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EXPERIMENTAL STUDY ON USING COMMERCIAL MEMBRANES FOR TREATMENT OF WASTEWATER GENERATED BY COLLAGEN PRODUCTION

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Abstract
Collagen production is generating wastewater with high organic loading. This type of wastewater is still containing valuable compounds that can be reused in other applications. In order to investigate the possibility to recover and reuse these compounds the membrane based processes were investigated. Four types of commercial available membranes were characterised and then used to recover the proteins. The results proved that membrane based processes represent a viable alternative to treatment of wastewater generated by collagen production facilities when recovery of valuable compounds is envisaged. It has to be stressed that on the other hand only membrane processes do not assure too reach the quality norms imposed by the legislation for treated wastewater discharge into sewerage systems or natural receivers. Therefore, when proteins recovery and reuse is wanted, the membrane processes represent only the first step of wastewater treatment and should be followed by biological processes in order to obtain the organic loading quality indicators required for wastewater treatment plants discharges.

Keywords: *collagen, polyethersulfon, regenerated cellulose, ultrafiltration, wastewater*

Introduction
Wastewater generated by porous collagen based substrates preparation are characterized by high organic loadings. Due to the fact that membrane processes represents one of the modern methods for separation of organic compounds from aqueous systems, its use on wastewater generated by collagen production was investigated as a first step towards the recovery of useful compounds (proteins) and their use in further applications.
A membrane represents a barrier (a discontinuity region) between two phases, the phase's components being unequally transported through membrane, allowing their separation. The mass transport can be diffusive or convective and take place due to a driving force such as a gradient of pressure, temperature, concentration or electric potential (Batrinescu et al 2014).

From various technologies used for wastewater treatment, membrane process is considered a viable option for secondary or tertiary step (Bourgeous et al 2001). Moreover, at international level there are operating more than 500 types of membrane bioreactors (Chang & Kim 2005). Membrane based technologies present advantages related to the operation without chemical substances addition and a relatively low energy consumption but the main drawback is represented by clogging process (Fan et al 2001, Scott 1995, Lee et al 2004).
From the materials that are used in membrane processes application can be mentioned: polyethylene (Kaiya et al 1996), polysulfon (Kweon & Lawler 2004), polypropylene (Gray et al 2004), polypiperazine (Her et al 2000), polyamide (Cho et al 2000), polyacrylonitrile (Xia et al 2004), polyethersulfon (Yuan & Zydney 1999), sulfonated polyethersulfon (Lee et al 2001), and regenerated cellulose (Manttari et al 2000).

The study was conducted using four types of commercial available membranes that were characterized the point of view of both average distilled water flows and morphologically (by scanning electronic microscopy SEM).

Experimental
A Koch-LabCell CF1 membrane test module was used in order to determine distilled water flows and a scanning electronic microscope Quanta FEG 250 was used for micrographs of membranes.

Three samples of real wastewater were used during the experiments (S1-S3). All water samples were pre-filtered prior to enter the membrane separation process in order to protect the membranes. The membranes are commercial ones provided by Sartorius (polyethersulfon PES with cut-off values of 1, 5, 10 kDa) and Millipore (regenerated cellulose RC with a cut-off value of 10 kDa).

Figure 1. Experimental installation

Results and discussions

The membranes were characterized from the point of view of average distilled water flows and the optimum working pressures were selected: 3 bars (PES 10 kDa), 5 bars (PES 5 kDa), 6 bars (PES 6 kDa) and 4 bars (RC).

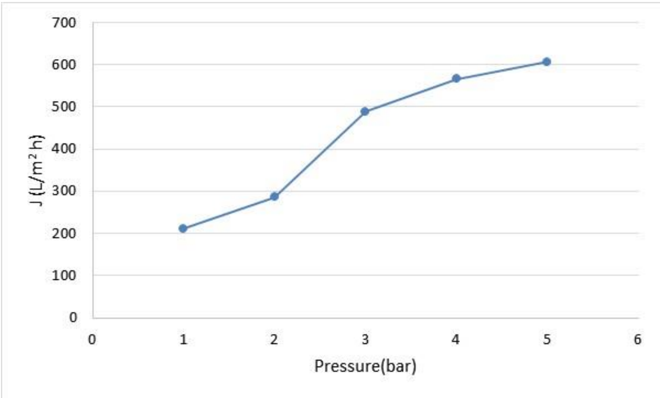

Figure 2. Average distilled water flow for PES 10 kDa membrane

Moreover, SEM was used to investigate the morphology of the membranes. As example SEM micrographs for PES 5 kDa membrane before and after S1 separation are presented in the next figure (clogging phenomenon can be observed).

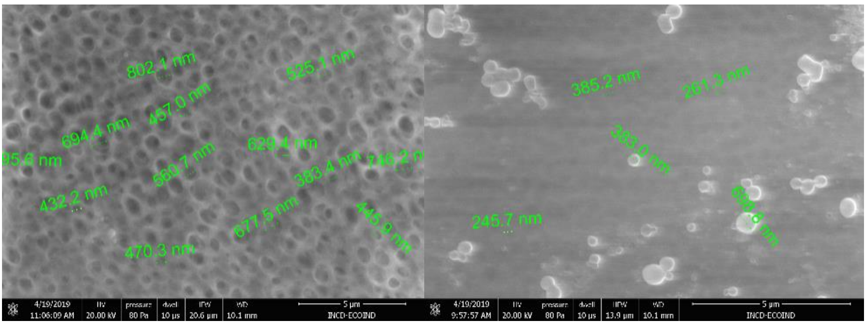

Figure 3. SEM micrographs for PES 5 kDa before and after S1 ultrafiltration

The three wastewater samples were characterized and organic loading expressed as Chemical Oxygen Demand (COD) were: 11968 mg O_2/L (S1), 11264 mg O_2/L (S2) and 3168 mg O_2/L (S3).

Table 1. Wastewater samples characterisation

Indicator	M.U.	S1	S2	S3
pH	unit	2.84	2.75	10.00
COD	mgO_2/L	11968	11264	3168
CBO_5 (BOD)	mgO_2/L	6200	6150	1735
TSM	mg/L	60	21	2
NTK	mg/L	26.46	22.2	48.3

Separation experiments were performed and the results are presented in the following table:

Table 2. Separation experiments results

Sample	COD (mgO_2/L)		Efficiency (%)	Membrane	Pressure (bars)
	Feed	Permeate			
S1	11968	11264	5.88	PES 10 kDa	3
		9152	23.53	PES 5 kDa	5
		9680	19.12	RC	4
S2	11264	11098	1.47	PES 10 kDa	3
		9240	17.97	RC	4
S3	3168	1716	45.83	PES 1 kDa	6
		2 684	15.28	RC	4

Membrane clogging was measured by average distilled water flow decrease (as percentage) between average flows before and after separation experiments, for example for RC membrane at 4 bars the % of clogging was found to be 2.01%.

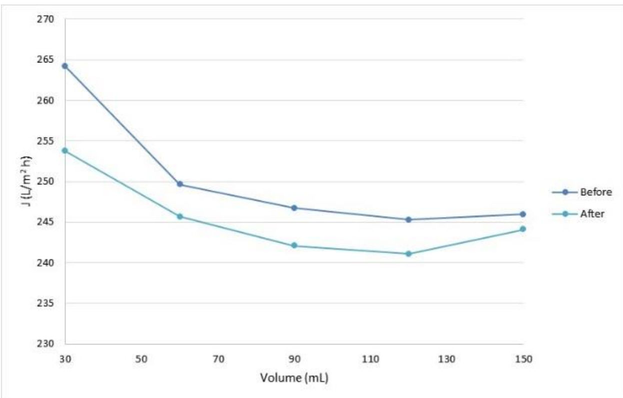

Figure 4. Clogging of RC membrane at 4 bars after separation experiments

Conclusions

The most efficient membrane in terms of separation efficiency proved to be PES 1 kDa which reached more than 45% but this type of membrane presents a low average flow of 18.95 L/m^2 h distilled water at 6 bars pressure. On the other hand, RC membrane presented separation efficiency between 15.28 – 19.12 % for all samples (almost similar with those obtained by using PES 5 kDa) but also a very good average distilled water flow of 250.37 L/m^2 h for a working pressure of 4 bars.
It should be noticed that only membrane processes are not assuring the imposed limits for discharge of treated wastewater. Taking into account the BOD/COD ratio a biological process can assure those limits but only after separation of useful compounds from wastewater flows by membrane based processes.

Acknowledgement

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