are then used to calculate the fouling curves of the fifth and sixth columns in the table. The last column contains one number only, the maximum resistance which may be tolerated under the given full scale conditions.

Along with the fouling constants the correlation coefficient, r, is given. The closer r is to 1.000 the better the curve describes the data collected in the laboratory. It is this value which FILTER uses to determine which model is the better choice to describe each filtration.

Between the constants and the table the window shows the laboratory and full scale conditions currently being considered. This is the place to look for a comparison of the laboratory and full scale face velocities. Face velocity is defined as the rate of filtration per area of filtration; the units used in FILTER are gallons per minute per square meter. The importance of face velocity is discussed in the section called *LIMITATIONS*.

Also with the laboratory conditions is a number titled equivalent volume passed. This value represents the volume of wine which would have passed the full scale filter under the same time and pressure conditions as the trial filtration. It gives an impression of how much extrapolation FILTER is being asked to perform. In Figure 2 the number is 1,400 gallons. If a day's work is 4,000 gallons the resistance for the last 2,600 must be predicted by FILTER.

FILTER will also display the resistance data and fouling curves graphically. Two types of graphs are available, a laboratory scale graph and a production scale graph. These may be selected under the Options menu. If the user selects Laboratory Graph FILTER will display the resistance data from columns three and four graphically with the fouling curves of columns five and six drawn on top. This graph will give the user a picture of how well each curve fits the laboratory data. To see how the fouling curves relate to cellar conditions Production Graph should be selected. This graph is the same as the laboratory scale graph except that the curves are drawn until they meet the maximum allowable full scale resistance shown in column seven. The two graphs frequently give different impressions; their use is discussed further in the section titled *data analysis*.

Commands and Controls

A command is a request for FILTER to do something, for example, "Give me a new wine," or "Close the active window." Commands may be generated by using the mouse or keyboard to select items from FILTER's menu, or through the use of a hot key shortcut. The menu and hot keys are referred to as controls.

When FILTER is first run a clean desktop is displayed, at the top of the desktop is the menu bar. The menu bar can be clicked on with the left mouse button to generate commands. Alternatively, the *F10* key will activate the menu allowing use of the keyboard to move through the menu. After striking *F10* the keyboard may be used in two ways. The keyboard direction arrows will navigate the menu and *return* or *enter* will select the highlighted choice. Also, striking the letter highlighted in a menu choice will generate that command.

Below the desktop is the hot key status bar. This bar reminds the user of basic keystrokes to generate commands (hot keys). For example, "**Alt-Q** Quit" indicates that pressing *Q* while

holding the *Alt* key will quit FILTER. In addition, clicking on status bar items with the left mouse button will generate that command. There is a hot key shortcut for every command available in the menu, so many hot keys exist that do not show up on the status bar. See Appendix 2 for a description of each hot key control.

If FILTER has a message to deliver or requires data entry from the user it will bring up a dialog box. Dialog boxes respond to left mouse button clicks just like windows. They may be moved via dragging with the mouse but they may not be resized. Also pressing *return* or *enter* will accept a dialog box as it exists. The example in the next section will demonstrate how dialog boxes function.

Your First Wine

Perhaps the best way to become acquainted with the FILTER system is to look at an example. This will show both how FILTER works and what sort of information it provides. The previous two sections, *The Basics* and *Commands and Controls*, discuss some of the terms used in this example (e.g. window, command, control, hot key, dialog box). The user should be acquainted with the information in those two sections prior to going through this example.

For this example the information in Figure 4 on page 5 will be used. The data is taken from a 1994 Sauvignon Blanc being filtered through cellulose pads.

It is necessary to be somewhat familiar with the laboratory procedures found in Appendix 1 before going through this example.

entering conditions and laboratory data

In practice filtration data will typically be collected automatically as wine is filtered into a container on a scale. In this case the data was originally collected by hand. Entering the data by hand will provide a sense for how collected data can be edited.

The first step for considering a new wine is to enter the laboratory and full scale filtration conditions. Table 1 is a cookbook to accomplish this. The first column is for mouse use, the second for keyboard use and the last indicates what is happening.

When entering data for the first time it is easiest to *<tab>* through the fields rather than use the mouse. To return to specific fields for editing the mouse is more helpful.

Menu Choice or **Mouse Selection**	**Hot Key** or **Keyboard Entry**	**Result**
Wine, New	*F2*	dialog box appears for entry of filtration conditions
Wine Name	*<tab>*	ready to enter wine name
-	*1994 Sauv Blanc*	wine name entered
Filter Name	*<tab>*	ready to enter filter name
-	*0.7um cel pads*	filter name entered
Accumulated	*<tab>, A*	select type of volume data recording
Table	*<tab>, T*	select type of wine being tested
Pressure	*<tab>*	ready to enter laboratory pressure
-	*5*	laboratory pressure entered in psi
Filter Diameter	*<tab>*	ready to enter lab filter diameter
-	*35.7*	filter diameter entered in millimeters
Pressure	*<tab>*	ready to enter max full scale pressure
-	*30*	full scale pressure entered in psi
Area	*<tab>*	ready to enter full scale area
-	*4.21*	full scale area entered in square meters
Rate	*<tab>*	ready to enter filtration rate
-	*9*	filtration rate entered in gal per min
gpm	*<tab>, G*	select units for filtration rate
OK	*<rtn>*	accept data as entered

Table 1 - cookbook to enter conditions for example wine

At this point FILTER brings up a second dialog box which allows the user to enter the data collected in the laboratory. The data to be entered here may be found in the table within Figure 2. The columns labeled V and Time contain the laboratory volume and time data used in this example. Table 2 outlines the data entry.

Menu Choice or **Mouse Selection**	**Hot Key** or **Keyboard Entry**	**Result**
box #1 under the V column	*<tab>*	ready to enter volume of first data point
-	*70*	volume of first data point entered in ml
next box under V column	*<tab>*	ready for volume of next data point
-	*170*	volume of next data point entered
repeat previous two steps until all volume data from Figure 4 is entered (12 points)		
box #1 under the min column	*<tab>* repeated	ready to enter minutes of first data point
-	*10*	minutes of first data point entered
box #1 under the sec column	*<tab>*	ready to enter seconds of first data point
-	*49*	seconds of first data point entered
next box under the min column	*<tab>*	ready to enter minutes of next data point
-	*19*	minutes of next data point entered
next box under the sec column	*<tab>*	ready to enter seconds of next data point
-	*18*	seconds of next data point entered
repeat previous four steps until all time data from Figure 2 is entered (12 points)		
OK	*<rtn>*	accept data as entered; new window appears displaying fouling information

Table 2 - cookbook to enter laboratory data for example wine

data analysis

The window which appears once all the data is entered should look like the one in Figure 4 (page 5). This window contains all of the fouling information regarding the filtration in question. However it is generally helpful to look at the information graphically. This will help answer several questions. For example, is the data set error free? How well do the model fouling curves fit the resistance data? Should I discard any portion of the data? And, how do the data and each fouling curve relate to the full scale filtration?

To answer questions about the data and how closely the model curves fit the data select **L**aboratory Graph from the **O**ptions menu. You should see that the first three data points of the example show the resistance falling, not rising as would be expected due to fouling. This is common when running pads. It takes some time for the pad to become saturated, even after being soaked in the lab. During this time the pad is swelling; the matrix of cellulose fibers expands for the first half hour or so of the filtration. Once this phase is complete normal fouling is observed. FILTER disregards the first three points as not representing the fouling curve for this filtration. The rest of the data is used to calculate the fouling constants, R_m, a, b and r.

When running membrane filters exactly the opposite problem occurs; it is common for the first data point to show an oddly low resistance. This is may be an artifact of the laboratory procedure - the pressure under no flow is slightly higher than when wine is flowing. In these cases FILTER will not skip the points automatically. The user must return to the data entry dialog box and ask FILTER to skip any points which do not represent the fouling curve. To do this go to the **O**ptions menu and select Edit **D**ata. In the dialog box mark the button next to the number of points to be skipped (0 to 12).

To answer questions about how the data and the model curves relate to full scale filtration select **P**roduction Graph from the **O**ptions menu. This graph follows the curves of both models until their resistance rises to the maximum allowable production resistance, represented by the horizontal dashed line. The point where each curve intersects that line represents the end of the full scale filtration - the moment when the pressure has risen to the maximum allowable pressure drop given the area and rate of filtration. FILTER calculates the volume at that point and reports it in the wine window. For this wine that volume is 5,488 gallons using the Depth model. That is the amount of wine which will pass a filter of the given size, at the given rate, with the given maximum pressure *if the filtration follows this fouling curve*. The full scale filtration will only follow this fouling curve if it is run at the same temperature and face velocity. For a more lengthy discussion of this see the section called *LIMITATIONS*.

The full scale conditions indicate that this filtration is to run at nine gallons per minute. A filtration run at 9 gpm for six hours would pass 3,240 gallons. FILTER predicts 5,488 gallons will pass the pads before they are completely fouled, so the winemaker may be confident that this wine will be filtered in a day's work with a single setup.

saving a file

A wine may be saved as a DOS file for retrieval at any later time. By default FILTER names files using the first eight characters of the wine and filter names and adds an ".FLT" extension. Nonalphanumeric characters are replaced with a "_". The default directory is "\FILTER". So the wine "1994 Sauv Blanc" would be saved in the file ":\FILTER\1994_SAU.FLT" unless the user requests otherwise. Table 3 shows how to save a wine to disk, close the window and then reopen it from the saved file.

Menu Choice or **Mouse Selection**	**Hot Key** or **Keyboard Entry**	**Result**
Wine, **S**ave	*F4*	Save a Wine File dialog box appears
-	*94SBPADS*	type new filename
OK	*<rtn>*	accept the file name as entered; file is saved as C:\FILTER\94SBPADS.FLT
wine window close icon	*Alt-F2*	close the wine window
Wine, **O**pen	*F3*	Open a Wine File dialog box appears
-	*94SBPADS*	type the name of the file to be opened
OK	*<rtn>*	file is read and wine window displayed

Table 3 - cookbook for saving and opening a file for the example wine

The sixth step in Table 3, entering the name of the file to be opened, may be handled as above, that is by simply typing the name of the wine. The Open a Wine File dialog box however allows for mouse use also. Double clicking on the file name in the list of files within the dialog box will also open that file. FILTER will start by listing files and directories in the "\FILTER" directory. If files have been moved to or saved in another directory, that directory may be selected with the mouse or typed into the "**N**ame" input line. The last item in the file list, "..\", can be clicked on to open the parent of the current directory. The arrow to the right of the "**N**ame" input line opens a history list of previously used path and file names.

When saving a wine as a DOS file it is important to remember some rules about DOS filenames. DOS does not recognize case, or allow spaces in file names, and filenames can be only eight characters long. FILTER replaces any non alphanumeric characters with a "_". So FILTER recognizes "New Wine", "new wine", "new_wine" and "new_wines" as legal and distinct names for four different wines. However, when saving them they all receive the same default file name "NEW_WINE.FLT". Conflicts will be avoided either by using only upper case alphanumeric characters and wine names of less than eight characters, or by simply being aware of DOS file naming protocol. In any event FILTER will issue a warning before overwriting any file.

SOLUTIONS

Several files were included on the FILTER distribution disk to help demonstrate some decisions which can be made using the software. These files have an FLT extension on their name. They can be opened from the FILTER desktop by selecting **F**ile, **O**pen from the menu or pressing *F3*. Each section below will take you through an example using the information in those files.

Ready To Bottle

Press *F3* and select the file MODELS1.FLT to be opened. This is a standard membrane fouling trial performed to decide if the wine was ready to bottle. The estimated volume that could be expected to pass a single 30 inch cartridge filter is shown for each model. For a discussion of which model is most appropriate see the discussion titled *Selecting a Model* from the *LIMITATIONS* section of this manual. For this example only the depth model will be considered.

The volume of wine which is expected to pass the filter during bottling is about 12,000 gallons. There is no blanket rule for interpreting a given data set. That is the strength of FILTER: it gives more than just a pass/fail score. Different winemakers will have different expectations with regard to the performance of membrane filtrations. The decision of whether to bottle or not will depend on the size of the lot, the willingness of the winemaker to put the wine through further treatments, the cost of the treatments, the cost of the cartridge, and the winemaker=s opinions and tendencies. So there is no way to say whether this data set represents a wine which is ready to bottle unless one has that background information

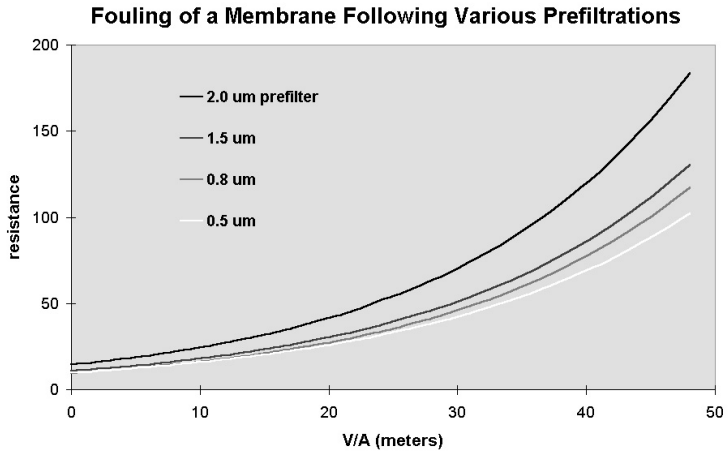
The data for this example was taken from a 4,000 case bottling run of Pinot Grigio, and it was the only white bottling scheduled for that winery that season. So this was a wine which was to be finished through a membrane and there would be no use for the membrane after this run, and FILTER predicted that the whole run could be done with one cartridge. Clearly, in this case, the wine is ready for bottling with no further treatments. At another winery, with different equipment, different volumes and a different winemaker, the answer could be different.

Sometimes a trial may show no fouling. The file NO_FOUL.FLT demonstrates this. Since no fouling is seen the estimated full scale volume cannot be calculated. In terms of the question, is the wine ready for bottling, the answer is definitely yes. However, this wine perhaps received more treatments that necessary in the cellar. It is not necessary to pad or earth filter a wine to the point where no fouling is seen at the membrane. It might have been gentler on the wine and saved money to not filter to such an extent.

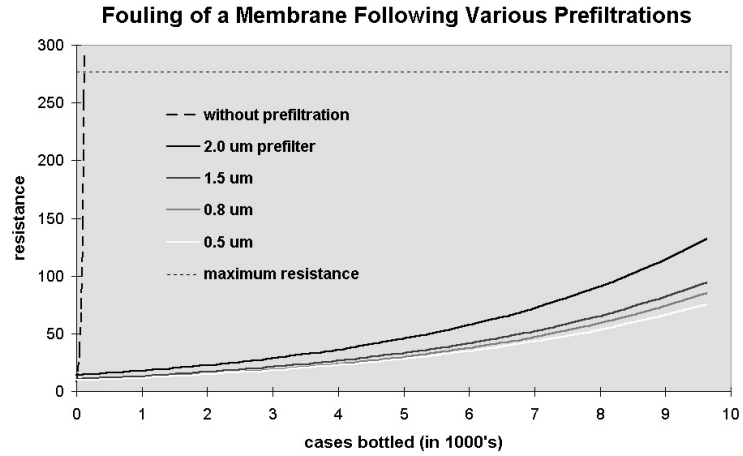
Another point about trials that show no fouling is that the correlation coefficient, *r*, is generally very low. This is because of how it is calculated. What the correlation sheds light on statistically is this: the amount of variation in the resistance, *R*, which can be accounted for by changes in *V/A*. A correlation of 1.000 indicates that all of the variation in *R* can be attributed to changes in *V/A*. If no fouling takes place then all variation in *R* can be attributed to noise in the data collection and the correlation will be near zero. Conversely, a trial which fouls very quickly will have a correlation coefficient near one. So a low *r* value does not necessarily indicate that the data is unreliable and a high *r* value does not necessarily mean that no error occurred in the collection of the data. The laboratory scale graph should be looked at closely to get a feel for the data set.

Pad Choice

Figure 5 shows four fouling curves; these curves are from data contained in the files PADCH?.FLT. Each is a picture of the same wine passing the same type of membrane after four different prefiltrations. The prefiltration media were cellulose pads rated at 2.0, 1.5, 0.8 and 0.45 µm. From the graph one can see that as the pads get more coarse they allow the wine to foul the membrane to a greater extent - not a surprising result.



The question remains which treatment is most appropriate to the finishing of the wine, but one can not see if the differences are significant from a production standpoint until one asks more questions. How much wine do I need to filter? What is the fouling of the untreated wine like? And, most importantly, given the area of my filter, the flow rate I expect, and maximum pressure I am willing to tolerate, how much resistance can I put up with full scale? Figure 6 answers those questions. The x axis is scaled in cases bottled rather than volume per area. The fouling curve of the untreated wine is shown as a dashed line. Finally, the maximum resistance which can be tolerated by this winemaker for this wine in this facility is shown as a horizontal dotted line.



With the perspective offered by Figure 6 it is easy to see that almost all of the

improvement in filterability is achieved with the loosest pad. The additional change provided by the tighter pads, while large enough to be measured by the system, is insignificant from a cellar standpoint.

The data from this example was collected during the finishing of a commercial wine from the 1998 season. It was a run of about 4,000 cases. The wine was finished with the 1.5 µm pad filtration, no cartridge in the prefilter housing, and a 0.45 µm membrane B completely atypical of the finishing of a wine for a membrane bottling. The 2.0 µm pad was not used because it was not on hand in the cellar; that test was run two weeks later out of curiosity at just how coarse we could go. We still don't know. We never will because this wine was long ago put into bottle and is almost entirely consumed, but we do know that the finishing of this wine was very unusual and involved decisions that could not have been made without the use of FILTER.

Crossover Plate Placement

When running pads in a series using a crossover plate the question arises of how many pads to devote to each stage. FILTER has a special function which will calculate this under the **O**ptions menu. In order to use this function there must be exactly two windows open, one representing each stage of the crossover filtration. The file XOVER1.FLT represents the primary stage and XOVER2.FLT the secondary. Make sure that all other files are closed and open these two files.

The data was generated as follows. A trial was run with the coarse pad (1.7 µm) and the filtrate was collected. A second trial was run using the collected filtrate and the fine pad (0.6 µm). Together these two files represent the crossover filtration.

With these two windows open select **C**rossover Calculation from the **O**ptions menu. FILTER now brings up a dialog box requesting the total number of pads to be used and the area of each one. Consider a filter with room for fifty 40 cm^2 pads. The useable area of each pad is 0.14 m^2. Enter 50 and 0.14 into the dialog box. FILTER reports the number of each type of pad to use. Also the full scale area, face velocity and expected volume are updated to reflect the number of pads for each stage. The expected volume for both stages should be fairly close to one another B in this case 6,014 and 5,733 gallons.

When making these recommendations FILTER does not consider the face velocity of each step. The winemaker should look at the face velocity of both steps and make sure that each fits within an acceptable range.

LIMITATIONS

Selecting a Model

The two models of fouling used by FILTER were introduced in the section called *GETTING STARTED*. Two data sets were considered there in order to illustrate some general differences between the models; the same two will be considered here. The example files which contain the data sets are MODELS1.FLT and MODELS2.FLT. Both examples are Pinot Grigio from the same winery; MODELS1 is from 1998 and MODELS2 is from 1999. The wines were being prepared for bottling and the question being asked is whether or not the wines are ready to pass a bottling membrane.

Begin by looking at the laboratory scale fouling graph for each wine. This is done by selecting **L**aboratory Graph from the **O**ptions menu. (This provides the same picture shown in Figures 1 and 2 on page 4.) In the 1999 wine the fouling is not accelerating. This is seen on the graphs as a downward curve to the data. In the 1998 example the fouling does accelerate, that is to say the fouling graph curves upwards.

Next consider the estimated full scale volumes for each wine. In the 1999 example there is substantial disagreement between the two models: the Surface predicts 7,900 gallons while the Depth 45,640. This reflects the divergence of the two models shown in the production scale graph (Figure 3 on page 4). This was a 10,000 case bottling run and the wine behaved more like what the depth model predicted. There is closer agreement between the models for the 1998 wine, where the fouling does accelerate.

The surface model is virtually always more pessimistic if there is a substantial difference. The depth model is capable of describing a greater variety of fouling situations. Initially FILTER was applied conservatively, using the more pessimistic surface fouling predictions of what could be expected in the cellar to make decisions on how to handle wines. Over time, with a variety of wines, the depth model has shown itself to be more robust and in general a better predictor of full scale filtration performance. At this point it is recommended that the results returned by the depth model be given more weight than those of the surface model.

As further evidence for this compare the predicted full scale volume for each of these two wines using the surface model. The numbers are very close even though the data sets are quite different. The surface model is unable to detect the difference while the depth draws a very different picture for each wine.

Face Velocity

When running any sort of laboratory trial it is important to be aware of full scale conditions. For example, a fining trial will accurately reflect the way the fining agent will behave full scale only if an effort is made in the lab to prepare the agent as it will be prepared in the cellar and to make the addition as it will be made in the cellar. In order to make a filtration take place in the lab as it will in the cellar it is necessary to filter at the same face velocity and temperature as full scale. While face velocity can be a bit harder to control in the lab it is every bit as important as temperature.

In the lab the face velocity depends on the pressure at which the trial is run. The pressure recommended for a typical filterability test is 4 psi. This is high enough to allow trials to proceed without specialized laboratory equipment and low enough to be within range of cellar conditions.

Often, at pharmaceutical companies and wineries alike, filterability testing is done at quite a high pressure - pressure like one might see just before declaring a filter completely

fouled. The logic of this is that the conditions which should be mimicked are those of the end of the filtration, and that in a given time frame more wine will be collected. While initially may seem an advantage it turns out to be a problem. As any filtration is run more quickly the rate of fouling would be expected to rise; in essence it becomes a different filtration - a filtration which fails to represent cellar conditions at all.

Sampling

As with any laboratory analysis acquiring a sample which represents the lot as a whole is important. For a tank which has been just been filled this is not a problem. For a well settled tank it is also not a problem. Winemakers should pay attention when they are in a time between these two moments and the tank is still settling. In practice this is probably a poor time to filter, but the demands of a bottling schedule may place a wine there at a time when a filtration must be scheduled.

Time

The only other thing which can cause trouble is time. If a filterability test is run and a month goes by during which microbes may grow, colloids may reform, or solids may be resuspended in a racking then the results may be inaccurate.

APPENDIX 1 - Laboratory Procedure

Table 4 shows protocol for data collection. It is impossible to create a single test which makes sense for all questions; the table is presented only to provide a starting point. Your procedure should then be adapted to your own wines and filtration media, and designed to answer questions specific to your cellar.

In general all tests may be run at a single pressure, perhaps 4 psi, and with a similar sample size, perhaps 3 liters, and data collection intervals adapted to the length of the resulting run. Membranes run much more quickly than pads, and a 2.0 µm pad may run twice as fast as a 0.5 µm pad.

	membranes		**pads**	
pressure	4 psi		4 psi	
filter diameter	47 mm (useable diameter is less)		47 mm (useable diameter is less)	
	minimum	typical	minimum	typical
sample size	1 liter	3 liters	1 liter	22 liters
total filtration time	10 minutes	30 minutes	2 hr @ 2.5 µm 2 hr @ 0.5 µm	12 hr @ 2.5 µm 5 hr @ 0.5 µm
data collection interval	0.5 minute	2 minutes	2 minutes	8 minutes

Table 4 - typical laboratory protocol

If one is simply trying to compare one tank with another, to see if they are different, a test might run for as little as ten minutes. If one is hoping to predict fouling for a bottling run which will last for weeks a much longer test should be employed. For a short test a short interval should be used. The shortest interval available is 30 seconds and eight data points is plenty of information for FILTER to base its calculations on, so a test could in theory be only a few minutes long. The longest interval available between collection of data points is 32 minutes; if all 36 points were collected the test would take over 19 hours. In practice tests might typically range between fifteen minutes and four hours.

The maximum weight that the scale can take is about seven kilograms so that provides a limit to data collection also. If a very long run is desired a very small filter area would have to be employed. Typically the lab scale media is 47 mm in diameter but 13 mm housings are available also.

APPENDIX 2 - Scale Settings

To automate the collection of data the receiving vessel must be placed on a scale connected to one of the computer's serial ports. FILTER uses an electronic balance manufactured by Denver Instrument.

FILTER is designed to be used with all of Denver Instrument=s default settings except two. The scale must be set to Aprint@ a weight on request whether stable or not, and the output must be formatted as FILTER expects. Details for this procedure can be found in the Denver Instrument manual; an outline is included here.

With the balance turned on press and hold the SELECT button. Press it repeatedly until the display reads SETUP. Then press ENTER. Press SELECT again until the display reads PRINT.OUT. Press ENTER. The display should read PRINT; press ENTER. Press SELECT until MAN W/O is displayed; press ENTER.

Press CLEAR to back out to the PRINT menu. Press SELECT until the display reads FORMAT; press ENTER. Press SELECT until the display reads 16 CHAR; press ENTER.

Press CLEAR four times to exit the menu and save the settings.

In addition FILTER must be set to communicate through the serial port into which the scale is plugged. This can be done by striking *Alt-T* or selecting Se**t** Scale Connection from the **W**ine menu.

APPENDIX 3 - Command and Control Reference

Keyboard and Mouse Use

Every action available to the user of FILTER is available through the menu located at the top of the screen. The left mouse button can be used to select menu items in two ways. A click on the menu title of interest followed by a click on the command to be chosen will generate that command. Alternatively, clicking on a menu title, dragging down the menu to a menu choice, and releasing will generate that command. Keyboard users can navigate the menu with the arrow keys after pressing the *F-10* key. As a shortcut to the arrow keys, the highlighted letter of a menu item may be pressed to select that item.

The *tab* key will skip through the input fields of dialog boxes one by one and *Shift-tab* will skip through in reverse order. This is generally most useful when performing data entry for a new wine. The left mouse button will select any field of a dialog box directly. Often dialog box fields contain highlighted letters which can be pressed as a shortcut to mouse selection (e.g. *O* to select an **O**K button).

Wine Menu

Open
Action: Used to retrieve a wine file.
The name of the file name may simply be typed or the file name may be selected with a double mouse click.
Hot key shortcut: *F3*

New
Action: Used to create a window representing a new wine.
Hot key shortcut: *F2*

Close
Action: Closes the currently highlighted window.
If the window contains information which may be useful at a later time **S**ave should be selected first.
Hot key shortcut: *Alt-F2*

Save
Action: Saves the currently active window to disk. The default name of the file will be the first eight characters of the wine name with the file extension ".ACD" added.
See page 9 for precautions to be followed when saving files.
Hot key shortcut: *F4*

`To Te`**`x`**`t`

Action: Saves the table in the currently active window as a text file so the information may be ported to a word processor or spreadsheet. The file is saved in the directory "\FILTER". The name of the file will be the first eight characters of the wine name with the file extension ".TXT" added. See page 9 for precautions to be followed when saving files.

Hot key shortcut: *Alt-X*

`P``rint`

Action: Prints the table contained in the currently active window; the printer must be connected to LPT-1.

Hot key shortcut: *F7*

`Se`**`t`**` Scale Connection`

Action: Brings up a dialog box which allows the user to set which COM port will be used for communication with the scale.

Hot key shortcut: *Alt-T*

`Q``uit`

Action: Quits the program; there are no prompts to remind you to save your work so be sure all of the files you need have been saved.

Hot key shortcut: *Alt-Q*

Options Menu

Edit Conditions

Action: Allows the user to change the lab conditions for the active window.

Hot key shortcut: *Alt-E*

Edit **D**ata

Action: Allows the user to edit the data set for the active window. The dialog box which this command brings up allows the user to tell FILTER to disregard the first points in a test if there is a sense that they do not represent the curve as a whole. It is recommended that the first point be skipped in virtually all data sets. In order to disregard points at the tail end of the curve it is not necessary to erase all of the data: if one simply deletes a single time point FILTER will not consider any data collected beyond that time

Hot key shortcut: *Alt-D*

Collect **N**ew Data

Action: Collects new data and writes it into the active window. While data is being collected other work may be done on the computer, including running a second instance of FILTER to bring up existing files and compare them with the current test.

Hot key shortcut: *Alt-N*

Laboratory Graph

Action: Displays a graph which allows the user to examine the data set.

Hot key shortcut: *Alt-L*

Production Graph

Action: Displays a graph which allows the user to see how the data set relates to full scale conditions.

Hot key shortcut: *Alt-P*

Crossover Calculation

Action: Proper use of this calculation is described in the section above called *Crossover Plate Placement*.

Hot key shortcut: *Alt-C*

View Menu

Cascade
Action: Arranges all open windows in a stacked arrangement with all window titles (wine names) visible.
Hot key shortcut: *Alt-F5*

Tile
Action: Arranges all open windows side by side, maximizing the area visible for each.
Hot key shortcut: *Shift-F5*

Zoom
Action: Expands the active window to fill the screen. Once a window is expanded choosing the zoom command again will return it to its previous size. Zoom is very useful after tiling four or more windows.
Hot key shortcut: *F5*

Next
Action: Causes the next window in line to become active.
Alternatively a mouse click on a window will make that window the active one.
Hot key shortcut: *F6*