Using optimized Colloidal fluid to clean or restore industrial membranes

Membrane flouting is very common in RO systems. The membranes used in reverse osmosis become fouled over the time due to mineral deposits, biologic materials, colloidal particles, and insoluble organic matters the membranes should be cleaned periodically. These cleaning operations, even if be on time and regular, will not lead to a performance similar to the initial performance. On the other hand, if cleaning operations do not be conducted on time and regularly, the membranes will experience serious problems and finally will be clogged completely. Membrane fouling leads to a decline in quality and quantity of the purified water and also increases energy consumption. RO membranes are not cheap and Industrial water producers are highly interested to improve the condition of the membranes, and to that end they use chemical washing methods. The conventional methods use chemical solvents (acidic, alkaline, etc.) to dissolve containments and remove them. But in these methods, always part of the containments will remain. The reason of is that the chemical solvents will not have access to the in-depth containments an on the other hand the time the containments will be exposed to the chemical solvent and in general the cleaning time are limited. The remaining containments act as initial cores for future sediments and facilitate formation of organic layers. In this innovation, a Super Generator (kind of machine) Converts common cleaning chemicals into colloidal fluid produces. This fluid is composed entirely of double-walled microbubbles and the fluid along with the bubbles flows in the compacted layers of the filters next to the contaminants surface and burst. After that, the mass contaminants are removed by physical shock and dissolved in the base chemical solution. This method uses increases the cleaning efficiency and recovers of worn-out membrane feasible. part of the containments become separated due to the strike and the chemical materials will have easier access to the in-depth layers of the foulants. The access to the separated foulants will also be easier. In general, chemical cleaning will be accompanied with mechanical processes.

What the This Service is?

Taking advantage of this method in common periodical cleaning improves effectiveness of cleaning that in turn leads to an increase in life span of the membranes. Convert to the cleanig fluid with a fluid consisting of multi-layer Nano bubble will be conducted in a special machine (Fig. 1), where the cleaning liquid turns into a colloidal liquid through creating high shear stress and at the presence of additive materials.

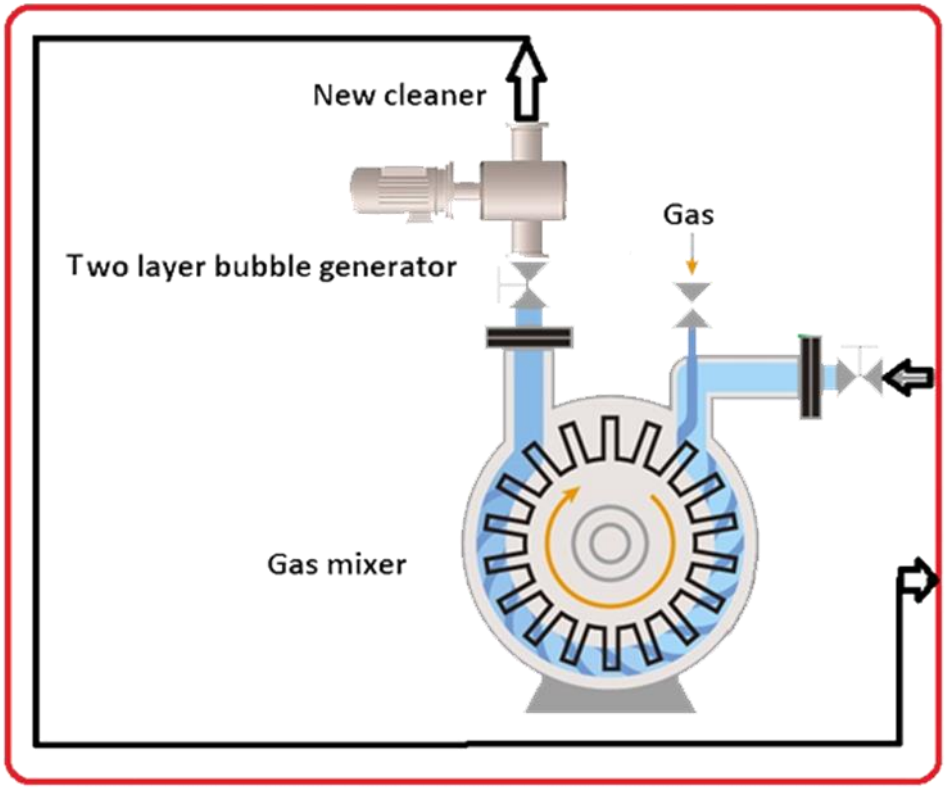


Figure 1. Super Generator

Plan Idea

Todays, using bubbles is suggested for cleaning membranes, but the problem of passing the bubbles through the membrane layers and the size and amount of the bubbles and not going the whole route due to limited stability have declined effectiveness of the method. Therefore, in order to solve the problem, a colloidal liquid (Fig. 2) consisting of multi-layer Nano bubbles was developed that is difference from common bubbles and can remove the defects of former plan and significantly improves effectiveness of cleaning process.

Colloidal liquids are stable nanoscale bubbles with a structure consisting of a central core and a protecting thin membrane. The term colloid refers to the small size of the bubbles. The fluids have a multi-layered protective shell, and are more stable than conventional foams with single-layer protective shells. This fluid protective shell is such that it creates a complex aggregation without merging into one another (Fig. 3) Which enters the membrane layers and causes the sediment to peel off (Fig. 4).

Figure 2. Colloidal liquid

Figure 3 - Multi-walled Nano bubbles in a liquid under the microscope

Figure 4. The bubbles in membrane pros

Onsite and offsite reverse osmosis membrane recycling and reverse osmosis membrane improved cleaning

An effective cleaning improves efficiency of the unit, reduces chemical materials consumption, and increases life span of the membranes, which in turn leads to a reduction in the costs of manufacturing unit. Although choosing an appropriate solution for a chemical washing is the first step for an effective washing operation, but using an appropriate method will be necessary to complete the operation. The present innovative plan has focused on execution method to improve cleaning outcome converts the cleaning fluid into a more efficient colloidal fluid.

In current innovation, commonly used chemicals including solvents, detergents, and disinfectants will be converted by a super generator into a colloidal fluid consisting of a multi-layer Nano-bubble and will be discharged into a chemical wash pipeline (Fig. 5). The rest of the work will be like current washing procedure. This fluid with a density three times less than water has unique characteristics that improve washing operation. In fact, washing materials will be solved in a suspension of colloidal liquid and will be used for cleaning.

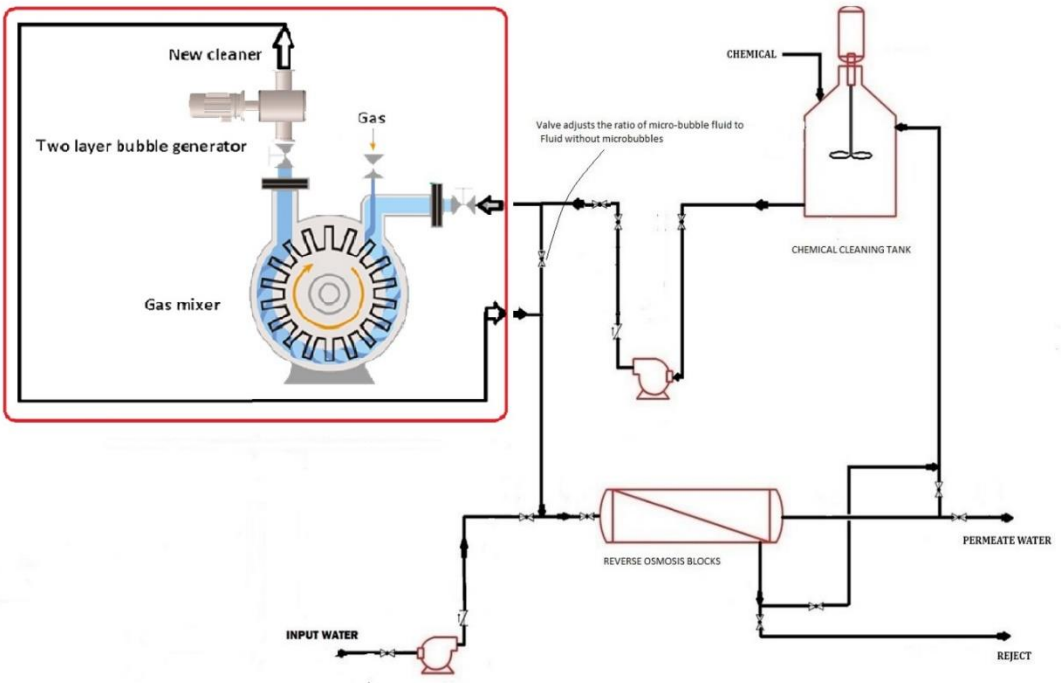


Figure 5. An in-place cleaning system with Super generator

In current technology, multi-layer Nano bubble is used to wash reverse osmosis membranes. Reverse osmosis membranes consist of several spiral layers, therefore, no access to the membrane surface exists for physical cleaning. But, the unique and numerous benefits of colloidal fluid have shaped the idea of using it and creating appropriate conditions for simultaneous chemical and physical washing in reverse osmosis membranes that also leads to an improvement in membrane cleaning. The colloidal fluid has unique properties that result in this improvement; these properties include:

1 .The stability and non-coagulation properties that cause the fluid does not get wasted immediately during the course of cleaning and affect the surfaces of the membranes located along each other as a series .

2 .This fluid is transferable, so it can flow in the course of cleaning in volume fraction of gas to the intended suspension and with required pace .

3 .The outer shell of the multi-layer Nano bubble attracts particles and carries them .

4 .The average diameter of multi-layer Nano-bubble is 50 µm, so its surface-to-volume ratio that is an effective factor is appropriate

5 .The amount and stability of double-walled microbubbles can be adjusted according to the amount of contamination.

The colloidal liquid will be produced in Super Generator through creating a shear stress and using a small amount of additives. In fact, it is the software cleaning software that has become completely colloidal fluid.

Technically, when the fluid flows into the membrane to wash it, the multi-layer Nano bubbles will be in contact with the contaminants sticking to the surface and will be removed, and physical separation of contaminants happens due to asymmetric flows and the strokes resulting from bursting, and the contaminants will be removed with physical and chemical factors (Fig. 4). In other words, the physical work required for removing the contaminants will be done by striking with two-layer micro bubble and its bursting adjacent to the organic layers

and mineral contaminants. In this method, both some parts of contaminants will be separated as tiny particles and the underlying contaminants become exposed to the solvents (acid, alkaline, etc.).

Super Generator:

The super generator consists of pressurized chambers which two system, by applying shear stress to the cleaning chemical, turn it into a colloidal fluid. This colloidal fluid is composed of double-walled microbubbles which are continuously produced and Membrane cleaning system is sent. Making colloidal fluid requires air mixed with a cleaning chemical, which will be supplied by compressed air A super generator is a machine that can be both part of a cleaning system (Fig. 5) and can be a stand-alone set (Fig. 6). This machine can convert any common cleaner into colloidal fluid.

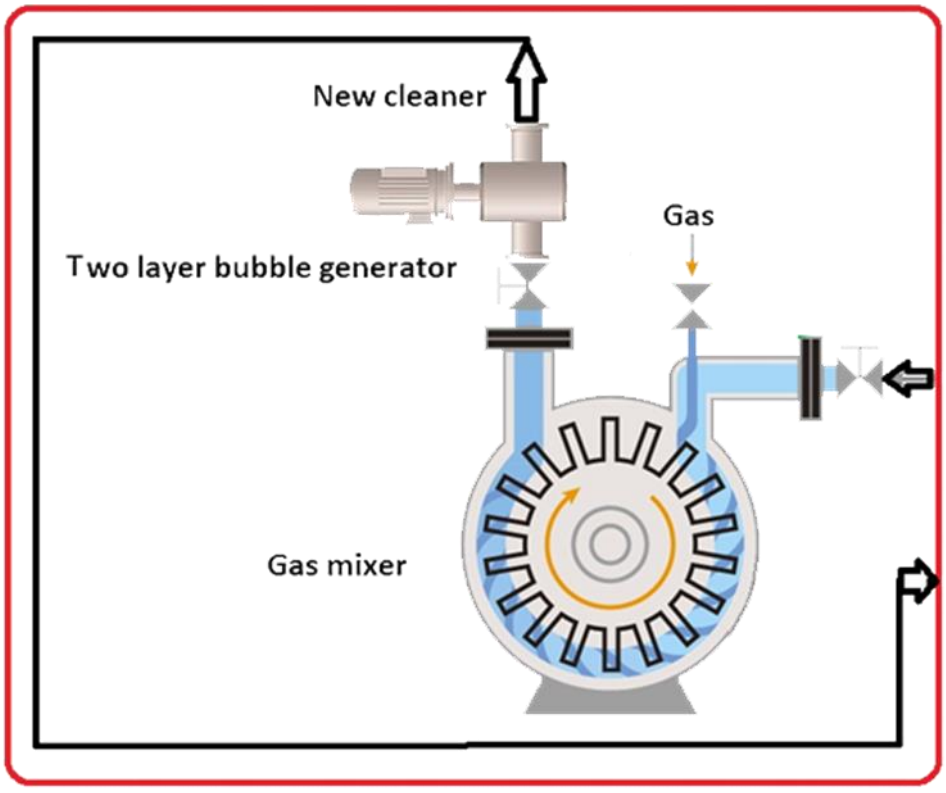


Figure 6. Super Generator

With the help of a super generator and some additives, any type of cleaning or disinfectant can be converted into colloidal fluid.

1. Providing colloidal liquid with stability and rheology characteristics, so that it can be send by pressure.

2. Provide the colloidal liquid with stability and rheology characteristics, so that it has the required stability to be used in acidic and alkali environments. The impact of OH- ion concentration can be minimized by using Additives with proper concentration. This technique stabilizes the multi-layer bubbles especially in acidic environments.

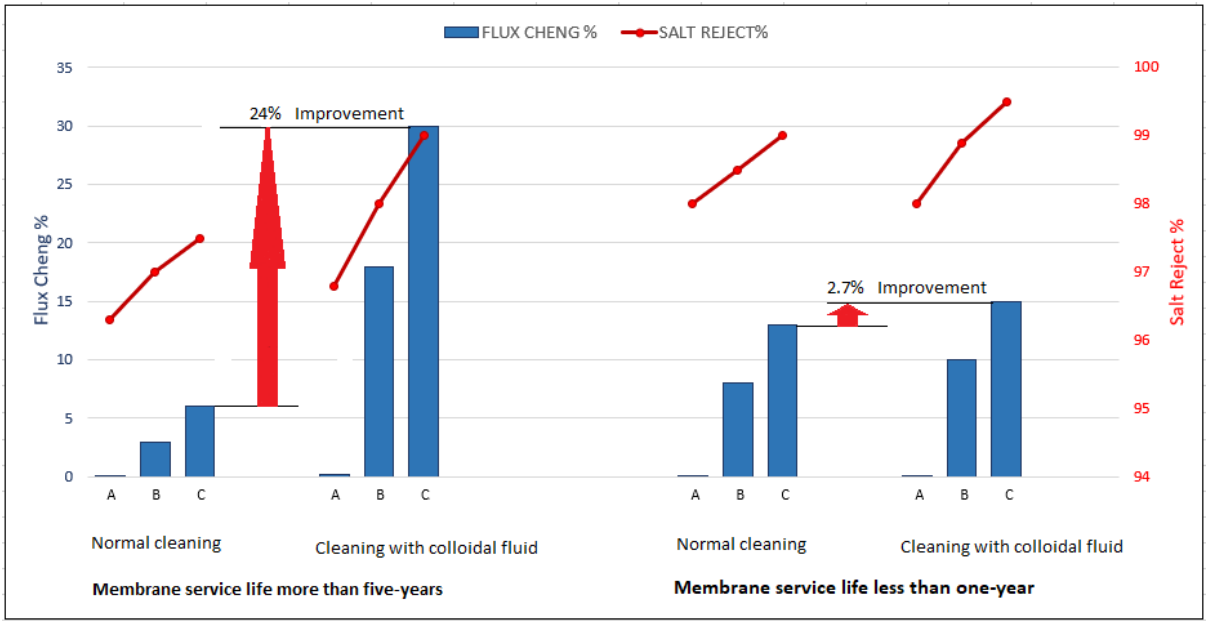
The market needs for this service

This service provides a new method for cleaning reverse osmosis membranes that cause:

- Dual CIP approach by chemical & physical means to agitate & remove membrane foulants
- A two-phase flow of two layer bubble/chemical results in an increased turbulence at the boundary layer (increased rotating fluid flow)
- Possibility of increasing air flow to an optimum level – increases chaotic flow, results in more mixing (generates vortices etc.) and flow pattern changes
- Cleaning is possible in a range from soft washing (low-performance membranes) to hard washing (highly contaminated and worn membranes).
- Removing fouling particles that will act as initial core for future fouling leads to an increase in cleaning efficiency
- This method will increase the interval between two cleaning operation.
- Cleaning time can be reduced using this method
- Foulant easier to remove
- Increase in life span of the membrane
- Increasing average product
- Reduction in consumption of chemical materials
- Reduction in operational costs
- This concept can be easily and cost effectively applied to any RO/NF cleaning system
- A specially designed device to introduce air from the atmosphere

Comparison of colloidal liquid with normal chemicals for cleaning reverse osmosis membranes

Comparisons were made between the two groups of membranes. The first group consisted of membranes that had been used for less than a year and the second group of membranes that had been used for more than five years. All of these membranes had been cleaned with normal chemicals in previous regular periods and were used in the program when a new cleaning was needed. The membranes are first alkaline cleaned and then acid cleaned. The results show that the performance of colloidal fluid is much better than the performance of general chemicals. And this performance improvement in worn membranes is much greater than in low-performance membranes.



A	Membranes need to be cleand
B	Membranes after alkaline clining and before acid clining
C	Membranes after alkaline clining and then acid clining

Chart 1. The changes in flux and salt rejection in different modes of cleaning

Membrane service life	FLUX CHENG %	SALT REJECT%
less than one- year	**2**	**0.5**
more than five- years	**24**	**2.7**

Table 4. Increase of improvement when using colloidal fluid