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MEASURING OF HAZE BY FILTRATION

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Abstract

Filtration index is shown as an objectiv measuring system of haze to be able to use it in beverage industries.

The Linear-, and the Power model are alternative descriptions of the accelerated fouling within the filter medium or on its surface.

The resistance, the filterability value is calculated from the change in filtrate volume over a small interval in time with the other quantities and being known from the test conditions.

$$IF = \left(\sum_{i=0}^{i=600} \tau_i - \sum_{i=0}^{i=200} \tau_i \right) - 2 \left(\sum_{i=0}^{i=400} \tau_i - \sum_{i=0}^{i=5200} \tau_i \right)$$

The data were analyzed by computer to determine the filtration rate instantaneous resistance.

The 5 IF value indicates a clearity limit so we can say that when IF value of the sample is less than 5 the sample is bright, brilliant, and if the value is bigger than 5 the turbidity of samples is undesirable.

1. Introduction

Filtration is an operation on processing stage in which insoluble solids are separated mechanically from the fluid in which they are dispersed.

Wine and similar liquids to be stabilized by filtration is passed through a membrane having uniform openings. All the insoluble solids and mincroorganisms that are larger than pores will be retained on the inlet surface.

The emerging filtered wine will be stable and ready for bottling.

But how to make it sure that this process is proper?

The need for filter testing has generally been accepted, but up to date there are few reliable tests for pads and membranes which are in general use and none of them which can be used to predict a full-scale filtration behaviour. [5]

Our target is to create a prompt, exact, objective measuring system for turbidity.

2. Theory

The filtrations rate equation based on the work of Darcy is: [5]

$$\frac{1}{A}\frac{dV}{d\tau} = \frac{\Delta p}{\eta\left(rc\frac{V}{A} + R_M\right)} \qquad (1)$$

where :

$-dV/d\tau$	rate of change of the filtrate volume with respect to time, $[m^3/s]$
$-\Delta p$	is the pressure difference across the filter, [Pa]
$-A$	filter area, $[m^2]$
$-\eta$	fluid viscosity, [Pas]
$-R_M$	medium resistance, [1/m]
$-r$	specific cake resistance, $[1/m^2]$
$-c$	concentration of the solids collected, $[m^3/m^3]$
$-V$	filtrate volume. $[m^3]$

The terms in the parentheses are the two components of the resistance. The first term R_M is the medium resistance, and it represents the resistance to flow due to the screen and the precoat material.

The second term rcV/A is the flow resistance of the cake collected. [1]

The cake resistance grows linearly with the volume filtered, V, and its magnitude is directly proportional to rc where r and c are constant properties of the solids collected. It is important to note that the first term is a property of filter medium only, while the rc term is a property of wine or liquid to be filtered. [3]

The Power model is an alternative description of the accelerated fouling within the filter medium or on its surface. [6]

The Power model:

$$\frac{dV}{d\tau} = \frac{\Delta p}{\eta\left(rc\left(\frac{V}{A}\right)^b + R_M\right)} \qquad (2)$$

The Power model says that the fouling term is not necessarily significant from the beginning of the filtration it can however, grow rapidly since the power constant is generally greater than unity.

3. Experimental

The system for evaluating the filterability and measuring the index filtration is constructed from the following parts (see fig.1.):

1 compressor
2 bench-top pressure reservoir with an accessary
3 filter holder (porous of membrane: 0,8 μm [2])
4 graded semianalytic electrical toploading scale

To operate the system the outlet pressure of air is kept at 0.2 MPa and the temperature is kept at 10 °C. Filtration rate does not depend on the alcohol and sugar contents of wine because the time difference is measured.For filterability determination wine is filled into the pressure reservoir and pressurized through the inlet pressure connecting tube and the mass of filtrate is recorded as a function of time. Our equation is based on Laurenty method, but it was changed by Meglioli: [4]

$$IF = \left(\sum_{i=0}^{i=600}\tau_i - \sum_{i=0}^{i=200}\tau_i\right) - 2\left(\sum_{i=0}^{i=400}\tau_i - \sum_{i=0}^{i=5200}\tau_i\right) \qquad (3)$$

i volume of filtratum $[m^3]$

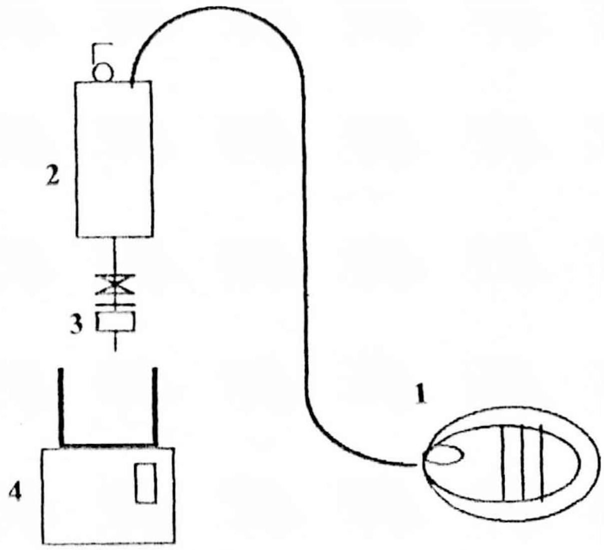

Figure 1.: Circuit diagram of system

4. Analysis of membrane filterability data

The data from membrane filterability determination were formulated as increments of time and of volume between successive points of each determination. The data were analyzed by computer to determine the filtration rate instantaneous resistance.

The slope of the supposed straight line is in direct ratio to rc (see Theory).

Table 1. Result of function analysis

Num.	Sample	linear form y=	lin.corr. coeff.	power form log y=	pow. corr. coeff..	IF
1	Sauvignon	0,177x+0,11	0,9962	0,75x-1,23	0,9928	0,8
2	Chardonnay 1	0,79x-0,78	0,9700	1,45x-1,22	0,9955	7,4
3	Pinot noire	1,37x-1,25	0,9898	1,5x-0,77	0,9976	12,9
4	Cabernet franc	0,2x+0,3	1,0000	0,61x-0,76	0,9951	2,8
5	Merlot	0,79x-0,77	0,9770	1,46x-1,22	0,9978	7,4
6	Riesling 1	1,19x-0,87	0,9831	1,5x-0,76	0,9985	11,4
7	Chardonnay 2	0,151x+0,15	0,9676	0,87x-1,45	0,8906	1,9
8	Riesling 2	0,1x+0,26	0,9639	0,46x-1,03	0,9318	1,6
9	Furmint	0,39x-0,046	0,9976	1,18x-1,12	0,9950	3,2
10	Ital.riesling	0,48x+0,06	0,9930	1,08x-7,95	0,9890	6,3
11	Szürkebarát	0,82x-1,2	0,9120	1,47x-1,53	0,9420	7,0

Fig. 2. shows the inverse rate of filtration for different haze samples and the numbers show the filtration indexes.

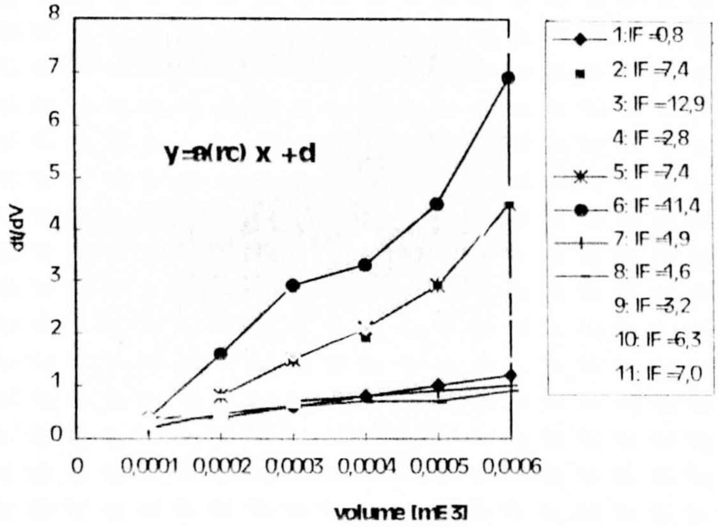

Fig. 2.: Inverse rate of filtration plotted against filtered volume

We can see that the slopes of stright lines are closely connected with filtration index, and as we know that the slopes have relation to specific cake resistance (rc) so filtration index has also relation to specific cake resistance.

To verify the truth of the above statement we delineate slopes against filtration index (IF).

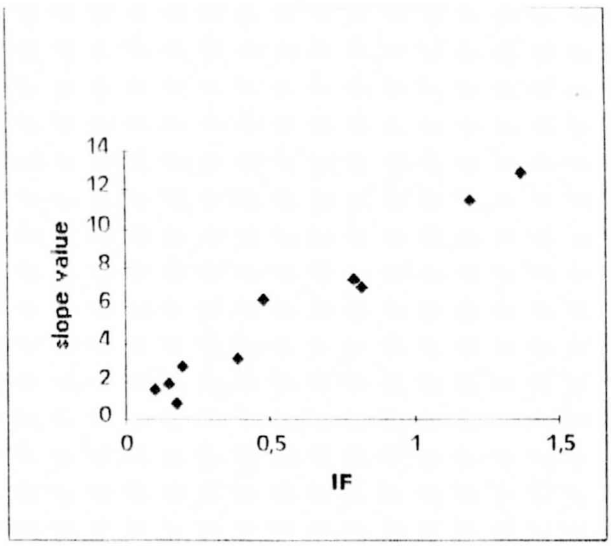

Fig. 3.: Correlation between IF and slopes

We get a linear functional relationship ($y = 0,1075x - 0,027$) with corelation coefficient, $r = 0.9863$, so we can say that there is a significant relation between IF and filtration resistance, namely filtration resistance determines the IF. IF gives expression to turbidity of fluids.

Let us see again the figure 2. or table 1. We can see, if the value of IF was bigger than 5 the line tends to be curved. When correlation coefficient of equations are calculated as linear equations (r) this values are lower than calculated correlation coefficient of power equations (r_p).

It is known that the linear model is a special case of the power model (b = 1), so we can say this value is the turning point of the cleanliness.

We mentioned above that the linear model is a special case of the power model so we can say that when IF value is bigger than 5 than the power fouling constant (b) becomes bigger than one unity and the equation becomes a power equation.

When IF value is 5 it indicates a clearity limit value, so we can say that when IF value of the sample is less than 5 the sample is bright, brilliant.

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ZAVAROSSÁG MÉRÉSE SZŰRÉSSEL

Összefoglalás

A szűrési műveletek hatásfokának, a szűrési tisztaságnak a mérésére szubjektív (Jackson féle turbidiméter), vagy olyan objektív (turbidimetria, nefelometria) módszerek állnak a rendelkezésünkre melyek mérési elvéből adódó hibalehetőségei igen nagyok.

Célul tűztükki tehát egy olyan szűrtségi tisztaságot jellemző módszer, ill. mérőszám (IF) meghatározását, mellyel a borok tisztasága gyorsan, egzakt módon objektíven jellemezhetővé válna.

Az irodalmi adatokkal összhangban, azok továbbfejlesztéseként kidolgoztunk egy mérőberendezést és egy mérési módszert, amely alkalmas a kitűzött cél megvalósítására.