RÉCENTS PROGRÈS EN GÉNIE DES PROCÉDÉS

MEMBRANE PREPARATION

FOULING - EMERGING PROCESSES

Euromembrane 92-Paris

European Society of Membrane Science and Technology

P. AIMAR
P. APTEL
Editors

VOLUME 6 - 1992

22

LAVOISIER
TECHNIQUE
ET DOCUMENTATION
PARIS

GROUPE
FRANÇAIS
DE GÉNIE
DES PROCÉDÉS

THE USE OF HOLLOW FIBER MEMBRANES IN THE CROSSFLOW FILTRATION OF GRAPE MUSTS

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Abstract

Among the different materials proposed in cross flow filtration, hollow fiber membranes are particularly interesting. However they present limitation in raw must processing due to the high content of lees in this juice. After the elimination of larger fractions of lees, the must could be filtered by such membranes. Employing polisulphone microporous membranes, the retention of suspended solids was obtained, without the loss of typical must substances like those obtained using ultrafiltration.

I. INTRODUCTION

One of the latest innovations in the wine making sector is the application of techniques using cross flow filtration with membranes made of different materials and shapes (1) (2) (3) (4) (5) (6) (7).

The two main spheres of intervention where this occurs is in the filtration of musts and wines.

While in the case of wines there is sufficient knowledge to be able to choose which type of materials is the most suitable for filtration, various practical aspects are still to be defined where musts are concerned (8) (9) (10) (11) (12) (13) (14) (15) (16).

As regards the types of membranes to be utilized in the filtration of musts, it must be remembered that, as in fruit juice in general, these products are rich in lees which can be of rather large dimensions and can contain high quantities of mucilage and pectin.

With this in mind, two different methods of filtration may be taken into consideration when utilizing the cross flow method for musts and grape juices.

The first presupposes the treatment of raw musts placed directly onto tubular shaped membranes (17) (18) (19).

The second needs a pretreatment of the raw musts to reduce the solid contents in the liquid which can in turn be filtered using hollow fibers or spiral membranes (20) (21).

In these case, filtration requires the installation of a relatively simple plant, thus limiting energy cost and lowering expenses for the membrane.

This study was carried out in order to evaluate the results of the first tests using this new process where the raw musts are pre-treated and then filtered using hollow fiber membranes.

II. RESULTS AND DISCUSSION

Figure 1 represents the permeation curves obtained during the filtration tests carried out on musts of white grapes (cv. Garganega) pretreated by flotation.

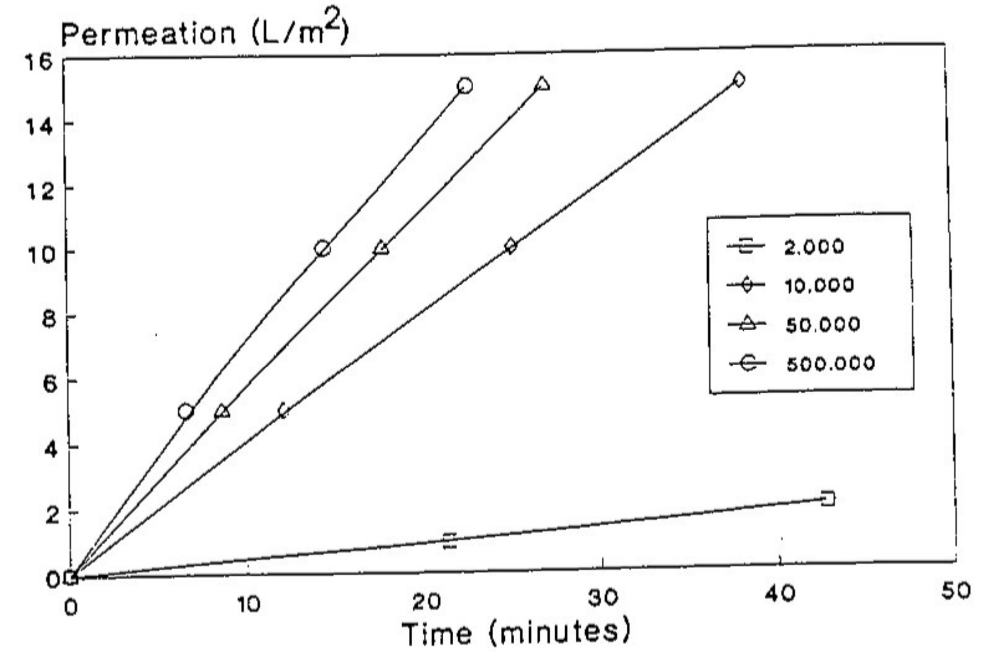

Figure 1

Polisulphone microporous membranes with cut-off variables from 2000 to 500000 Daltons were used for the tests. They were carried out with musts at 22 °C, average transmembrane pressure was 1.2 bar and velocity of the fluid was 3.0 m/s.
The permeation flow was considerably influenced by the membrane cut-off where values were less than 50000 Daltons.
When only taking permeability into consideration the choice has two fall on the higher porosity of this value. Table 1 lists the retention percentages of some of the components of red grape juice cv. Ancellotta cross flow filtered with hollow fibers at different cut-off and using the same methods as in figure 1.
Even in this case the discriminating cut-off is equal to 50000 Daltons. But in this case there was on even more significant reduction in colour intensity and nitrogen compounds.
Wherefore if both the permeation flow and the effect of the composition of the juices are considered it is best to use membranes with a 500000 Daltons cut-off.
Figure 2 represents the permeation flows obtained during experiments carried out on Moscato grapes white musts where cross flow filtration using polisulphone membranes with 500000 Daltons cut-offs and of different origins were used. The tests were carried out on musts at less than 15 °C, average transmembrane pressure was 1.4 bar and the velocity of the fluid was 2.7 m/s.
The three membranes reacted in very different ways. Membrane A showed a lower but costant permeation flow. Membrane B had a very high permeation flow which diminuished by half in the first hour. Membrane C showed a decrease in the permeation flow which was half way between A and B and which resulted as the highest value in respect to membrane A, that is almost double.
Table 2 shows various parameters concerning the composition of the juice obtained.
The most significant differences are those regarding the decrease of the content in colloids which are particularly evident after filtration with membrane A. This leads to

	Membrane Nominal MWCO (Daltons)			
	500000	50000	10000	2000
° Brix	0	1	1	1
Total acidity	0	0	2	2
Total phenols	19	21	41	62
Tannic phenols	20	21	46	65
Non tannic phenols	17	20	33	58
Proanthocyanidins	15	17	40	61
Catechins	26	27	48	66
Anthocyanins	10	16	28	53
Colour	9	16	22	58
Total nitrogen	5	9	15	20

Table 1

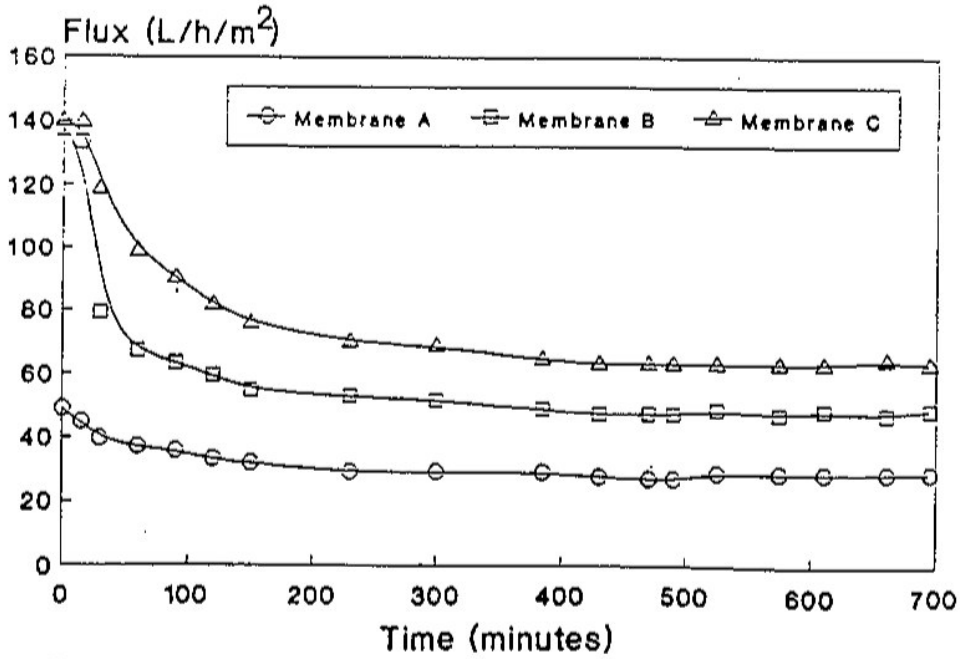

Figure 2

		TEST	MEMBRANE A	MEMBRANE B	MEMBRANE C
Turbidity	NTU	14,40	0,22	0,21	0,25
Colloidal substances	mg/L	215	41	103	138
Total phenols	mg/L	114	112	113	104
Colour	O. D. 420 nm	0,177	0,176	0,165	0,171
Yeast	CFU/mL	4000000	<1	480	45
Lactic bacteria	CFU/mL	2800	15	200	50

Table 2

		CLARIFIED	CLARIFIED AND FILTERED
Carbon dioxide kinetics parameters			
Maximum production rate	mg/L · h	461,6 A	388,9 B
Average acceleration production	mg/L · h^2	14,89 A	12,54 B
Average deceleration production	mg/L · h^2	0,403	0,538
Composition parameters			
Ethanol	% by vol.	9,99	10,03
Reducing sugar	g/L	0,68 A	0,87 B
pH		3,32 A	3,15 B
L-Malate	g/L	0,46 A	2,83 B
L-Lactate	g/L	1,71 A	0,01 B
Acetate	g/L	0,31 A	0,15 B
Glycerol	g/L	4,53 a	4,94 b
Acetaldehyde	mg/L	0,41 A	1,91 B
Ethyl acetate	mg/L	44	36
Ethyl lactate	mg/L	24 A	10 B
Higher alcohol total	mg/L	171 a	201 b

Table 3

the belief that the effective cut-off is less compared to the other two, and/or that there is a higher interaction with the product leading to a greater presence of the polarization gel. Membranes B and C also reveal a lower retention effect of the microorganisms showing that there is a more heterogenic distribution of the porosity.

Table 3 gives the average composition of the fermented products from white wine musts cv. Garganega which had previously been clarified by flotation and then clarified and filtered with a 500000 Daltons cut-off polisulfone membrane.

The table also reports the results of the analysis of variance; the averages which are marked with the same letters are not significantly different when p=0,05 (small letters) and p=0,01 (capital letters).

The results show that the filtration treatment significantly slows down the start of fermentation, but which none the less is completed as shown by the presence of ethanol and reducing sugars. All the other differences of composition found are due to malolactic fermentation which is characteristic of non filtered products and fermented without sulphur dioxide.

III. CONCLUSIONS

Membranes with high cut-offs (Dalton numbers comparable to those in microfiltration) are preferible when dealing with white wine musts. In fact the permeation yields are improved with only a minimum retention of the non-solid components in musts.

Polisulphone microporous membranes can satisfy these needs. However, amongst the different products available on the market, the permeability values and the retention effects proved to be very different.

From the microbiological point of view, technological sterility was obtained, sufficient to allow fermentation by inoculated selected yeasts. The retention of lactic acid bacteria prevents bacterial fermentation even without the use of sulphur dioxide.

The appreciable characteristics of filtered musts and the easy control using the hollow fiber cross-flow microfiltration system, make possible the musts clarification through this technique.

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