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(54) **Title:** METHOD AND DEVICE FOR PURIFYING A LIQUID

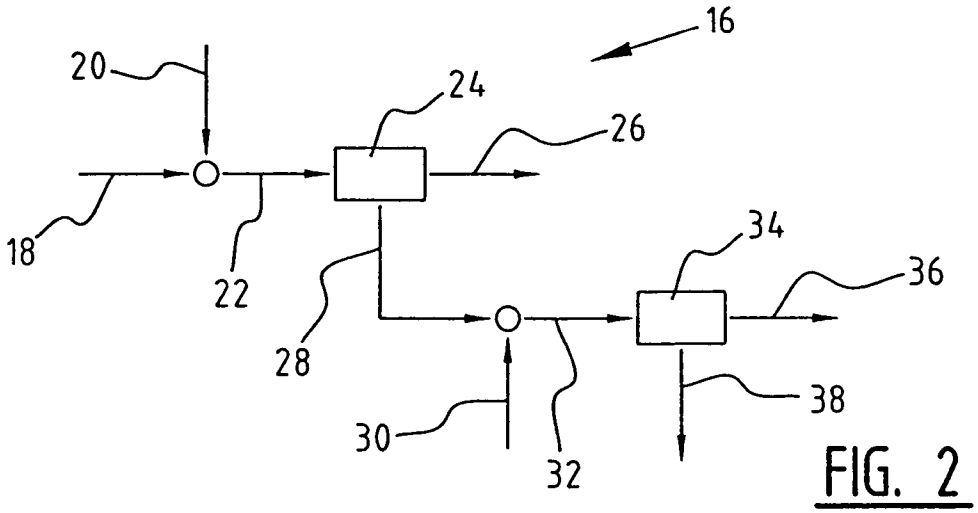


FIG. 2

(57) **Abstract:** The present invention comprises a method and device for purifying a liquid, comprising the steps of : supplying a liquid for purifying provided with a quantity of crystal growth inhibitor; separating the liquid, with the added crystal growth inhibitor, into a purified liquid flow and a residual flow; discharging the separated purified liquid flow; discharging other parts of the liquid flow as a residual flow; adding a crystallizing agent to the residual flow for the purpose of forming crystals in the residual flow; removing the formed crystals from the residual flow; discharging the purified residual flow; and discharging the formed crystals.

WO 2009/045100 A1

PCT/NL2008/000219

METHOD AND DEVICE FOR PURIFYING A LIQUID

The present invention relates to a method for purifying a liquid, such as in a water treatment, for instance for the purpose of drinking water or process water.

In known purification processes, for instance for the purpose of producing drinking water from pumped-up groundwater or surface water, the liquid flow for purifying is carried through a membrane in for instance a reverse osmosis step or nanofiltration step. It is likewise possible to purify the liquid in a distillation process. After possible further treatment steps the purified liquid can then be supplied, among other purposes, as drinking water. The membrane removes as many of the undesirable components as possible from the supplied liquid flow, so that a purified liquid flow is ultimately obtained. These components, which can occur as among others ions and solids, are among others calcium carbonate, barium sulphate, calcium sulphate, struvite, magnesium hydroxide, magnesium sulphate, silicates and strontium sulphate. Owing to the concentration or accumulation of these components in the process the solubility limit of some of these components in the process can be exceeded. This can cause precipitation of the salts, resulting in contamination of the membrane or distillation plant (scaling) with the possible consequence of a higher energy consumption, lower production capacity, more maintenance and a shorter lifespan of the process installations. The risk of such contamination is usually prevented by adding a quantity of agent in the form of a chemical additive, such as an anti-scalant or crystal growth inhibitor, to the liquid flow for purifying. Through the use

of such a crystal growth inhibitor or agent the growth of the crystals which can cause the contamination is slowed, or the supersaturation is reduced by adding acids, bases or complexing agents with which the formation of new crystals is (temporarily) suppressed so that no contamination occurs in the plant. The residue (concentrate) or residual flow is discharged. The residual flow, for instance membrane concentrate, from the purification step therefore also comprises, in addition to the contaminating components, a quantity of crystal growth inhibitor. This waste flow is in practice often discharged to surface water. In view of the nature of the contaminating components and the fact that the crystal growth inhibitor is generally not a substance which occurs naturally, or at least not in these concentrations, such a discharge can have a significant effect on the environment. This means that the capacity of the plant is hereby limited and/or the flow for discharge must be transported over greater distances to locations where a sufficient quantity of surface water is available. This means that the surface water must comprise a capacity and background concentrations of substances such that the effect of the discharge is minimal. The crystal growth inhibitor as environmentally-alien substance may enhance the growth of, among others, algae in the surface water. This substance may also be toxic to water organisms.

The present invention has for its object to provide a method and device for purifying a liquid with which the existing methods and devices are improved by limiting, among others, the quantity of environmentally-alien substances entering the environment, such as surface water, and by herein allowing the purification process to progress as efficiently as possible.

This object is achieved with the method according to the invention, comprising the steps of:

- supplying a liquid for purifying provided with a quantity of crystal growth inhibitor;
- separating the liquid, with the added crystal growth inhibitor, into a purified liquid flow and a residual flow;
- discharging the separated purified liquid flow;
- discharging other parts of the liquid flow as a residual flow;
- adding a crystallizing agent to the residual flow for the purpose of forming crystals in the residual flow;
- removing the formed crystals from the residual flow;
- discharging the purified residual flow; and
- discharging the formed crystals.

Due to the presence of a quantity of chemical additive, such as an anti-scalant or crystal growth inhibitor, in the liquid flow, such as a groundwater or surface water flow, and/or by adding for instance already naturally present humic acids, the further growth of the formed proto-nuclei in the purification process is prevented or in any case decreased. Such proto-nuclei are formed from ions of the contaminating components. By preventing or slowing further growth as much as possible the formation of crystals is avoided as far as possible, whereby contamination of for instance a membrane in the case of filtration and/or (a part of) the plant in the case of distillation is reduced in the purification step. A phosphonate is preferably used as crystal growth inhibitor, particularly on fresh water. These crystal growth inhibitors particularly create a threshold value for the growth of the proto-nuclei, a whereby the proto-nuclei remain small and will therefore be less likely to contaminate the membrane. An example of a phosphonate

that is used is amino trimethylene phosphonic acid (ATMP). Such phosphonates can be decomposed by, among others, a number of specific micro-organisms. Alternative crystal growth inhibitors include a polyphosphate base and/or polyacrylate base and/or polysaccharide base and/or partially oxidized saccharide base and/or saccharose base. In order to prevent discharge of the crystal growth inhibitor into for instance surface water, a crystallizing agent is added to the residual flow from the purification process. Such a crystallizing agent or adsorber removes the anti-scalant so that the crystals can grow. The supersaturated components, such as for instance calcium carbonate, will hereby crystallize. During this crystallization the crystal growth inhibitor is bound to the newly formed crystals. Possible adsorbers are, among others, clay, such as layered double hydroxide (LDH) zeolite, ion-exchanging resin and active carbon (PHC or GHC). Also an option is to use calcium carbonate ($CaCO_3$) as adsorber, for instance in the form of aragonite. Aragonite functions here as a type of inoculant, or as crystallization surface. A larger surface will therefore enhance the crystallization. By then dividing the residual flow, for instance by filtration, distillation, precipitation or centrifugation, the formed crystals can be separated from the residual flow. The hereby purified residual flow can then be discharged. This discharge of purified residual flow can then be drained to the surface water with less of an impact on the environment. The formed crystals can optionally be discharged separately. This achieves that a purer residual flow is discharged to the surface water. A greater flow can hereby be discharged per unit of time and/or the impact on the surface water is reduced and optionally the process can suffice with a small quantity of surface water. Such a small

quantity means that surface water with a lower flow rate can usually suffice. This can usually be found closer by, so that the transport distance to the surface water becomes shorter. This increases the overall efficiency of the purification process. In an advantageous embodiment the separation of the liquid flow for purifying is performed by filtration making use of a membrane.

In a preferred embodiment according to the present invention a base, such as a salt, is used as crystallizing agent. The pH of the residual flow is increased by using a base substance as crystallizing agent. This increases the degree of supersaturation in this residual flow. Because the still present crystal growth inhibitor, such as ATMP, still present in the residual flow cannot absorb this supersaturation, crystallization of the components will begin to occur. The crystal growth inhibitor can here adsorb to the new calcium carbonate crystals. The crystal growth inhibitor can also form an insoluble salt with the calcium ions and/or can be incorporated in the crystal lattice of for instance calcium carbonate. The crystal growth inhibitor can be removed from the residual flow by one of these mechanisms, or by a combination thereof, by then filtering the residual flow. A more efficient removal of crystal growth inhibitor from the residual flow can take place through the use of a base substance with which the supersaturation is increased. This means that the process can be operated more efficiently. In addition, the concentration of a number of ions in the residual flow is reduced, this being advantageous during discharge. The effect of the process on the environment is also further reduced. In an advantageous embodiment the base crystallizing agent is lime milk ($Ca(OH)_2$). Supplementary to the above mechanism, the crystal growth inhibitor, such as

in the case of calcium carbonate, can also adsorb to the solid lime milk. A further advantage of lime milk is that it is generally relatively widely available and can be added at relatively low-cost to the residual flow. This has the additional advantage that the crystallization step can be performed in efficient manner while an environmentally friendly process is realized. Another advantage of $Ca(OH)_2$ as crystallizing agent is that through dissolving thereof the supersaturation of calcium carbonate is not only increased due to a rise in the pH (whereby bicarbonate is converted into carbonate), but also by an increase in the concentration of calcium ions in the liquid.

The crystallizing agent is preferably added in the range of 0.01-10.0 gram per litre and more preferably in the range of 0.1-1.0 gram per litre of residual flow in the presence of crystal growth inhibitor in the order of magnitude of 10-30 mg per litre of residual flow. An advantageous removal of crystal growth inhibitor from the residual flow is hereby realized.

In an advantageous preferred embodiment according to the present invention at least a part of the discharged purified residual flow is separated, such as by a membrane, in order to obtain an additional purified liquid flow and a concentrated residual flow.

By carrying the purified residual flow, i.e. after the filtration step, through for instance a membrane, this flow is further purified. If desired, it is hereby possible to obtain an additional purified liquid flow as end product (after optional further treatments). In an advantageous embodiment the purified residual flow is fed back wholly or partially after the filtration step to for instance the membrane in the initial purification process (zero liquid discharge). Owing to this feedback the process can be

operated in efficient manner without addition of additional process steps. Also achieved is that more end product can be obtained from a specific quantity of starting material by carrying a purified residual flow through the membrane.

In a further advantageous preferred embodiment according to the present invention the discharged crystals are dissolved for the purpose of recovering crystal growth inhibitor.

It is possible to recover the crystal growth inhibitor by once again dissolving the formed crystals after the filtration step. This is advantageous, among other ways, when the crystal growth inhibitor is bound to an adsorber and both can be reused. It is hereby possible in advantageous manner to wholly or partially reuse the crystal growth inhibitor by adding it to the supplied liquid for purifying. A more or less closed system can hereby be realized in respect of the crystal growth inhibitor. This means that the environmentally-alien substance will hardly any longer enter the environment. An alternative embodiment is recovering the crystal growth inhibitor adsorbed to the formed crystals by exposing the crystals to high shear rates of the surrounding liquid, whereby desorption of the crystal growth inhibitor occurs. This is possible for instance by stirring the suspension very strongly by applying for instance hydrocyclones or decanting centrifuges. The recovered crystal growth inhibitor is preferably used immediately as additive for the initial purification step. The process can hereby be operated more efficiently in that the use of this relatively expensive substance is limited to a minimum. An additional advantage is that it is hereby also possible to use other crystal growth inhibitors which improve the further processing, for instance by further suppressing contamination and/or corrosion without these

agents entering the environment. It hereby becomes possible in practice to use a new group of inhibitors. An example of this new group of inhibitors are the biologically poorly degradable crystal growth inhibitors.

The invention further relates to the device suitable for performing the method according to the present invention. Such a device provides the same effects and advantages as those stated with reference to the method.

Further advantages, features and details of the invention are elucidated on the basis of preferred embodiments thereof, wherein reference is made to the accompanying drawings, in which:

- figure 1 shows a known purification process;
- figure 2 shows a purification process according to the present invention; and
- figure 3 shows an alternative embodiment according to the present invention.

In a known purification process 2 (figure 1) a crystal growth inhibitor or agent 6, such as ATMP, is added to a supplied liquid flow 4. The resulting incoming flow 8 is carried to purification step 10. This purification step 10 makes use of the reverse osmosis principle in which the liquid is pressed under pressure through a membrane. After optional follow-up treatments the resulting product flow 12 can be supplied as end product. Residual flow 14 from purification process 10 is discharged as waste. In the case of drinking water production the liquid flow 4 can be pumped-up groundwater or pretreated surface water. Product flow 12 can then be used as drinking water and residual flow 14 can be discharged to surface water.

A purification process 16 according to the present invention shows a liquid flow 18 to which a crystal growth inhibitor 20 is added. The incoming flow 22 resulting from

liquid flow 18 and crystal growth inhibitor 20, with optional further extra additives, is carried to purification process 24. The outgoing flow 26 is a purified liquid which, after optional further treatments, is suitable as end product. Waste flow 28 from purification process 24 is discharged. Crystallizing agent or adsorber 30 is added to residual flow 28, resulting in a flow or quantity 32. After crystallization of the contaminating components with the crystal growth inhibitor, the quantity or flow 32 is filtered in filtration step 34. The outgoing flow 36 can be used as product flow or be discharged to surface water. Residual flow 38 with the crystals present therein can be discharged separately.

In another embodiment of the purification process according to the invention 40 (figure 3) the product flow 36 resulting from filtration step 34 is carried to the membrane in purification step 24. A feedback loop is hereby realized in which the liquid still present in residual flow 28 can be recovered. Residual flow 38 is also carried to a dissolving step 42 in which the formed crystals with the crystal growth inhibitor are dissolved. A flow of crystal growth inhibitor 44 can be fed back from this step 42 and added to the incoming liquid flow 18. This means that the addition of crystal growth inhibitor in additive flow 20 is reduced. A closed system is in fact realized in respect of the crystal growth inhibitor, wherein the flow of additive 20 serves solely to reduce possible losses of crystal growth inhibitor in for instance waste flows 46. Compared to the known systems the waste flow 38, 46 is greatly reduced in volume relative to residual flow 14. This means that the effect of purification process 16,40 on the vicinity/environment is greatly reduced. The capacity of a process can for instance also be further increased and/or it is possible to suffice

with for instance a smaller volume of surface water for discharge of possible residual flows.

Examples

Example 1: Removal of crystal growth inhibitor with addition of precipitated calcium carbonate

Isotherm is measured in two different solutions:

- A first supersaturated solution of Ca^{2+} and CO_3^{2-} is held in solution by a crystal growth inhibitor (anti-scalant) with:
- 250 mg/l Na_2CO_3 (= 142 mg/l CO_3^{2-};
- 350 mg/l $CaCl_2*2H_20$ (= 95.4 mg/l Ca^{2+});
- (therefore 237 mg/l $CaCO_3$);
- 20 mg/l crystal growth inhibitor;
- No adjustment of acidity, pH = 10.5; and
- a second solution without supersaturation and only crystal growth inhibitor with:
- 20 mg crystal growth inhibitor per litre liquid.

The experiments are carried out in duplicate in 100 ml erlenmeyer flasks with screw cap. The erlenmeyer flasks are filled with 50 ml of both solutions and different quantities of calcium carbonate. These erlenmeyer flasks are placed for 24 hours in a shaking bath at 150 rpm, at 25°C, without air inclusion. No visible primary nucleation was observed here for 24 hours.

The samples are filtered through a 0.45 μm filter. In order to prevent crystallization of $CaCO_3$, and thereby removal of crystal growth inhibitor after the filtration step, the samples are acidified to a pH between 2 and 3 by adding 20 μl HCl (37%) to 12 ml of sample.

With 1 gram of calcium carbonate per litre of liquid 83% of the crystal growth inhibitor is removed in the

supersaturated solution. 61% is removed in the case of the unsaturated solution.

An explanation for this difference may be that due to the removal of crystal growth inhibitor the supersaturated calcium carbonate crystallizes, and that the crystal growth inhibitor binds to these new crystals and is taken up into the crystal lattice.

Example 2: Removal of crystal growth inhibitor with the addition of lime milk

A membrane concentrate (synthetic concentrate) is first simulated. The components of this synthetic concentrate are compared in Table 1 to an average concentrate from a purification process. The solutions are here stirred for half an hour and filtered through a 0.45 μm filter.

Table 1: Components of real and synthetic concentrate

	Real concentrate	Synthetic concentrate
	(mg/l)	(mg/l)
Na	139	725
Ca	462	640
Mg	63	72
CO_3	1200 (HCO_3)	945
SO_4	380	289
Cl	245	1135
Crystal growth inhibitor	125	125
pH	6.5 to 8.5	7 to 8

The values of the synthetic concentrate stated in Table 1 are values calculated from the added chemicals.

Table 2 shows the different concentrations of lime milk ($Ca(OH)_2$) with the percentage found of removed crystal growth

inhibitor. Also shown is the measured pH. The quantity of crystal growth inhibitor is calculated from the amount of phosphor (P) measured in the solution (Dr Lange test).

Table 2: Removal of crystal growth inhibitor with $Ca(OH)_2$

Number	$Ca(OH)_2$	Phosphor	Crystal growth inhibitor	Acidity	Percentage removed
	[gram/l]	[mg/l]	[mg/l]	[pH]	[%]
1	1.0000	<0.074	<0.95	11.41	>92.4
2	0.5004	<0.074	<0.95	7.90	>92.4
3	0.2614	0.126	1.62	9.72	87.1
4	0.1283	0.678	8.69	8.32	30.5
Blank		0.976	12.51	7.42	

Since $Ca(OH)_2$ is a base substance, the acidity is increased. The supersaturation hereby becomes greater because bicarbonate is converted into carbonate. Since the Ca^{2+} concentration also increases due to the dissolving of $Ca(OH)_2$, the crystal growth inhibitor can no longer prevent crystallization. Crystal growth inhibitor is removed by this process. There are a number of possible explanations for this, including:

1. Crystal growth inhibitor adsorbs to the new $CaCO_3$ crystals;
2. Crystal growth inhibitor forms an insoluble salt with Ca^{2+};
3. Crystal growth inhibitor adsorbs to the $Ca(OH)_2(s)$; and
4. Crystal growth inhibitor is incorporated into the crystal structure of $CaCO_3$.

It follows from Table 2 that at a dosage of more than 0.5 gram per litre $Ca(OH)_2$ more than 92.4% of total crystal growth inhibitor is removed.

Example 3: Removal of crystal growth inhibitor with addition of lime milk and NaOH

Two (supersaturated) synthetic solutions of 1 litre are prepared, wherein 500 ml $Ca(OH)_2$ is added to one solution and 500 ml NaOH to the other. The synthetic solution consists of the components stated in Table 1.

The results are given in Table 3.

Table 3: Addition of $Ca(OH)_2$ and NaOH to synthetic concentrate

	$Ca(OH)_2$	NaOH	Phosphor	Crystal growth inhibitor	Ca	Mg	SO_4	Acidity
	[g/l]	[g/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[mg/l]	[pH]
$Ca(OH)_2$	0.2490	0	0.06	0.77	457	72.8	237	7.37
NaOH	0	0.2720	0.42	5.38	394	69.7	250	8.54
Calculated values	0	0	0.98	12.5	640	72.0	289	7 to 8

Almost the same amount of OH is added to both solutions:

- 0.2490 g/l $Ca(OH)_2$= 0.1143 g/l OH^-
- 0.2720 g/l NaOH = 0.1156 g/l OH^-

Crystal growth inhibitor and Ca^{2+} is removed in both solutions. Removal of crystal growth inhibitor by $Ca(OH)_2$ is better than with NaOH.

Example 4: Influence of lime milk on removal of crystal growth inhibitor

Three different solutions are tested:

The first solution is milliQ-water with 12 mg/l crystal growth inhibitor and 0.5 g/l $Ca(OH)_2$. After stirring for half an hour the solution is filtered through a 0.45 μm filter and analyzed for phosphor.

The second solution is milliQ-water with 0.5 g/l $Ca(OH)_2$. After stirring for 17 hours 12 mg/l crystal growth inhibitor is added to the solution and stirred for a further half-hour. The solution is then filtered through a 0.45 μm filter and analyzed for phosphor.

The third solution is milliQ-water with 12 mg/l crystal growth inhibitor and 0.5 mg/l $Ca(OH)_2$. After stirring for 17 hours the solution is filtered through a 0.45 μm filter and analyzed for phosphor.

The results are given in Table 4.

Table 4: Influence of $Ca(OH)_2$ on crystal growth inhibitor

	Solution	$Ca(OH)_2$	Phosphor	Crystal growth inhibitor	Removed crystal growth inhibitor	Acidity	Conductivity	Turbidity
	[ml]	[g]	[mg/l]	[mg/l]	[mg/l]	[pH]	[mS/cm]	[NTU]
Sol. 1	200	0.099	1.02	13.08		12.01		31
Sol. 1 after filtration			0.773	9.91	3.17			
Sol. 2	200	0.103	0.94	12.05		12.08	2.8	30
Sol. 2 after filtration			0.809	10.37	1.68			
Sol. 3	200	0.097	0.903	11.58		12.14	2.93	24.6
Sol. 3 after filtration			0.711	9.12	2.46			

It follows from Table 4 that with all three solutions a small part of the crystal growth inhibitor is removed. All three solutions are turbid, so it is not possible to state with certainty whether all $Ca(OH)_2$ has been dissolved or the turbidity is caused by crystal growth inhibitor with Ca^{2+}. Further measurements have shown that no soluble salt is formed from crystal growth inhibitor with Ca^{2+} and that the inhibitor is removed by binding to undissolved $Ca(OH)_2$.

Example 5: Measurements in real concentrate

Different quantities of $CaCO_3$ and $Ca(OH)_2$ are added to 200 ml concentrate, followed by stirring for half an hour, filtering through a 0.45 μm filter and analysis for phosphor.

The results are shown in Table 5.

Table 5: Results of measurements in real concentrate

		Phosphor	Acidity	Conductivity
			[pH]	[mS/cm]
Reference		1.27	7.66	2.54
Reference after filtration		0.159		
Solution 1	0.500 g/l $CaCO_3$	0.072	7.67	2.52
Solution 2	1.005 g/l $CaCO_3$	0.066	7.56	2.52
Solution 3	0.525 g/l $Ca(OH)_2$	0.051	9.03	1.68
Solution 4	0.100 g/l $Ca(OH)_2$	0.042	11.71	2.92

It is noted that the removal of at least 90% of the crystal growth inhibitor is achieved using only a 0.45 μm filter. The solution with $Ca(OH)_2$ otherwise precipitates very well, which results in a better and more rapid separation of the solid.

The present invention is by no means limited to the above described preferred embodiments. The rights sought are defined by the following claims, within the scope of which many modifications can be envisaged. In addition to use of the invention in for instance water purification or water production, it is possible to apply the method and device according to the invention during for instance a brewing process. The use of crystal growth inhibitor must be avoided as far as possible in such a process, while possible contaminated components must be purified as far as possible from the used process water. It is also a possibility for the concentrate to form the desired product. This is the case for instance in the treatment of whey. It will be apparent that the present invention can also be applied here in advantageous manner.

CLAIMS

1. Method for purifying a liquid, comprising the steps of:

- supplying a liquid for purifying provided with a quantity of crystal growth inhibitor;
- separating the liquid, with the added crystal growth inhibitor, into a purified liquid flow and a residual flow;
- discharging the separated purified liquid flow;
- discharging other parts of the liquid flow as a residual flow;
- adding a crystallizing agent to the residual flow for the purpose of forming crystals in the residual flow;
- removing the formed crystals from the residual flow;
- discharging the purified residual flow; and
- discharging the formed crystals.

2. Method as claimed in claim 1, wherein a crystal growth inhibitor on a phosphonate basis is used.

3. Method as claimed in claim 1 or 2, wherein separation of the liquid is realized by filtering thereof using a membrane.

4. Method as claimed in claim 1, 2 or 3, wherein a base is used as crystallizing agent.

5. Method as claimed in claim 4, wherein lime milk is used as base.

6. Method as claimed in one or more of the claims 1-5, wherein the crystallizing agent is supplied in the range of 0.01-10.0 gram/litre of residual flow.

7. Method as claimed in one or more of the claims 1-6, wherein the discharged purified residual flow is separated, such as by a membrane, in order to obtain an additional purified liquid flow and a concentrated residual flow.

8. Method as claimed in claim 7, wherein at least a part of the discharged purified residual flow is added to supplied liquid for purifying to be separated.

9. Method as claimed in one or more of the claims 1-8, wherein at least a part of the discharged formed crystals are dissolved for the purpose of recovering crystal growth inhibitor.

10. Method as claimed in claim 9, wherein at least a part of the recovered crystal growth inhibitor is added to the supplied liquid for purifying.

11. Device suitable for performing the method as claimed in one or more of the claims 1-10.

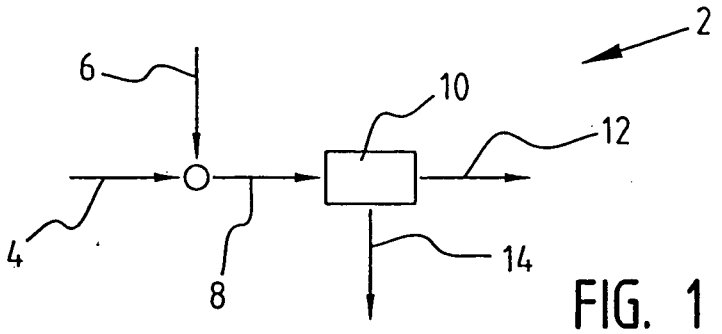


FIG. 1

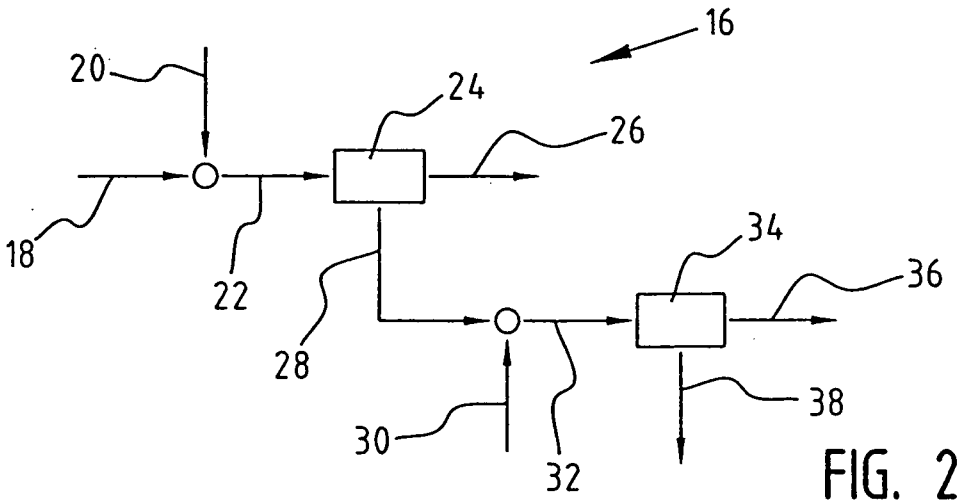


FIG. 2

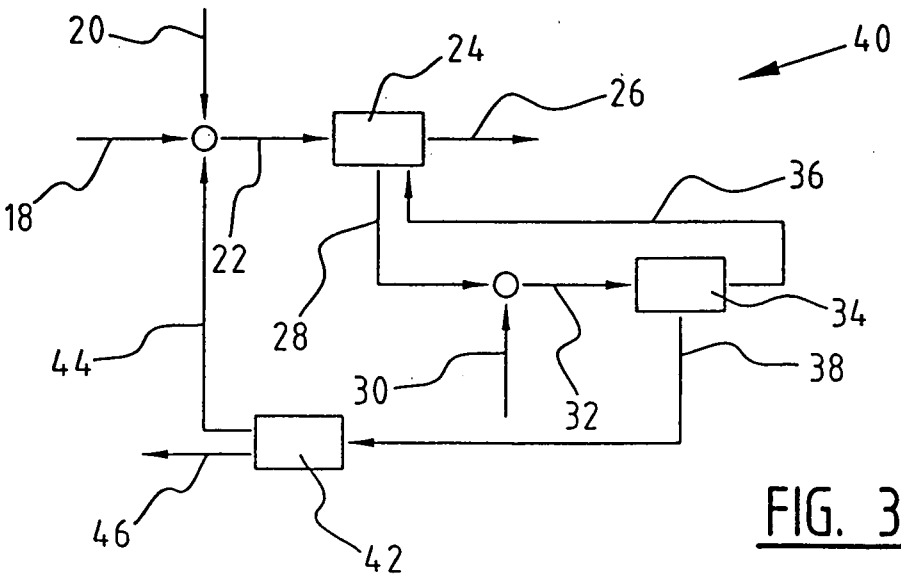


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2008/000219

A. CLASSIFICATION OF SUBJECT MATTER
INV. C02F5/14 C02F1/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 501 798 A (AL-SAMADI RIAD A [CA] ET AL) 26 March 1996 (1996-03-26) figure 1 example 1 column 3, line 54 - column 5, line 30	1-11
X	US 2006/150892 A1 (MAYER MATEO J J [NL]) 13 July 2006 (2006-07-13)	11
A	figure 2 paragraph [0075] paragraphs [0091], [0092]	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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