Nutrients recovering from livestock manure by Nanofiltration

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Introduction

Livestock effluents that contain organic carbon and nutrients are usually directly spread on agricultural land or spread after anaerobic digestion which offers advantage to produce renewable energy. However, when intensive spreading is practised, dissolved content are poorly fixed in soils or absorbed by plants and they move towards surface and ground waters inducing some pollution. To reduce eutrophication of surface water, the liquid phase is generally treated by biological way to transform ammonium in gaseous nitrogen and phosphates are precipitated by physic-chemical way [1]. This work introduces the interest of nanofiltration (NF) as a post-treatment to recover nutrients such as phosphates and ammonium ions.

Material and Methods

Different types of liquid effluents were collected at different anaerobic digestion wastes in France (biowaste mixed with green waste (BIO), pig manure mixed with slaughterhouse waste (TER)) with a suspended solids of 28 g/L, 24 g/L, 4.3 g/L and dry matter content 38 g/L, 65.8 g/L, 22 g/L respectively. Before their treatment by membrane processes, the liquid effluents were treated by screw press and / or centrifugation to remove the largest particles, then they were stored at 4°C prior to membrane treatment. Then the liquid phase was clarified by ultrafiltration (UF) using different cut-off. The UF clarified water was then treated by nanofiltration (NF) using organic flat sheet membranes (filtration area of 28.27 10^{-4} m^2). The separation was operated in tangential mode. All the experiments were conducted under constant trans-membrane pressure (3 10^5 Pa) and constant temperature (20°C). The cut-off of the NF membrane was 200 D.

Results

Table 1 gives some examples of data concerning the removal of mineral ionic compounds by UF and NF steps. These data concern results obtained on TER effluent.

Table 1.1 Retention of mineral ionic compounds.	[Na+]	[K+]	[Mg2+]	[Ca2+] (mg/L)	[Fe3+]	[Cl-]	[PO43-]	[SO42-]	Conductivity (mS/cm)	**[NH4+]**
TER	6125	920	1734	25,4	277	100	1482	796	25,4	40
300kD	5495	872	1645	4,1	63,5	0	1194	491	6,1	31,5
50 kD	5532	883	1637	4,6	50,5	0	1243	508	4,3	35
8 kD	5291	870	1638	7,1	51,4	0	1229	443	13,5	31
NF	3013	698	1302	5,29	67	-	1268	47,3	3,8	16,24

The retention of monovalent ions was not efficient by clarification but some retention of polyvalent ions could be observed during clarification, it can be due to some precipitation of these compounds and also to their interactions with colloids and flocculated structure retained by clarification step. Concerning nutrients, it can be observed that 90% of phosphates were retained by NF and about 40% of ammonium. Then the concentrate of NF step can be interesting in term of nutrient content. The concentrations of sodium and chloride in NF concentrate were depending of the concentrated ratio (volume of effluent versus volume of concentrate) and can be the limiting criteria for concentrate reuse in agronomy. Of course reverse osmosis can be also used to improve the water desalination and recover soft water for reuse.

Conclusion and perspectives

Using membrane processes to post-treat livestock effluents can be favorable to recover water of quality and moreover some nutrients. These operations must be optimized now to quantify their interest in term of economical aspect.

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Keywords

Livestock effluent, nanofiltration, nutrients recovery