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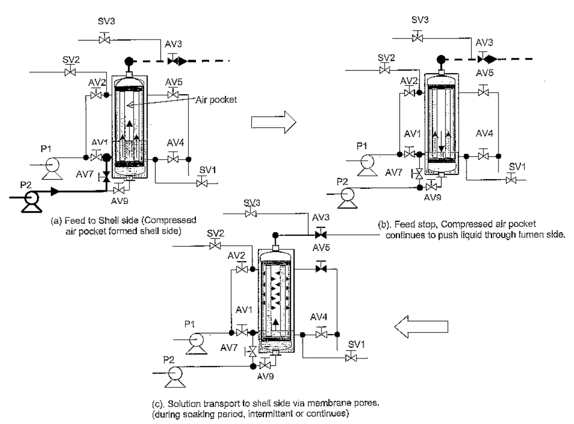
(54) Title: CHEMICAL CLEAN FOR MEMBRANE FILTER



(57) Abstract: A method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of introducing a fluid containing a cleaning agent to the permeate side of a membrane allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time, and contact the pores of the membrane, or introducing a fluid containing a cleaning agent to the feed side of a membrane; applying a transmembrane pressure to force the fluid containing the cleaning agent from the feed side to the permeate side of the membrane; allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time, and contact the pores of the membrane. Preferably a concentration gradient between the feed side fluid and the lumen side fluid containing the cleaning agent causes cleaning agent to diffuse into the feed side fluid. Pressure may be applied to the fluid containing a cleaning agent to dislodge, where present, dissolved and undissolved solid from the membrane pores. The pressure may be applied in a pulsed fashion, and can be by way of compressed air at a pressure not more than the membrane's bubble point. The methods of the present invention may be preceded by, or followed with a backwash.

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TITLE: CHEMICAL CLEAN FOR MEMBRANE FILTER

FIELD OF THE INVENTION

The invention relates to methods of cleaning suitable for use in filtration apparatus. More particularly, the invention relates to methods of cleaning microfiltration or ultrafiltration membranes used for water filtration purposes.

BACKGROUND ART

Microfiltration and ultrafiltration membrane filters are increasingly used in municipal drinking water treatment and wastewater treatment. With a typical microfiltration or ultrafiltration operation, transmembrane pressure (TMP) is the main driving force for the filtration process. As the process progresses and filtered water permeates through the membrane, most of the solid contaminants are retained either on the membrane surface, forming a fouling layer or as plugs in the membrane pores blocking filtration. The presence of a fouling layer or plugged pores or both can significantly increase the transmembrane pressure and ultimately the filtration energy consumption.

Frequent backwashes with either filtrate or gas can partially reclaim the membrane permeability, however, with these methods it is known that foulants may continue to build up on the membrane surface and in the pores. Successive backwashes do not remove all the deposited material, and consequently over time there is deterioration in filter permeability.

Cleaning protocols supplemented by the use of chemical cleaning agents are known. The general criteria for selecting a chemical cleaning method are firstly to achieve a good recovery of membrane permeability, secondly to minimise the amount of chemical cleaning agent required and the resultant amount of waste generated and thirdly to allow ease of operation.

One cleaning method involves immersing the membranes in a chemical cleaning solution for a period of time. The chemical reactions dissolve the solids accumulated on the membrane surface and plugged in the pores. The cleaning effect may be facilitated by injecting air to scour membranes or by recirculating the chemical solution. This is a common method currently used for full chemical recovery of membrane performance, however it suffers from the drawback that a significant volume of chemical solution is required and the process generates large volumes of chemical waste.

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In other attempts to control permeability deterioration, short chemical cleans (maintenance cleans) are frequently carried out with membrane filters. US 5,403,479 describes one such method of carrying out such a process. A cleaning solution is introduced into the lumen of a hollow fibre membrane, and recirculated at low flow at a pressure below the membrane bubble point. The cleaning solution permeates through membrane pores under low transmembrane pressure and at a low rate. The authors also indicate that diffusion of cleaning solution through membrane may occur even when fluid is held in the fibres at no velocity but under pressure. During the course of cleaning, the membrane is immersed in water. This method requires storage of a volume of chemical solution sufficient to fill the permeate lines and for recirculation. During the recirculation process, an increasing amount of chemical solution penetrates through the membrane pores from the lumen side to the feed side.

Another method of conducting a membrane clean involves repeatedly backpulsing membranes with a chemical cleaner, as described in JP09313902 and US6045698. Similar methods of chemical cleaning backwash methods for submerged membrane systems are disclosed in US Patent applications 20010052494A1, 20030146153A1, 20040007525A1, PCT application WO0108790A1 and US 6,547,968. Chemical cleaning backwash can be continuous or pulsed, and can be carried out after the membrane tank is drained, while the membrane tank is draining, or even without draining the membrane tank prior to the chemical backwashes. The chemical solution is delivered to the system via a header at the top of the membranes by pump when the membranes are oriented vertically. The chemical cleaning solution is forced under pressure through the membranes to the lumen side. Repeated backpulses may bring the biofilm in the permeate lines back to membranes.

The second and third methods mentioned above generally use less volume of chemical solution than the first method, but they require that the chemical solution be of very high quality and free of solids because the solution is introduced into the permeate side.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

DESCRIPTION OF THE INVENTION

According to a first aspect the invention provides a method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of: introducing a fluid containing a cleaning agent to the permeate side of a membrane;

allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time, and contact the pores of the membrane.

Preferably the cleaning agent contacts the permeate side under static pressure.

According to a second aspect the invention provides a method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of:
introducing a fluid containing a cleaning agent to the feed side of a membrane;
applying a transmembrane pressure to force the fluid containing the cleaning agent from the feed side to the permeate side of the membrane;
allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time, and contact the pores of the membrane.

Preferably, the transmembrane pressure is a small differential pressure.

According to a third aspect the invention provides a method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of:
providing a feed side fluid in contact with the feed side of the membrane;
introducing a fluid containing a cleaning agent to the permeate side of a membrane;
allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time to contact the pores of the membrane and diffuse into the feed side fluid.

Preferably, the solution diffusion in this aspect of the invention is driven by a concentration gradient between the feed side fluid (preferably low in concentration of cleaning agent) and the lumen side fluid containing the cleaning agent. Most preferably, the feed side fluid contains no cleaning agent.

Preferably, the methods of the present invention further include the step of applying a pressure to the fluid containing a cleaning agent on the permeate side to dislodge, where present, dissolved and undissolved solid from the membrane pores. More preferably, such pressure is applied in a pulsed fashion. In one particularly preferred embodiment, the source of pressure is compressed air at a pressure not more than the membrane's bubble point.

Preferably, the methods of the present invention are all preceded by a backwash.

Preferably, the methods of the present invention are also followed by a backwash prior to the recommencement of filtration.

If necessary, the methods of the present invention may be repeated in cycles.

The cleaning methods described in this invention can be applied to pressurized membrane filtration or immersed membrane filtration systems. The membranes can be microfiltration, ultrafiltration or nanofiltration membrane, and can be either capillary or flatsheet membrane.

Preferably, the membrane is an ultrafiltration or microfiltration membrane.

In preferred embodiments, the membranes of the present invention are hollow fibre membranes, having a lumen side (permeate side) and a module or shell side (feed side), a plurality of which are housed inside a module housing.

Most preferably, a plurality of the membranes is arranged in aligned bundles. The modules are potted at the ends of the bundles, creating a plurality of lumen spaces inside the hollow fibres and a contiguous space on the outer or shell side of the hollow fibres. The lumens are arranged so that filtered water accumulates therein and is passed from the plurality of lumens into a combined filtration stream.

The fluid may be water.

In the first and third aspects, the fluid containing a cleaning agent is introduced to the lumens of these hollow fibre membranes. In the second aspect, the fluid containing a cleaning agent is introduced to the shell side of the membrane, preferably by partially filling the shell side of the module before being transported into the lumens.

Preferably, the fluid containing the diffusible cleaning agent is retained in the membrane permeate side without applied pressure or slight pressure, approximately equal to the static head pressure may be applied.

The cleaning solution can be any conventional cleaning solution, either acidic, basic or neutral, or can be oxidative or reductive depending upon the origin of the foulant. The cleaning agent can also inorganic or organic. Preferred cleaning agents include dissolved halogens, such as chlorine, or dissolved oxidative or reductive agents, for example sulfite based reagents. Alternatively, cleaning agents may be chelating agents, such as citric acid or EDTA. To facilitate the wetting out and dissolving the foulant, a small amount of surfactant may be added to the cleaning solution.

In a membrane system, the preference on delivery of chemical cleaner varies according to the system design. For example, in some membrane filtration systems it is preferable that chemical cleaner be delivered to the feed side of the membrane. If so, the requirement on the water used to prepare the chemical solution in terms of solid content is not particularly stringent and the cleaning solution may be re-used for several times. This, however, may require a chemical storage tank and a chemical transfer pump. This delivery method is commonly found in large membrane systems. In other membrane systems, it is preferable to deliver the chemical cleaner to the permeate side to further reduce the volume of chemical solution and improve ease of operation. A dosing pump may be used in such circumstances. The methods of the present invention are adapted to handle either feed side or lumen side dosing.

DESCRIPTION OF THE DRAWINGS

Figure 1 shows an embodiment of the invention which enables solution delivery to the shell side of a hollow fibre membrane and permeation through to the lumen side.

Figure 2 shows an embodiment of the invention which enables solution delivery to lumen side of a hollow fibre membrane with the shell side at least partially drained/filtered down first.

Figure 3 shows an embodiment of the invention which enables solution delivery to lumen side of a hollow fibre membrane while water containing solid remains on the shell side.

Figure 4 shows the test profiles of maintenance clean and definition of cleaning efficiency.

Figure 5 shows the membrane performance recovery with different tested methods

Figure 6 shows the relative chemical cleaner consumption for a number of cleaning methods.

BEST METHOD OF PERFORMING THE INVENTION

The invention will be disclosed with reference to hollow fibre polymeric microfiltration and ultrafiltration membranes arranged in bundles and housed in modules, and with reference to maintenance clean for pressurised membrane filtration system with an outside-in filtration mode, however, it will be appreciated that the invention is not limited to such embodiments, and may for example encompass an inside-out filtration mode.

Several maintenance clean (membrane cleaning) protocols involving dosing of the cleaning agent to the shell side or the lumen (filtrate) side were tested and compared. The methods and their performances are discussed below.

Backwash is preferably performed prior to any maintenance clean. In the backwash process of a hollow fibre membrane, for example, a liquid is forced through the membrane from the lumen side, either by gas pressure or pumped by further liquid. As part of the backwash process, the shell side can be either drained, partially drained or filled with liquid during the backwash and prior to any cleaning solution being introduced.

The normal procedure for carrying out a backwash usually involves an initial filtering down or draining down process. Filtering down is the more preferred. Filtering down is, for preference, achieved with compressed air at a pressure below the membrane bubble point entering the shell side as the filtration driving force to push the shell-side liquid through the membrane and into the lumen. Filtering down continues until the shell side liquid level is at least less than half of the shell side liquid holding volume. In the case where no backwash is carried out before the clean, filtering down is carried out as the initial step of the maintenance clean. Preferably the shell side liquid level is down to the lowest level that filtering down with compressed air can achieve, which in most cases is usually just above the lower module potting. Filtering down means the shell side volume is greatly reduced and any maintenance clean solution can thus enter the system without the necessity of draining the shell side. For immersed membrane filtration processes, no compressed air is required to perform filtering down.

Following the drain down or filtering down, a liquid backwash can be carried out, preferably with air scouring. The liquid backwash can be achieved in different ways. The air pushed backwash is preferably used. Compressed air below the membrane bubble point enters the lumen and pushes the filtrate through the membrane in the reverse direction to the filtration direction. Only filtrate retained in the lumen at the end of filtration or filtering down is used for the backwash. Following the backwash, the lumen is empty and ready to receive the chemical cleaning solution.

Membranes requiring maintenance cleaning are usually covered with a layer of fouling materials and some of the membrane pores may also be plugged. Backwashing has the advantage of partially removing pore blockages and the fouling layer enabling cleaning solution to reach a greater percentage of the membrane surface. When maintenance cleaning is used without backwashing, the cleaning solution may preferentially diffuse through the membranes via unblocked pathways which may be present as a result of regions of less fouled membrane surface and unblocked membrane pores. With sufficient air pressure, filtrate in the lumen flows through membrane pores at reasonable velocity and removes some fouling materials on the membrane surface and opens a portion of blocked pores. This enables chemical solutions, when introduced, to reach a greater percentage of membrane pores.

At end of any pre maintenance clean backwash, the shell side liquid can be either drained or retained as part of the backwash process. Because of the reduced shell side liquid volume achieved by prior filtering down, the shell side liquid volume before maintenance clean is generally less than half of the total shell side liquid holding volume even when draindown is removed from the end of the backwash sequence. Drain down of the shell side liquid before maintenance clean is optional.

Alternatively, before maintenance clean, the membrane is not backwashed, but rather the shell side is filtered down or drained down to reduce the shell side volume before the delivery of maintenance clean solution.

Depending on the particular method chosen, the chemical solution is either delivered to the shell side, preferably via the lower CIP (Cleaning-In-Place) manifold or to the filtrate (lumen) side, preferably via the lower filtrate/CIP manifold or both in a sequence.

In the methods of the present invention, the solution flow rate is preferably low (0.1 – $4m^3/h$ per module depending on module size) for the lumen side chemical delivery, to minimise the negative transmembrane pressure which may occur during this stage. The maximum cleaning solution volume used in the clean is preferably no more than the lumen volume, shell volume or both (plus any pipe holding or tidal volume) depending on the particular delivery method. This is particularly important for controlling chemical solution consumption.

Cleaning solutions can be delivered by any existing pump connected to the appropriate fluid volumes, such as for example, the plant CIP pump. If the cleaning solution is mainly delivered to the lumen side, the cleaning solution usage is very low. In such cases, the cleaning solution can be stored in a sealed storage tank and compressed gas may be used as a delivery tool to push the solution from the storage tank into the lumens of the hollow fibre membranes. The advantage of this is that if the storage tank is fitted with a fluid level sensor, or if the storage tank volume is similar to the total lumen volume, then control of solution volume delivered to the system can be greatly simplified.

Once cleaning solution is delivered to the system, the CIP pump is stopped or the gas pressure source is removed. Depending on the chemical used in the clean, if desired, the shell side and lumen side may be vented via upper manifolds during the soaking period or periodically vented during the soaking period. When vented, shell side aeration may be used to mix the chemicals and improve the contact between the chemical and the membrane. When the solution is dosed to the filtrate (lumen) side, shell side aeration can be used when the solution diffused through membrane wall and reaches the shell side. The solution diffuses through membrane pores to reach the side where there is little or no liquid or where the concentration of cleaning agent in solution is low.

When both the shell side and lumen side are filled, the chemical cleaning agent diffuses into the membrane pores only through a concentration gradient. Membrane pores are soaked in solution for a period of time, preferably 30 seconds to 20 minutes for a typical maintenance clean, and a longer time is required for a full chemical clean. If desired, the shell side and lumen side may be vented via upper manifolds during the soaking period or periodically vented during the soaking period. Humidity loss due to vaporization in the lumen or shell side is very low and membrane pores are kept wet with cleaning solution.

If desired, a backwash can be carried out to remove the remaining cleaning solution from the system prior resuming filtration.

Method 1: Partly fill shell side of membrane with chemical cleaning solution

In this method, the chemical solution enters the shell side, preferably via the lower feed manifold. However, the solution enters the shell side with all the shell outlet valves closed, ie in dead-end filtration mode, forcing the cleaning solution to lumen side. If the pressure is not high enough to push the cleaning solution to the permeate side, additional transmembrane pressure can be supplied by injecting compressed gas, as in a pressure filtration process, or by suction, as in an immersed membrane filtration process. The shell side is only partially filled with membrane cleaning solution. The minimum delivery volume of solution to the shell side is slightly more than the lumen volume plus the permeate manifold volume. The consumption of chemical and filtrate of this method is significantly less than that of a conventional clean where the shell side is filled with the chemical solution.

The first step of this method is preferably to backwash and then empty both shell and lumen sides. Cleaning solution enters the shell side via the lower CIP valve. However, because the shell side upper CIP return valve is closed and the lumen CIP return valve is opened, the CIP solution is forced by the shell side pressure to enter lumen side once the CIP solution level in the shell side is above the lower potting level. A compressed air pocket is also formed above shell side liquid level. Depending on the shell side pressure, the CIP pump may only run for short period of time and this enables the pressure from the air pocket to continue to press solution to lumen side. Additional transmembrane pressure may be supplied when necessary. Depending on the mixing of solution prior to entering the shell side, the filtration of membrane cleaning solution may just fill the lumen or be extended to send some solution back to the CIP tank or recirculation pipe loop. Alternatively, the CIP solution can be pushed into the shell side by compressed air eliminating a short running cycle of the CIP pump.

After the lumen side is filled up with the chemical solution, the shell side and lumen side vent valves are then opened to equalise the pressure. After the lumen side pressure is close to the shell side pressure, the shell side vent valve is opened while the lumen side vent valve can be either opened, closed or opened periodically to control the diffusion process. When the lumen side vent valve is opened periodically, the valve is preferably opened briefly during the initial stage of soaking. During the whole soaking period, the lumen side can be vented for 1 – 10 times, with each time lasting from 1s to 10 mins. The solution in the lumen side slowly diffuses to through the membrane, and the diffusion process may be aided by static pressure in the lumen side when lumen side vent valve is opened. The membrane is partially soaked in the solution, however capillary effect helps to hold solution within membrane wall.

An optional post-aeration may also be applied. This aeration helps to suspend foulants loosened or removed by solution.

The above fill-lumen and back-diffusion procedure can be repeated when necessary to achieve a higher cleaning efficiency.

An optional post membrane cleaning backwash may also be used after the soak. A full backwash is preferably undertaken, at the end of which the shell side chemical waste is fully discharged. If preferred, membrane cleaning chemical drained from shell side can be reused by draining to CIP tank.

Filtration is then resumed.

Conventional cleaning methods of the prior art will typically involve 1) fully filling the shell side with a chemical solution, 2) filtering the chemical solution through for a short period of time, 3) allowing the membrane to soak and 4) discharging the subsequent chemical waste. Method 1 described above can significantly reduce the chemical and chemical waste volume, typically by more than 50%. The repeated lumen-fill and back-diffusion procedures help to enhance the cleaning efficiency without additional chemical.

Figure 1 shows method 1, with both the shell side and the lumen empty. The shell side is partially filled with cleaning solution and then pressurised so that the liquid passes into the lumen.

Method 2: Fill permeate side of membrane with chemical solution while shell side at least partially drained/filtered down

In this method, cleaning solution is delivered to fill the membrane lumen (permeate side) and therefore the chemical and filtrate consumption is very low.

The first step of this protocol is preferably to backwash membrane via the method described above. This leaves the lumen side empty and the shell side either empty or partially empty. The membrane lumen side is then ready for receiving the cleaning solution. In case the membrane lumen side is not empty through backwash, the chemical solution has to be delivered under pressure to displace permeate remained in the membrane lumen.

The lumen is then filled with membrane cleaning solution. The chemical dosing pump or the CIP pump is used to introduce the membrane cleaning solution to the lumen side preferably via lower filtrate/CIP valves and any extra solution can exit the lumen side via upper filtrate/CIP valves returning to the CIP tank. During the chemical delivery, shell side upper CIP valve can be either opened or closed. When the lumens are filled with chemical solution, the shell side vent valve is opened and the lumen side vent valve can be either opened, closed or opened periodically. When the lumen side vent valve is opened periodically, the valve is preferably opened briefly during the initial stage of soaking. During the whole soaking period, lumen side can be vented for 1 – 10 times and each time last from 5s to 10 mins. Chemical diffusion occurs until the chemical concentration at lumen and shell sides are equalized.

As shell side is empty or partially empty, part of the solution in the lumen side slowly diffuses through the membrane pores and aided by static pressure in the lumen side when lumen side vent valve is opened. During this process, both shell side and lumen side are partially empty, however the capillary effect helps to hold solution within membrane wall. The process of soaking and diffusion is carried out for a predetermined time, until the membrane is as clean as desired, or until most of the cleaning solution is consumed.

The lumen fill procedure with chemical cleaning solution can be repeated when necessary after the solution in the lumen side is diffused to shell side and consumed. Alternatively solution diffused into shell side can be pushed back to lumen side by applying compressed air to shell side. This can be repeated if necessary.

Figure 2 shows method 2, solution is introduced to lumen side while shell side is fully or partially drained.

Method 3: Fill permeate side of membrane with chemical solution and shell side not drained

This method is similar to Method 2 with the exception that the shell side is not filtered down. If the solid containing water remains on the shell side (tank not drained as in Figure 3), the chemical solution diffuses through membrane pores to the shell side under concentration gradient and the diffusion rate is comparatively uniform along the membrane module. The diffusion process continues until the chemical concentration on both sides reaches equilibrium.

The lumen fill procedure with chemical cleaning solution can be repeated when necessary after the chemical concentration in the lumen side is reduced to certain level.

An optional post-aeration may also be used. This aeration helps to suspend foulants loosened or removed by solution.

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An optional post membrane cleaning backwash may also be used after the soak. A full backwash is preferably utilised, at the end of which the chemical waste is discharged.

Filtration is then resumed.

Figure 3 shows a schematic of method 3. The lumen is filled with water or other fluid and the cleaning solution introduced into the lumen. The cleaning species diffuses through the membrane from a region of higher concentration in the lumen to lower concentration in the shell side.

Figures 1-3 shows the piping and instrumentation diagram of various methods.

In the figures, P1 is the feed pump and P2 is the CIP pump. P2 can be substituted by a small solution storage vessel with compressed air inlet on top of the vessel.

SV1 supplies scouring air if aeration is required. SV2 supplies compressed draindown air to assist fast draindown at shell side or filtering down. SV3 supplies compressed liquid backwash air to push filtrate in the lumen through membrane pores in a reverse direction to the filtration direction. AV1 is the lower feed valve and AV2 is upper feed valve. AV4 is the lower shell side drain valve and AV5 is upper shell side return valve

In Method 1 shown in Figure 1, the cleaning solution is delivered to the shell side. The shell side is partly filled with Chemical Solution and the solution is allowed to penetrate to the permeate side under TMP.

When the CIP pump starts to deliver the cleaning solution to the shell side, AV7 and AV3 are opened and AV5 closed. The pressure on the shell side increases slowly, and some chemical solution penetrates to the lumen side under pressure. The chemical delivery stops when the solution level on the shell side reaches between the lower potted head and mid of the module, or membrane lumen is filled up with chemical solution. If the pressure on the shell side is not high enough to push the solution to the lumen side, compressed air can be injected to the shell side via SV2. After soaking for a predetermined period of time, a backwash can be performed to push the remaining chemical solution on the permeate side back to the shell side. It is preferred that compressed air is introduced through SV3 to push the remaining solution in the lumen back to the shell side.

In Methods 2 and 3, the cleaning agent is dosed to the lumen side. During the dosing stage, AV9 and AV3 are both opened, and AV5 on the shell side outlet can be either opened or closed (Figures 2&3). The chemical delivery stops after the permeate side is filled up with the solution. The chemical solution then penetrates through the membrane pores. In Method 2, the penetration goes on by liquid static pressure and the chemical solution diffuses back to the shell side. The diffusion is only driven by the concentration gradient as the shell side is full (Figure 3). Again a backwash is preferably to be performed after a period of diffusion.

Example

A six-module Memcor CMF-L pilot was used for the comparative tests. The filtration process involves 30 minutes filtration followed by a gas pushed backwash. The recycle repeats several times before maintenance clean is carried out.

As shown in Figure 4, the membrane fouling rate is judged by an increase in the membrane resistance. After filtering for 30 minutes, the membrane resistance rises. The backwash can partially reduce the membrane resistance. However, the backwash did not fully recover the membrane's permeability and the trend of resistance continues to rise. Maintenance clean was performed to further reduce the membrane's resistance and therefore better recover the membrane's permeability. A general trend is depicted in Figure 4. The efficiency of maintenance clean is defined as:

$$\underline{\textit{MC Efficiency} = (R_1 - R_2)/(R_1 - R_0)}$$

Where R_0 is Resistance straight after the last chemical clean

R_1 is Resistance straight after the last backwash before maintenance clean

R_2 is Resistance after the previous maintenance clean

Figure 5 shows the maintenance clean efficiency with different methods, where:

MC0 – Conventional cleaning method with shell side fully filled of cleaning solution,

MC1 – Method 1 described above, shell side is partially filled of cleaning solution,

MC2 – Method 2 described above with shell side drained and cleaning solution fills permeate side,

MC3 – Method 3 described above without shell side drain and cleaning solution fills permeate side.

Figure 6 illustrates the relative chemical solution consumption compared to the conventional method.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of:
introducing a fluid containing a cleaning agent to the permeate side of a membrane;
allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time and contact the pores of the membrane.

2. A method according to claim 1 wherein the cleaning agent contacts the permeate side under static pressure.

3. A method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of:
introducing a fluid containing a cleaning agent to the feed side of a membrane;
applying a transmembrane pressure to force the fluid containing the cleaning agent from the feed side to the permeate side of the membrane;
allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time and contact the pores of the membrane.

4. A method according to claim 3 wherein the transmembrane pressure is a small differential pressure.

5. A method of cleaning a porous polymeric membrane having a feed side and a permeate side including the steps of:
providing a feed side fluid in contact with the feed side of the membrane;
introducing a fluid containing a cleaning agent to the permeate side of a membrane;
allowing the cleaning agent to contact the permeate side of the membrane for a predetermined time to contact the pores of the membrane and diffuse into the feed side fluid.

6. A method according to claim 5 wherein a concentration gradient between the feed side fluid and the lumen side fluid containing the cleaning agent causes cleaning agent to diffuse into the feed side fluid.

7. A method according to claim 6 wherein the feed side fluid is lower in concentration of cleaning agent than the lumen side fluid.

8. A method according to any one of the preceding claims further including the step of applying pressure to the fluid containing a cleaning agent on the permeate side to dislodge, where present, dissolved and undissolved solid from the membrane pores.

9. A method according to claim 8 wherein the pressure is applied in a pulsed fashion.

10. A method according to claim 8 or 9 wherein the membrane has a bubble point and pressure is by way of compressed air at a pressure not more than the membrane's bubble point.

11. A method according to any one of the preceding claims preceded by a backwash.

12. A method according to any one of the preceding claims followed by a backwash prior to the recommencement of filtration.

13. A method according to any one of the preceding claims repeated in cycles.

14. A method according to any one of the preceding claims wherein the porous polymeric membrane is part of a pressurized membrane filtration or immersed membrane filtration system.

15. A method according to any one of the preceding claims wherein the membrane is selected from a microfiltration, ultrafiltration or nanofiltration membrane.

16. A method according to any one of the preceding claims wherein the membrane is a capillary or flatsheet membrane.

17. A method according to any one of the preceding claims wherein the membranes are hollow fibre membranes, having a lumen side (permeate side) and a module or shell side (feed side).

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18. A method according to claim 17 wherein a plurality of hollow fibre membranes are housed inside a module housing.

19. A method according to claim 18 wherein a plurality of the membranes is arranged in aligned bundles, creating a plurality of lumen spaces inside the hollow fibres and a contiguous space on the outer or shell side of the hollow fibres and wherein the lumens are arranged so that filtered fluid accumulates therein and is passed from the plurality of lumens into a combined filtration stream.

20. A method according to any one of the preceding claims wherein the fluid is water.

21. A method according to claim 19 or 20 wherein the fluid containing a cleaning agent is introduced to the lumens of these hollow fibre membranes.

22. A method according to claim 19 or 20 wherein the fluid containing a cleaning agent is introduced to the shell side of the membrane.

23. A method according to claim 22 wherein the fluid containing a cleaning agent is introduced to the shell side of the membrane by partially filling the shell side of the module before being transported into the lumens.

24. A method according to any one of the preceding clams wherein the fluid containing the diffusible cleaning agent is retained in the membrane permeate side without applied pressure.

25. A method according to any one of clams 1 to 23 wherein the fluid containing the diffusible cleaning agent is retained in the membrane permeate side with pressure approximately equal to the static head pressure.

26. A method according to any one of the preceding claims wherein the cleaning solution is any conventional cleaning solution.

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27. A method according to claim 26 wherein the cleaning solution is acidic, basic or neutral.

28. A method according to claim 26 or 27 wherein the cleaning solution is oxidative or reductive.

29. A method according to any one of claims 26 to 28 wherein the cleaning agent is inorganic or organic.

30. A method according to claim 26 wherein the cleaning agent includes dissolved halogens, such as chlorine.

31. A method according to claim 26 wherein the cleaning agent includes sulfite based reagents.

32. A method according to claim 26 wherein the cleaning agent includes a chelating agents.

33. A method according to claim 32 wherein the chelating agent is citric acid or EDTA.

34. A method according to any one of claims 26 to 33 wherein a surfactant is added to the cleaning solution.

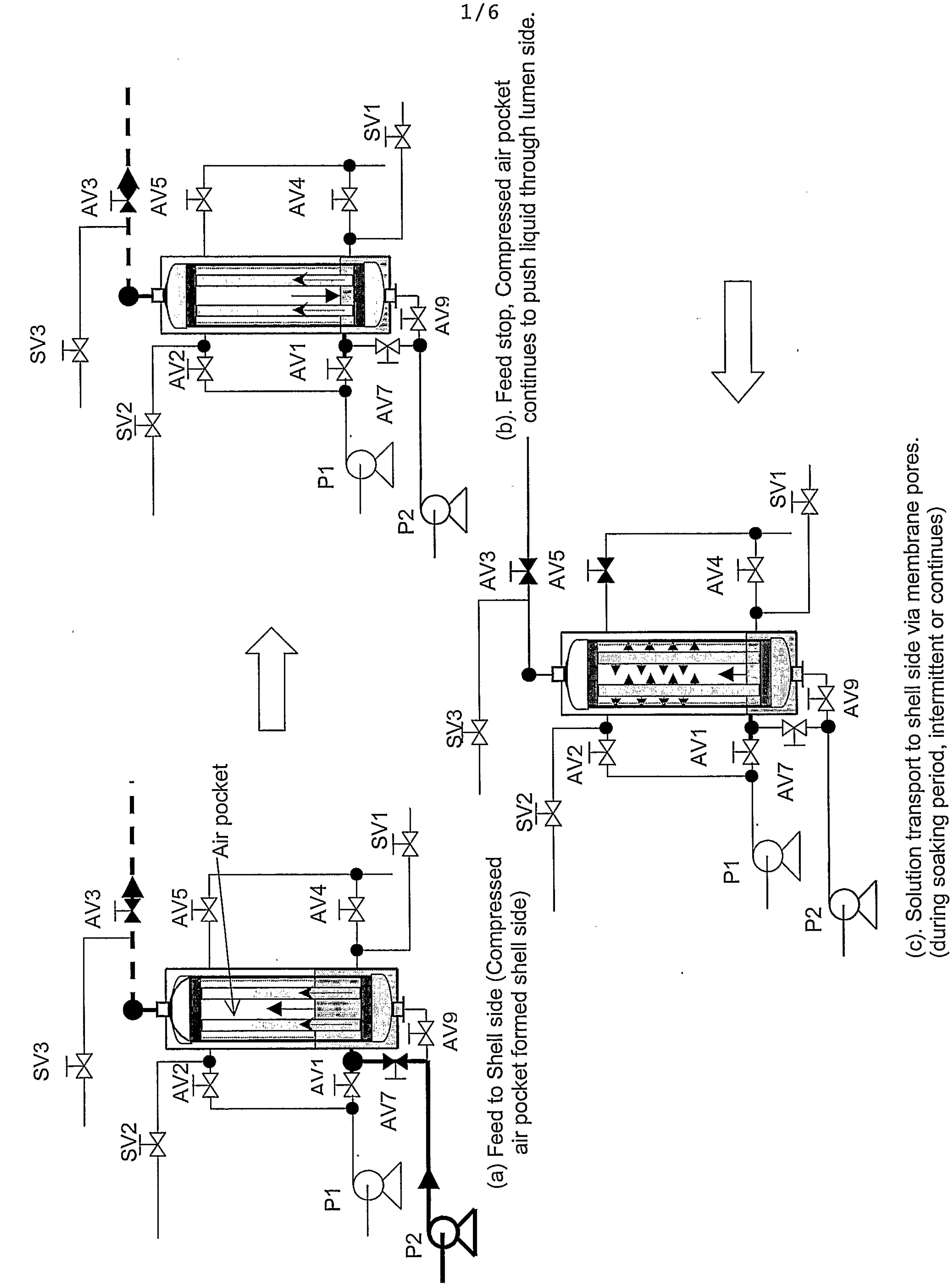

(a) Feed to Shell side (Compressed air pocket formed shell side)
Air pocket
(b). Feed stop, Compressed air pocket continues to push liquid through lumen side.
(c). Solution transport to shell side via membrane pores. (during soaking period, intermittent or continues)
SV1
SV2
SV3
AV1
AV2
AV3
AV4
AV5
AV7
AV9
P1
P2

Fig 1

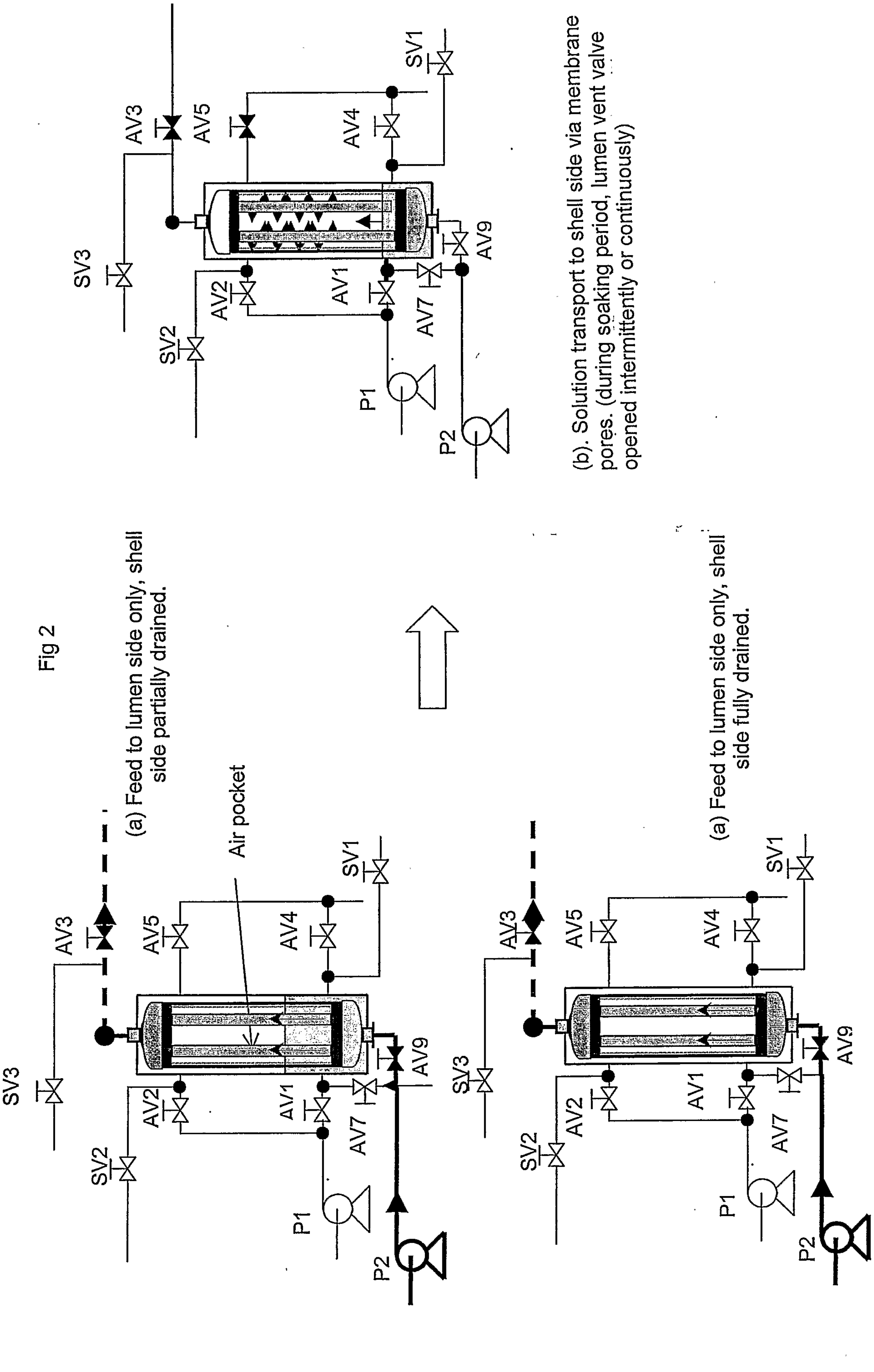
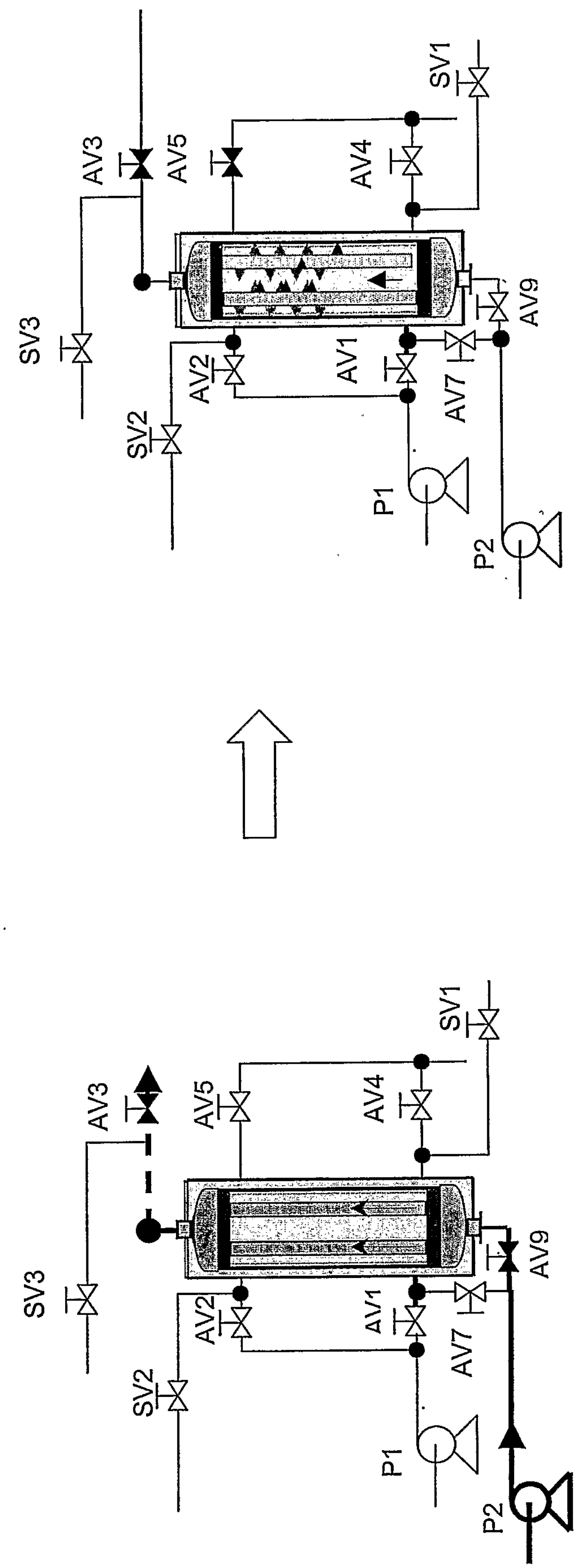

(b). Solution transport to shell side via membrane pores. (during soaking period, lumen vent valve opened intermittently or continuously)
SV3
AV3
AV5
SV2
AV2
AV1
AV7
AV9
AV4
SV1
P1
P2
(a) Feed to lumen side only, shell side partially drained.
Air pocket
(a) Feed to lumen side only, shell side fully drained.

Fig 2

Fig 3



(b). Solution transport to shell side via membrane pores. (during soaking period, lumen vent valve opened intermittently or continuously)

(a) Feed to lumen side

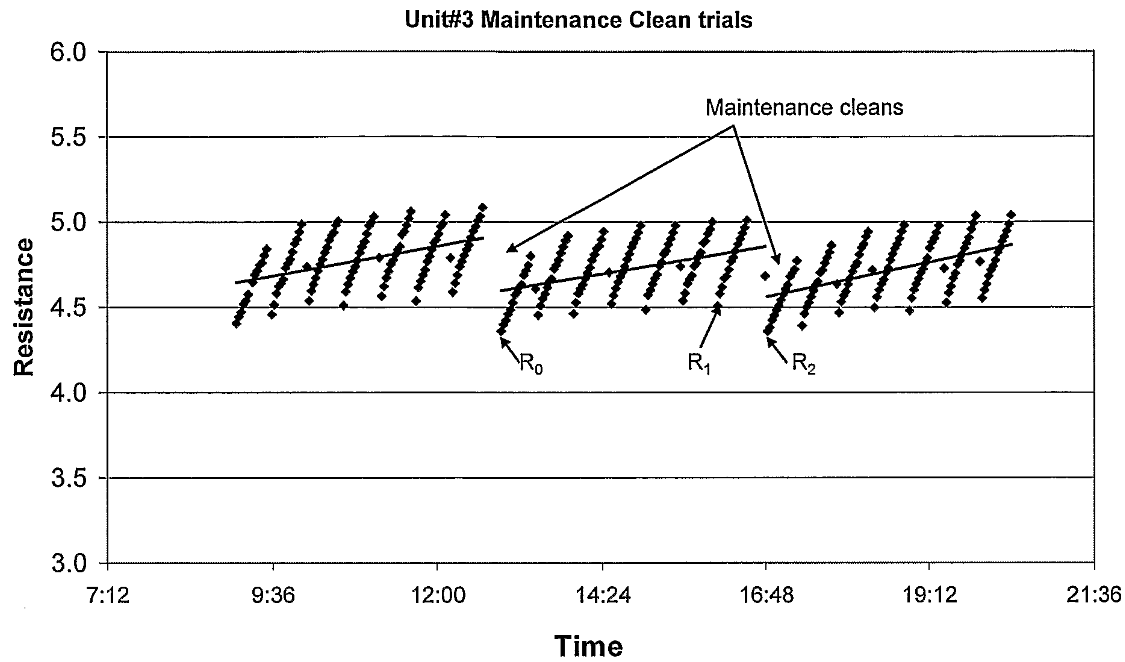

Unit#3 Maintenance Clean trials
6.0
5.5
5.0
4.5
4.0
3.5
3.0
Resistance
Maintenance cleans
R0
R1
R2
7:12
9:36
12:00
14:24
16:48
19:12
21:36
Time

Figure 4

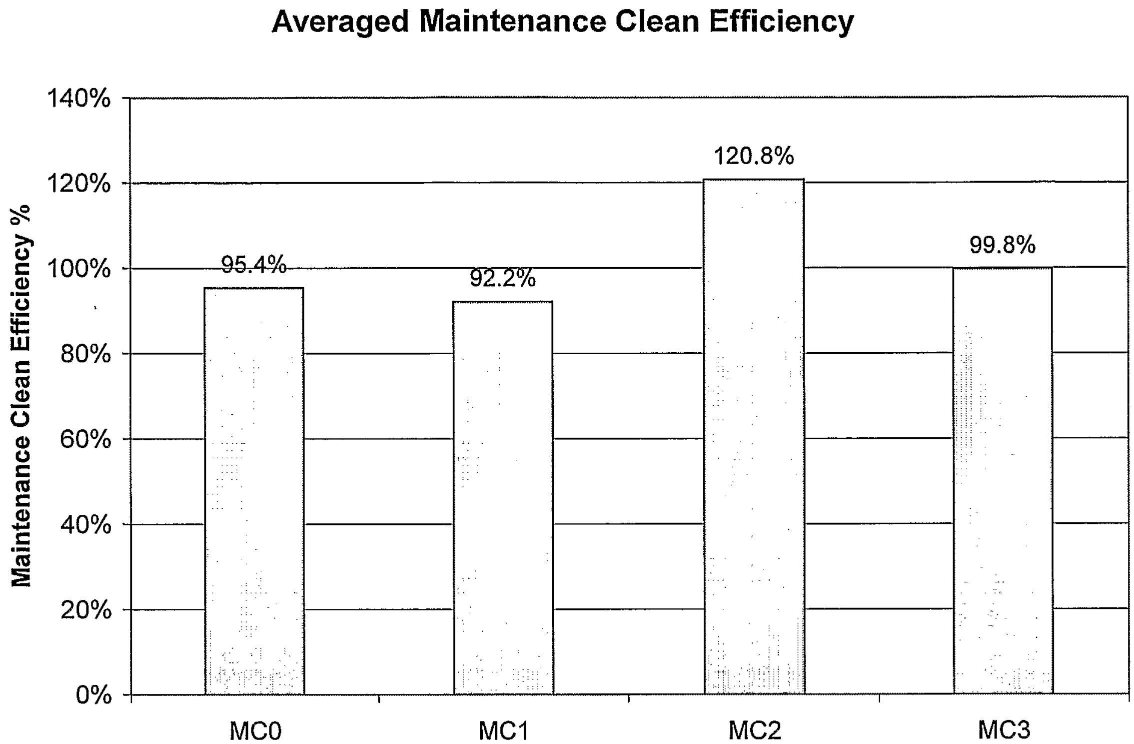

Averaged Maintenance Clean Efficiency
140%
120%
100%
80%
60%
40%
20%
0%
Maintenance Clean Efficiency %
95.4%
92.2%
120.8%
99.8%
MC0
MC1
MC2
MC3

Figure 5

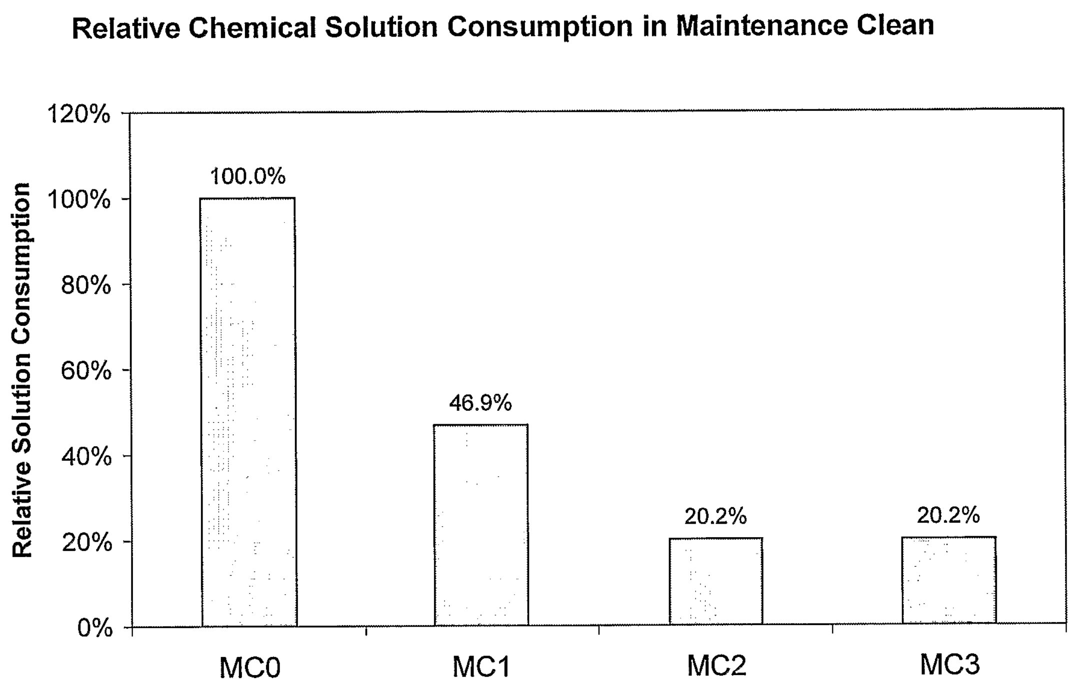

Relative Chemical Solution Consumption in Maintenance Clean
Relative Solution Consumption
120%
100%
80%
60%
40%
20%
0%
100.0%
46.9%
20.2%
20.2%
MC0
MC1
MC2
MC3

Figure 6