

Intelligent saving of resources on membrane plants

Part 1: New concepts – the ALPMA driving assistant



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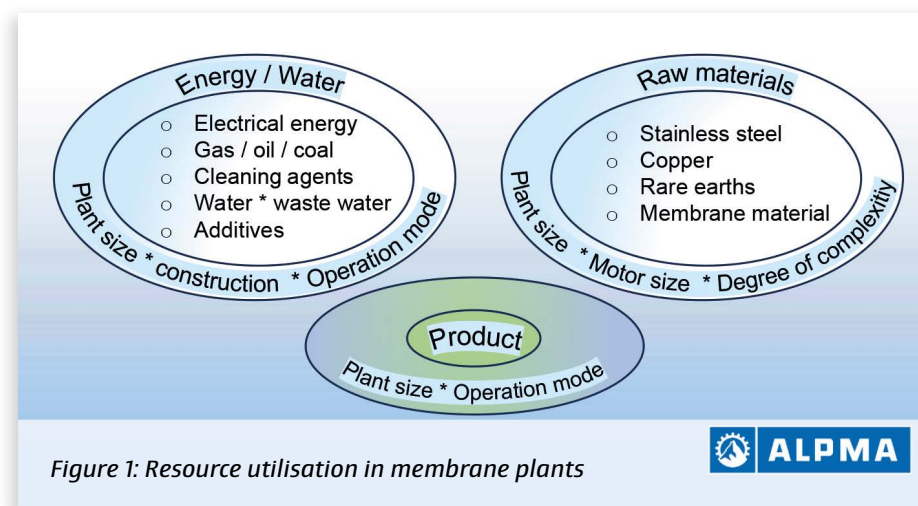
Responsible use of everything that is taken from nature is currently one of the most important tasks facing humanity. The need to conserve resources does not need to be explained or justified in 2025. It is common knowledge that our world is being used too wastefully. And that this process is finite.

What can be done to give this process a different, positive direction? Saving the world in one fell swoop – it would be nice if that was possible. However, the rescue must consist of many pieces of the puzzle. Regulations need to be changed on a large scale. And on a small scale, every company and all specialists must do what they are able to do in their own area.

Our area of expertise in the Membrane Filtration department of ALPMA's Division of Process Technology are membrane filtration systems. What can be done here – what resources can be saved and by what means? To answer this question, we will first look at the resources used by a membrane filtration plant, see Figure 1. It can

be seen that there are involved different groups of resources. One group of resources is required in the operation of the plant; the other group of resources is already utilised in the construction of the plant. The third group is the product itself, which is to be produced with the plant. The topic of product yield is focussed on from an economic point of view and also from an ecological point of view.

All resource groups are influenced by the size of the system. These include the consumption of steam to heat up a certain volume of plant, the mass of stainless steel used in the plant, the mass of copper, which depends on the size of the motors used and more. The first task is therefore to design the system exactly to the point so that it can fulfil the task set, but does not have any excessive size reserves beyond



this. At ALPMA, the design is carried out on the basis of a special design tool and using data from the installed base (see Fig. 2). Alternatively it can be determined via pilot tests in the Technical Centre for membrane filtration (see Fig. 3).

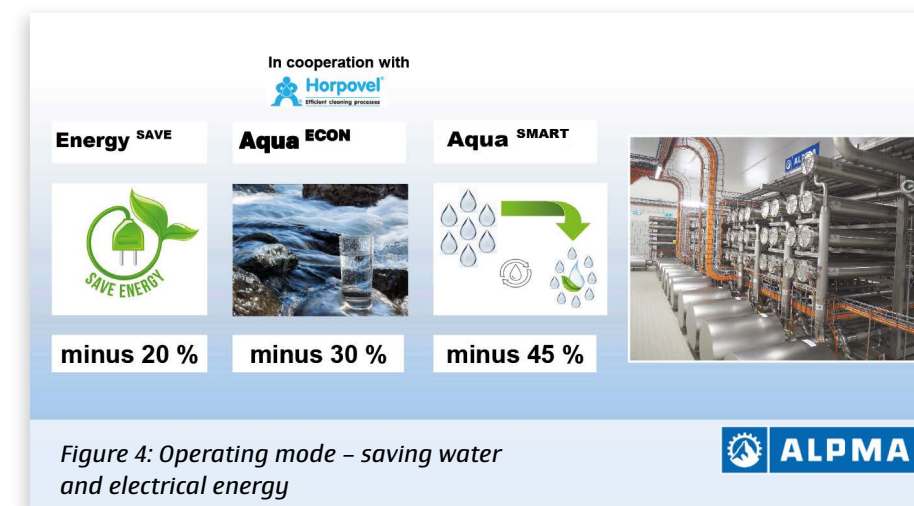
The operating mode of the system has a further, very significant influence. This can be used to control the consumption of resources for the ongoing production and for the CIP processes.

ALPMA has developed the 'Energy^{SAVE}', 'Aqua^{ECON}' and 'Aqua^{SMART}' energy- and water-saving modules, partly together with its cleaning partner Horpovel. Figure 4 shows the amounts of electrical energy and water that can be saved.

It is important not to save blindly and thus generate increased expenditure elsewhere by not operating the membranes appropriately, which may initially appear to save a little, but would necessitate premature membrane replacement. This would mean saving too much. What is needed is an optimisation process between desirable savings and essential expenditure for stable and safe system operation.

This includes knowing which savings are sensible and effective for which type of system in conjunction with which product. One example is the applied amount of crossflow over the membrane modules by means of the stage pumps. Standard values exist for this, from which it is possible to optimise downwards. As the crossflow is essential for controlling the fouling, the fouling potential of the product must be considered. In RO systems for UF permeate, for example, this is low as long as no calcium precipitation occurs. UF permeate contains neither fat nor casein nor whey protein as surface layer-forming substances, and the RO membrane has no pores that could become blocked. The situation is completely different with a ceramic microfiltration membrane for skimmed milk. Skimmed milk contains all the proteins found in milk. Casein has different structure-forming properties to whey proteins, which are also more effective in generating cover layers. In addition, ceramic microfiltration membranes have pores inside which deposits can build up.

In order to take this distinction properly into account, ALPMA categorises saving measures into specific clusters according to the type of system and the product's relevance to the formation of surface layers, within which the same or similar measures should be taken, see Figure 5. The less complex the system is and the lower the proportion of potentially surface-layer-forming substances in the product, the higher the savings potential.



To further ensure that the correct, i.e. the optimum operating mode is used, the 'response of the system' to the operating mode used is 'queried'. The ALPMA driving assistant can be used for this purpose. In many discussions, the terms Industry 4.0 or AI are used in an almost inflationary manner. Instead of repeating these terms, the ALPMA driving assistant offers a concrete solution to urgent questions.

The driving assistant is aimed at anticipatory driving. In car terms, this means - staying in lane - avoiding accidents - recognising problems in good time and taking countermeasures - driving in a fuel-efficient manner while ensuring that the destination is reached on time. This can be guaranteed by the ALPMA membrane experts and can also be realised electronically.

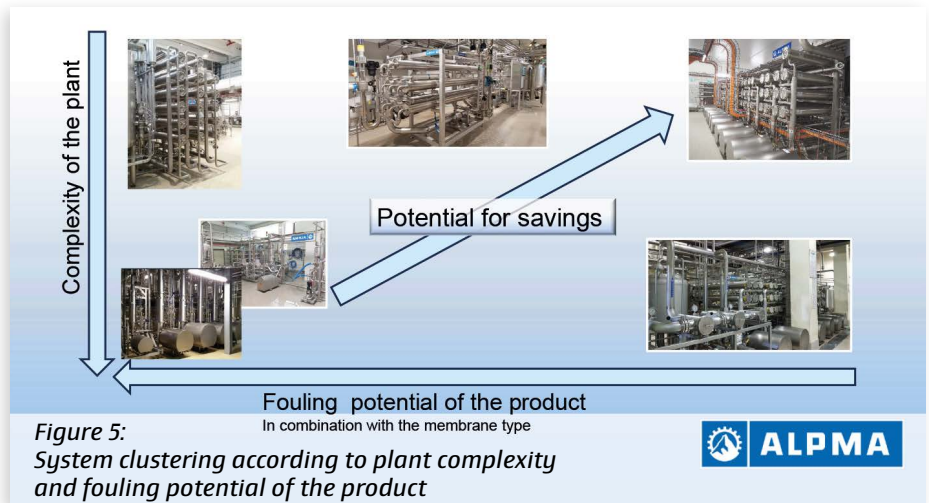
For example, a sensible CIP is configured on the basis of analysing the previous production data. This ensures that no over-cleaning takes place, which would take up more resources than necessary. On the other hand, deficient CIP is not selected, which would lead to losses in subsequent production performance and even prematurely required membrane replacement. The cleaning status can also be checked by regular maintenance as part of the ALPMA membrane service package (see Fig. 6).

A similar approach is used to optimise the saving of electrical energy. With a few exceptions, the largest consumers of electrical energy in membrane filtration systems are the loop pumps. This is where the greatest saving potential exists. At the same time, the loop pumps have one of the most important tasks within a membrane system - namely to control the formation of the surface layer. Here, too, the reaction of the system to the saving measure must be analysed and taken into account. This is done by adapting the crossflow to the analogue actual values of the system, i.e. only reducing it to the extent that the formation of the surface layer is still justifiable and can be cleaned economically.

In the future, the ALPMA driving assistant may be integrated into a cloud-based solution. The ALPMA Eco Clean system is

already available in the ALPMA Connect cloud solution. This is an optimised operating mode for the dairy plant CIP that was developed by our colleagues from ALPMA France.

The following article by Horpovel presents the optimisation and solution of a complex cleaning task on an ALPMA nanofiltration system with diafiltration at Brixen-Milch.



Short-, mid-, long-term Review

Optical cleanliness

Microbiology

Verification of organic substances

Figure 6: Monitoring of the long-term cleaning status by the ALPMA service team in collaboration with Horpovel

1			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			0 s	0 s	1800 s	48,0 °C	0,0 l 240 s	15,0 l 120 s	0,0 l 120 s	0,0 l 360 s
2			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			1020 s	120 s	90 s	48,0 °C	0,0 l 0 s	0,0 l 120 s	0,0 l 120 s	0,0 l 120 s
3			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			0 s	0 s	2700 s	48,0 °C	0,0 l 0 s	0,0 l 120 s	0,0 l 0 s	4,5 l 120 s
4			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			550 s	120 s	2400 s	48,0 °C	10,5 l 120 s	0,0 l 600 s	0,0 l 360 s	0,0 l 600 s
5			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			120 s	90 s	0 s	49,0 °C	0,0 l 600 s	0,0 l 600 s	0,0 l 360 s	0,0 l 360 s
6			INT Vorspülen	EXT CIP	Temp.	Leuge	Säure	Puffer	Enzym	
			120 s	0 s	300 s	15,0 °C	0,0 l 600 s	5,0 l 360 s	0,0 l 360 s	0,0 l 360 s

Analyses of production

Evaluation

CIP-configuration

Dynamic adjustment

Figure 7: Driving assistant, configuration of the optimum CIP