

Title

MICROPUMP HAVING A CAPILLARY STRUCTURE, AND USE

Description

The invention pertains to a micropump for exchanging liquid between a supply region and a working region by means of a capillary structure, wherein an enclosed gas region is located above the working region, and to a use of the micropump.

Numerous technical applications require the transport of minute quantities of liquids. In this context, it is necessary to overcome occurring surface tensions and to utilize capillary forces.

Prior Art

The prior art most closely related to the invention is disclosed in **DE 198 60 227 C1**. This publication describes a micropump for a miniaturized gas generating system in the fuel cell technology. Minute quantities of water and hydrocarbon have to be fed to a conversion process in a working region in order to generate hydrogen. The liquid to be transported is stored in an enclosed supply region. The liquid is transported from the supply region into the working region by means of a capillary structure in the form of a hollow fiber bundle and further processed in the working region. The exchange of liquid respectively utilizes diffusion forces or the diffusion pressure of the molecules in the liquid occurring as a result of the capillary effect. No pressure above the ambient pressure is applied to the micropump from outside. A gas is generated in the process in an enclosed gas region above the liquid in the working region. The gas is discharged from the

working region through an outlet. The liquid is not transported through the enclosed gas region.

EP 1 835 275 A2 discloses a pipette-like micropump for extracting a liquid from another liquid, wherein said micropump can aspirate different liquids from different supply regions through an open pipette tip by means of a capillary structure. The aspiration takes place successively such that the initially aspirated liquid can be treated with the subsequently aspirated liquid. An open gas region in the form of ambient air is located above the supply region that does not form part of the micropump. However, the liquid once again does not have to be transported through this ambient air. This applies analogously to the needle known from **DE 199 33 838 A1**, wherein said needle serves for transferring liquids between a supply region and a working region and has capillary structures in the region of its tip. These capillary structures can aspirate liquid by means of capillary forces when the needle tip is immersed in a supply region and retain said liquid until it should be discharged again at a different location. An open gas region is once again formed by the ambient air.

Furthermore, Figure 1 of **DE 197 11 270 A1** discloses a micropump for fluid mediums that operates with a vibration generator or sound generator, wherein the pump chamber of said micropump consists of the interior of a capillary tube.

Objective

Based on the generic micropump according to the most closely related prior art described above, the **objective** of the present invention can be seen in enhancing this micropump in such a way that the liquid can also be transported through the enclosed gas region. The solution

should be simple and cost-efficient. The **solution** to this objective is disclosed in the master claim. Advantageous modifications of the invention are disclosed in the dependent claims and described in greater detail below together with the invention and a preferred use thereof.

According to the invention, a capillary pipette with a closed pipette tip on its lower end and an open pipette inlet lying opposite thereof is provided, wherein the working region is enclosed by a pipette section above the closed pipette tip and the open pipette inlet is covered by a liquid-permeable filter, and wherein the filter is connected to the supply region. According to the invention, it is furthermore proposed that the capillary structure extends through the gas region between the closed pipette tip and the filter.

The micropump claimed by the invention essentially is a specially modified capillary pipette. A conventional capillary pipette in commercially available and unmodified form is also referred to as "Pasteur pipette." It has an open pipette tip on the end of a capillary tube such that minute liquid volumes can also be dripped out. An open pipette inlet for introducing liquid into the pipette is located on the other end of the capillary tube. In the inventive micropump, the pipette tip is closed such that a very small liquid volume, which cannot be dripped out downward, can be accumulated in the interior of the capillary tube above the pipette tip. A pipette section lying above the closed pipette tip encloses the working region of the claimed micropump, in which the stored liquid can be examined or processed. The enclosed gas region is located above the working region in the modified capillary pipette. The liquid in the working region has no direct contact with the liquid in the supply region, but rather is separated therefrom by the gas region. The working region of the inventive micropump is delimited by the closed

pipette tip on its one side, as well as by the gas region on its other side, and constantly defined in its small volume. The liquid to be exchanged typically is water or an aqueous liquid. However, all other liquids that are subject to the effect of capillary forces and in the process build up a diffusion pressure, e.g. liquid hydrogen, can also be reliably transported in minute quantities with the inventive micropump.

The modified capillary pipette of the inventive micropump furthermore has an open pipette inlet, which serves for supplying liquid into the interior of the pipette, on its end that lies opposite of the pipette tip. According to the invention, the open pipette inlet is covered by a liquid-permeable filter. The filter forms the interface between the liquid in the supply region and the gas in the gas region in the interior of the pipette. The gas region forms a barrier for the liquid in the supply region and does not allow this liquid to readily enter the interior of the pipette. In order to bridge the gas barrier, the invention therefore proposes that the capillary structure extends between the closed pipette tip and the filter on the open pipette inlet. In this way, the working region is fluidically connected to the supply region through the blocking gas region. A continuous exchange of liquid between the two regions is made possible and permanently ensured due to the capillary effect of the provided capillary structure. In this case, a very small volume in the working region is continuously exchanged and kept constant. Without the inventive capillary exchange, the liquid would remain in the working region due to the blocking gas region and the retaining capillary forces and therefore would not exchange itself with the liquid in the supply region. Examinations of changing liquid from the supply region in the working region would not be possible.

The micropump claimed by the invention particularly is constructed of only a few simple constructive elements and requires no external energy supply, particularly also no external pressure supply. It is therefore also particularly cost-efficient. The price of the individual components lies in the single-digit Euro range. The manufacture is likewise simple and cost-efficient. Commercially available components can be easily adapted. In addition to these obvious advantages, another advantage can be seen in achieving a particularly small, constant working region in the capillary section. If minute particles or organisms should be examined, for example, they have to accumulate and therefore concentrate in this small volume. This allows a better observability than in a spatially distributed arrangement. According to a first enhancement of the inventive micropump, it is therefore preferred and advantageous that the working region has a volume in the range between one-fourth and one-third of the volume of the capillary pipette. Commercially available capillary pipettes have capillary tubes with a length between the 45 mm and 120 mm and can have a volume between 1 ml to 10 ml. The length of the capillary pipette can also be shortened in this case. According to the invention, the working region preferably and advantageously has a volume in the range between 0.4 ml and 0.5 ml, e.g. between 400 μ l and 500 μ l. This is an extremely small volume and the liquid contained therein would without the measures of the invention not enter into an exchange with the surroundings if no external pressure is applied. The retaining forces would prevent such an exchange from taking place. According to the invention, these retaining forces are overcome in a highly effective manner by utilizing liquid-immanent capillary and diffusion forces.

It was already mentioned above that sound observations of the liquid in the working region can be carried out because particles or organisms present in the minute volume are

accumulated at this location. According to another inventive embodiment, it is therefore preferred and advantageous that at least the capillary section enclosing the working region is realized transparently. Commercially available capillary pipettes typically consist of glass or of opaque or transparent plastic. Glass pipettes (e.g. of quartz glass) are particularly well suited for use in the invention because they are highly transparent and their open pipette tip can be easily closed by means of fusing or bonding. Plastic pipettes can likewise be used as long as they are translucent. Furthermore, the capillary tubes of conventional capillary pipettes can be realized cylindrically with a constant diameter (piston) or in a conically tapered manner with a decreasing diameter - toward the pipette tip. According to the invention, it is preferred and advantageous that the pipette section is conically tapered in the direction of the pipette tip and that the pipette tip is realized cylindrically. Commercially available capillary pipettes can then be modified.

Capillary forces occur on all smooth solid surfaces. They are particularly strong on dense plastic surfaces and glass surfaces. According to another inventive embodiment, it is therefore advantageous and preferred that the capillary structure consists of glass. According to another advantageous embodiment of the invention, it is furthermore preferred that the capillary structure is formed by a rod or a tube. Capillary structures of this type likewise are easily available commercially, particularly of glass, and particularly inexpensive. Rods or tubes of plastic or another solid material may also be used. However, it has to be ensured that sufficiently high capillary forces for the exchange of liquid occur in this case. Glass threads and glass rods consist of solid glass such that the capillary effect occurs on their surface. Glass threads have a smaller diameter than glass rods. These may have a

diameter, for example, of 1.5 mm or less. Glass tubes consist of hollow glass. The capillary effect primarily occurs on the inner side of the glass tubes. In any case, the outer surface and, if applicable, the inner surface of such capillary structures are sufficiently large such that the liquid to be transported can migrate in both directions (into and out of the working region) due to the capillary effect. Consequently, a bidirectional exchange of liquid between the working region and the supply region takes place. The volume in the working region or capillary section does not change in the process, but rather remains constant. The glass rods or glass tubes advantageously consist of the same glass material as the chosen pipette.

A cylindrical extent of the pipette tip provides the advantage that an inserted rod or tube is axially centered. According to another inventive modification, it is therefore preferred and advantageous that the rod or the tube, particularly a glass rod (or glass thread) or a glass tube, also extends in the pipette tip and is axially centered in the capillary pipette by this pipette tip. In this case, the rod or tube has such a diameter that it is on the one hand properly guided in the pipette tip, but a remaining annular gap in the conical pipette section is on the other hand sufficiently large for enabling the small liquid volume to easily accumulate. The particles or organisms to be examined can then easily accumulate and be represented in the annular gap. The insertion of the rod or the tube up to the pipette tip reliably ensures that the entire working region is penetrated by the capillary structure and subjected to the continuous exchange of liquid with the supply region. The axial centering prevents the rod or tube from contacting the inner wall of the capillary section. In this way, the entire outer surface of the rod or tube is available for the liquid transport in both directions. The effective capillary forces basically are so high that it is according to another inventive

embodiment possible to arrange the capillary pipette in any orientation. The capillary pipette or the entire micropump can be arranged vertically, as well as horizontally and also obliquely. The capillary-driven exchange of liquid between the working region and the supply region reliably takes place in any orientation of the micropump.

The ability to arbitrarily orient the micropump claimed by the invention is advantageous with respect to the realization of the supply region. This supply region may be a constructive part of the micropump and be directly connected to the pipette inlet, e.g. in the form of a small container (enclosed or with flow-through connection) or an elastic balloon. In this case, the micropump typically is arranged vertically. According to another inventive embodiment, however, the supply region preferably and advantageously can also be formed by a region of an open body of water, e.g. a lake or a bay, wherein the supply region also directly adjoins the pipette inlet in this case. It is advantageous and preferred that the capillary pipette is in this case completely immersed in the supply region. The micropump is placed into the body of water either directly or in a water-permeable housing or cage such that the supply region (the region of the body of water that particularly adjoins the pipette inlet) completely surrounds the micropump. Consequently, the micropump lying on the bottom of a body of water or a cage typically is arranged horizontally. An oblique arrangement may also be chosen so as to not impair the circulation of liquid at the pipette inlet, wherein the micropump is placed against an object in such an oblique arrangement and the pipette inlet points upward.

If the micropump is completely immersed in the supply region, the composition of the liquid located therein may be known or unknown. This liquid frequently is natural water of unknown composition and contains a plurality of

minute particle and organisms. However, these particles and organisms typically are not the subject of examinations and therefore should not be admitted into the interior of the micropump. According to another modification of the invention, it is therefore preferred and advantageous that the filter has a mesh width that is adapted to minute particles and organisms to be retained in the supply region. The filter is arranged on the pipette inlet and permeable to liquids. The filter retains undesirable foreign matter with a size above the mesh width of the filter, but still allows water to advance into the working region along the adjoining capillary structure due to the effective capillary forces. However, since the claimed micropump operates without external application of pressure, it is only possible to use minimum mesh widths that do not impair the liquid transport due to diffusion pressure. The capillary structure, preferably a glass rod or a glass tube, extends up to and contacts the filter material. This is realized in a particularly reliable manner if the capillary structure slightly protrudes beyond the end of the capillary pipette at the pipette inlet, e.g. by approximately 1 mm to 3 mm. In this case, the filter may slightly bulge outward in the region of the capillary structure if it is realized flexibly. According to the invention, it is therefore advantageous and preferred that the filter is realized in the form of flexible gauze. A gauze mesh width of 50 μm is particularly preferred for the purely diffusion-driven exchange of liquid. This mesh width makes it possible to retain undesirable foreign matter and to simultaneously allow the admission of substances to be detected or nourished into the interior of the pipette together with the liquid. According to another inventive enhancement, it is preferred and advantageous to permanently arrange the flexible gauze in front of the pipette inlet of the capillary pipette by fastening the gauze with the aid of an elastic sealing ring that is slipped over the pipette inlet. In this case, the gauze is

simply placed over the open pipette inlet and fixed by slipping over the elastic sealing ring consisting, for example, of flexible rubber. Particles that are larger than the chosen mesh width of the gauze are reliably retained in the supply region.

The micropump claimed by the invention including the above-described advantageous modifications is - if a transparent pipette section is used - particularly advantageous for use in measuring equipment for fluorescence measurements. Substances or living organisms in the liquid can be accumulated within the smallest of spaces in the working region of the micropump and examined with respect to their fluorescence properties (stimulated fluorescence and autofluorescence). The signal strength is sufficiently high due to the high concentration of the substance to be examined in the working region. It is considerably higher than in a spacious distribution of the particles or organisms to be detected in a larger working region. This preferably and advantageously makes it possible to carry out fluorescence measurements on living marine organisms that have accumulated in the working region filled with liquid from the supply region. In this context, it is once again preferred and advantageous that the supply region is formed by a region of an open body of water and that the capillary pipette is completely immersed in the supply region. It is possible to use all living marine organisms that have autonomous fluorescent properties or fluorescent properties that can be stimulated, e.g. also algae. It is preferably and advantageously also possible to use marine flatworms, which exhibit a significantly increased autofluorescence upon contamination with toxic matter contained in the liquid from the supply region; in this context, see also patent **DE 10 2014 012 130 B3** of the present applicant, which pertains to the in-situ detection of toxins in bodies of water by means of genetically modified organisms. More details on this and on the above-

described modifications of the invention can be gathered from the following exemplary embodiments.

Exemplary Embodiments

The micropump according to the invention and its advantageous modifications and uses are described in greater detail below with reference to the schematic **figures** that are not true to scale. In the individual figures,

Figure 1 shows a schematic cross section through a micropump with a constructively delimited supply region, and

Figure 2 shows a schematic cross section through a micropump with a supply region in the form of a portion of an open body of water.

Figure 1 shows a micropump **01** for exchanging liquid between a supply region **02** and a working region **03**. The micropump **01** comprises a modified capillary pipette **04** that preferably consists of glass. The capillary pipette **04** has a closed pipette tip **06** on its lower end **05** and an open pipette inlet **07** lying opposite thereof. The working region **03** is enclosed by a pipette section **08** that is arranged above the closed pipette tip **06**. An enclosed gas region **09** is located above the working region **03**. The pipette inlet **07** is covered by a liquid-permeable filter **10**. The filter **10** is located directly adjacent to the supply region **02**. The supply region **02** is defined by a balloon **11** in **Figure 1**. This balloon has connections **12** in order to allow a liquid **13** (typically water or an aqueous liquid) to pass through the balloon. The preferred embodiment of the micropump **01** claimed by the invention is illustrated in **Figure 2**. Reference symbols that are not elucidated with reference to this figure can be gathered from **Figure 1**.

Figure 2 shows an embodiment of the micropump **01**, in which the supply region **02** is formed by a region **14** of an open body of water **15**. Consequently, the liquid **13** from the open body of water **15** is also located in the supply region **02** of the micropump **01**. The capillary pipette **04** is completely immersed in the supply region **02**. The capillary pipette **04** is oriented vertically in the exemplary embodiment shown. A horizontal or oblique orientation is also possible. The liquid **13** is likewise located in the working region **03**. This liquid respectively originates from the supply region **02** or the region **14** and therefore from the open body of water **15**. The enclosed gas region **08** filled with air **16** is located above the working region **03**. In order to accomplish a continuous exchange of liquid between the region **14** (supply region **02**) and the working region **03** through the gas region **08**, both of these regions are connected to one another by means of a capillary structure **17**. This capillary structure is formed by a rod **18** consisting of solid glass in the exemplary embodiment shown. It is likewise possible to use a hollow tube that preferably also consists of glass.

In **Figure 2**, the region **14** (supply region **02**) is a portion of a body of water **15**, which may also contain minute particles and organisms that are undesirable with respect to the exchange of water by means of the micropump **01**. In order to prevent the admission of these particles and organisms into the interior of the capillary pipette **04**, a filter **10** that retains the minute particles and organisms **19** in the region **14** is placed over the open pipette inlet **07**. The filter **10** is realized in the form of gauze **20** in the exemplary embodiment shown. This gauze is flexible and securely fastened on the pipette inlet **07** by means of an elastic sealing ring **21** (rubber ring) that is slipped over the pipette inlet. In the order to ensure that the exchange of liquid can reliably take place through the filter **10** as a result of capillary forces, the capillary structure **17**

(in this case the rod **18**) slightly protrudes beyond the pipette inlet **07** (this is not illustrated true to scale and rather exaggerated in **Figure 2**). This causes the gauze **20** to slightly bulge outward. The upper end **22** of the rod **18** is pressed against the gauze **20**. The liquid **13** comes in contact with the rod **18** through the mesh of the gauze **20** and then creeps into the working region **03** along the rod. Liquid **13** from the working region **03** reaches the region **14** (supply region **02**) in the opposite direction. The continuous exchange of liquid through the gas region **08** and the filter **10** is reliably ensured while the volume of the working region **02** remains constant.

A few details regarding the potential dimensions of the micropump **01** are described below, but merely intended to exemplify the proportions. Different dimensions can be readily realized and the cited dimensions should be interpreted as approximate values. In the exemplary embodiment shown, the capillary pipette **04** of glass has an overall length of 75 mm. The pipette tip **06** is realized cylindrically and has a length of 25 mm. The pipette section **09** surrounding the working region **03** is conically tapered in the direction of the pipette tip **06** and has a length of 15 mm. The gas region **08** above the working region **03** accordingly has a length of 35mm. The capillary pipette **04** has an overall volume of 1.3 ml (overall volume between 1.2 ml and 1.5 ml), wherein the working region **03** comprises approximately one-fourth of the overall volume. The working region **03** comprises 400 μ l (0.4 ml, working region **03** between 0.3 ml and 0.5 ml) in the exemplary embodiment shown. The pipette tip **06** has an inside diameter of 2 mm. The closed semicircular rounding of the pipette tip **06** has an inside radius of 1 mm. The rod **18** has a length of 76 mm and a thickness of 1.5 mm, wherein its ends are semicircularly rounded with a radius of 0.75 mm. The rod **18** therefore is axially guided in the pipette tip **06** during its insertion. A concentric annular gap remains around the

inserted rod **18**. This annular gap suffices for an easy insertability of the rod **18** into the pipette tip **06**. However, no working region **03** is formed in the annular gap of the pipette tip **06**. The working region **03** begins above the pipette tip **06** and is enclosed by the conical pipette section **09**. The inserted rod **18** extends up to the closed end **05** of the pipette tip **06**. Since it is dimensioned slightly longer than the capillary pipette **04**, it protrudes by approximately 1 mm on the pipette inlet **07**. This protrusion suffices for sound contact with the gauze **20** and therefore with the liquid **13** present in the mesh thereof. The gauze **20** preferably has a mesh width of 50 μm , which proved optimal for the exchange of liquid because it is not obstructive. The pipette inlet **07** has an inside diameter of 6 mm. The entire capillary pipette **04** is realized transparently in the exemplary embodiment shown. The pipette section **09** in particular is realized transparently. The working region **03** therefore is visible from outside and transmissive. Consequently, the micropump **01** is particularly well suited for use in measuring equipment for fluorescence measurements. The procedure for the modification of the capillary pipette **04** and the use of the micropump **01** for fluorescence measurements with living organisms is briefly described below.

The modified capillary pipette **04** of the micropump **01** may serve as a container for keeping marine flatworms **23** (*Macrostomum lignano*) for at least 10 days in a small volume, in which fluorescence measurements are regularly carried out. The small volume is necessary in order to be able to measure the bundled, emitted fluorescence signal during the irradiation of the flatworms **23** with a corresponding stimulation wavelength. To this end, the micropump **01** is vertically integrated into correspondingly constructed measuring equipment. The measurement initially takes place above water (test measurements). Subsequently, in-situ underwater measurements are carried out in order to

detect potential toxic matter in the (sea) water based on the measured fluorescence signals of the flatworms **23**. The capillary pipette **04** with a water-conveying capillary structure **17** in the form of the rod **18** proves to be an optimal caging and measuring container for fluorescence measurements with the flatworms **23**. The claimed micropump **01** is highly effective for this purpose. An efficient, uncomplicated exchange of water is realized within a few hours with very cost-efficient means. The flatworms **23** are not negatively affected in any way and no interference in the fluorescent measurements takes place.

In the manufacture of the modified capillary pipette **04**, a conventional Pasteur pipette of glass is shortened on the top and on the bottom, wherein the lower end **05** of the pipette tip **06** is fused shut and the capillary pipette **04** is thoroughly rinsed out with ethanol and tap water. Subsequently, the capillary structure **17** (rod **18** of the same material as the capillary pipette **04**) is vertically inserted into the pipette tip **06** such that the lower end of the rod **18** rests on the closed lower end **05** of the pipette tip **06**. This suffices for causing the upper end of the rod **18** to slightly protrude from the pipette inlet **07**. Flatworms **23** and liquid **13** are transferred into the capillary pipette **04** with an Eppendorf pipette and the liquid **13** in the working region **03** is corrected to the desired volume such that an air-filled gas region **08**, which is penetrated by the rod **18**, is formed between the working region **03** and the supply region **02**. Subsequently, the capillary pipette **04** is closed with gauze **20** and a rubber sealing ring **21** and placed into the region **14** of the open water **15**. Liquid **13** is then exchanged between the supply region **02** and the working region **03** via the rod **18** without filling up the capillary pipette **04** or losing volume or flatworms **23**.

The micropump **01** claimed by the invention already has been successfully used for fluorescence measurements of marine flatworms **23** under laboratory conditions. The exchange of liquid via the rod **18** was verified in preliminary tests in a small aquarium. The capillary pipette **04** was filled halfway with an undyed liquid **13** (water, medium, surrounding water), provided with the rod **18**, closed with the gauze **20** and horizontally placed into the aquarium (open water **15**), the supply region **14** of which was filled with dyed liquid **13**, for a total of 20.5 h. Absorption measurements were carried out during this time period within regular time intervals. These measurements already showed - in comparison with the absorption values of a dilution series of the dyed liquid **13** as reference (without capillary structure **17**) - a distinct exchange of liquid after a few hours. Consequently, the micropump **01** with its modifications claimed by the invention is particularly suitable for fluorescence measurements on living organisms; compare also to **DE 10 2014 012 130 B3**.

List of Reference Symbols

01	Micropump
02	Supply region
03	Working region
04	Capillary pipette
05	Lower end of 06
06	Pipette tip
07	Pipette inlet
08	Pipette section
09	Gas region
10	Filter
11	Balloon
12	Connection
13	Liquid
14	Region of 15

- 15** Open body of water
- 16** Air
- 17** Capillary structure
- 18** Rod as 17
- 19** Particle
- 20** Gauze as 10
- 21** Sealing ring
- 22** Upper end of 18
- 23** Flatworm

PATENT CLAIMS

1. A micropump (01) for exchanging liquid (13) between a supply region (02) and a working region (03) by means of a capillary structure (17), wherein an enclosed gas region (09) is located above the working region (03),
characterized in that
a capillary pipette (04) with a closed pipette tip (06) on its lower end (05) and an open pipette inlet (07) lying opposite thereof is provided, wherein the working region (03) is enclosed by a pipette section (09) above the closed pipette tip (06) and the open pipette inlet (07) is covered by a liquid-permeable filter (10), and wherein the filter (10) is connected to the supply region (02), and in that the capillary structure (17) extends through the gas region (09) between the closed pipette tip (06) and the filter (10).
2. The micropump (01) according to claim 1,
characterized in that
the working region (03) has a volume in the range between one-fourth and one-third of the volume of the capillary pipette (04).
3. The micropump (01) according to claim 2,
characterized in that
the working region (03) has a volume in the range between 0.4 ml and 0.5 ml.
4. The micropump (01) according to one of the preceding claims,
characterized in that
at least the capillary section (08) enclosing the working region (03) is realized transparently.

5. The micropump (01) according to one of the preceding claims,
characterized in that
the pipette section (08) is conically tapered in the direction of the pipette tip (06) and the pipette tip (06) is realized cylindrically.
6. The micropump (01) according to one of the preceding claims,
characterized in that
the capillary structure (17) consists of glass.
7. The micropump (01) according to one of the preceding claims,
characterized in that
the capillary structure (17) is formed by a rod (18) or a tube.
8. The micropump (01) according to claims 5 and 7,
characterized in that
the rod (18) or the tube is axially centered in the capillary pipette (04) by the pipette tip (06).
9. The micropump (01) according to one of the preceding claims,
characterized in that
the capillary pipette (04) can be arranged in any orientation.
10. The micropump (01) according to one of the preceding claims,
characterized in that
the supply region (02) is formed by a region (14) of an open body of water (15) and the capillary pipette (04) is completely immersed in the supply region (02).

11. The micropump (01) according to one of the preceding claims,
characterized in that
the mesh width of the filter (10) is adapted to minute particles (19) and organisms to be retained in the supply region (02).
12. The micropump (01) according to claim 11,
characterized in that
the filter (10) is realized in the form of flexible gauze (20), which preferably has a mesh width around 50 μm .
13. The micropump (01) according to claim 12,
characterized in that
the gauze (20) is fastened by means of an elastic sealing ring (21), which is slipped over the pipette inlet (07).
14. A use of the micropump (01) according to one of preceding claims 4 to 13 in measuring equipment for fluorescence measurements.
15. The use of the micropump (01) according to claim 14,
characterized in that
the fluorescence measurements are carried out on living marine organisms, which are accumulated in the working region (03) filled with liquid (13) from the supply region (02).
16. The use of the micropump (01) according to claim 15,
characterized in that
the supply region (02) is formed by a region (14) of an open body of water (15) and the capillary pipette (04) is completely immersed in the supply region (02).

17. The use of the micropump (01) according to claim 15 or 16,
characterized in that
the living marine organisms are flatworms (23), which exhibit a significantly increased autofluorescence upon contamination with toxic matter contained in the liquid (13).