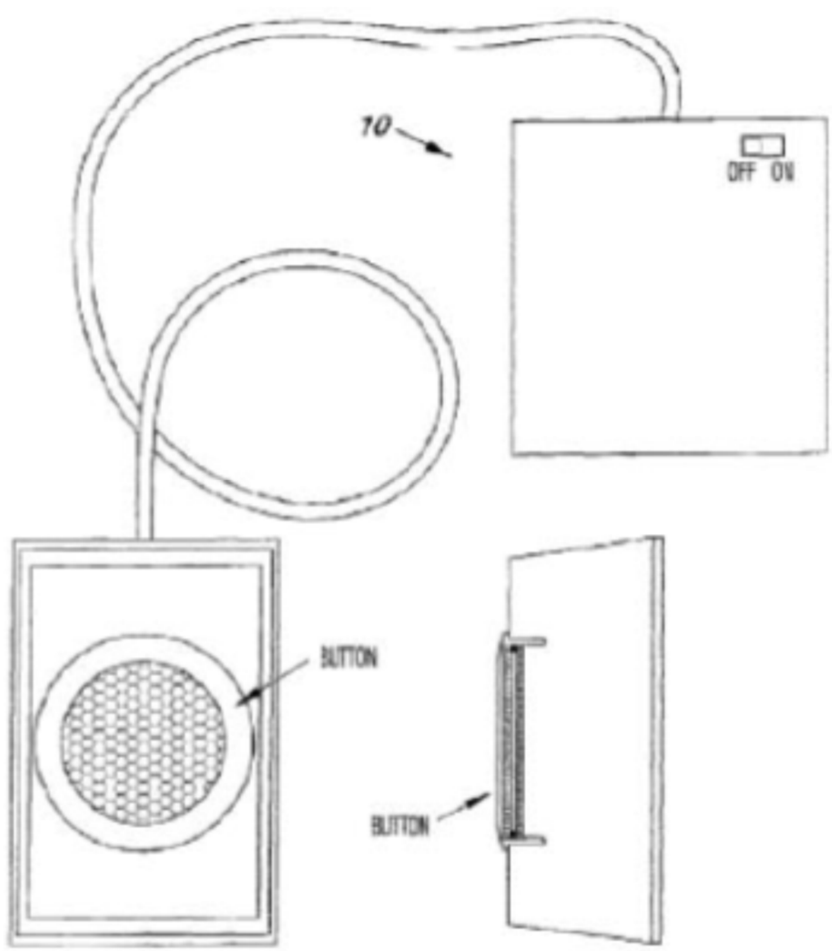
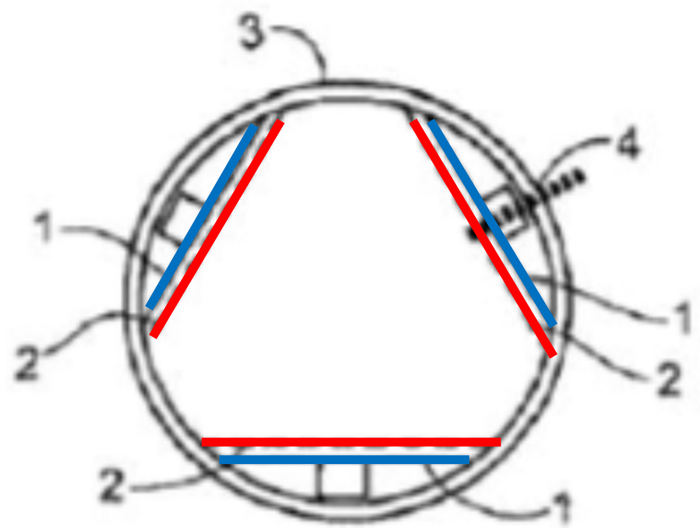
Tennant Company v. Oxygenator Water Technologies, Inc., IPR2021-00625

Patent Owner's Hearing Demonstratives

RE45,415





Paper 34 (“Response”) at 3-4.

RE45,415

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

Ex.1101 at 11:20-45.

Ground 1:
Anticipation Based on Wikey

Wikey

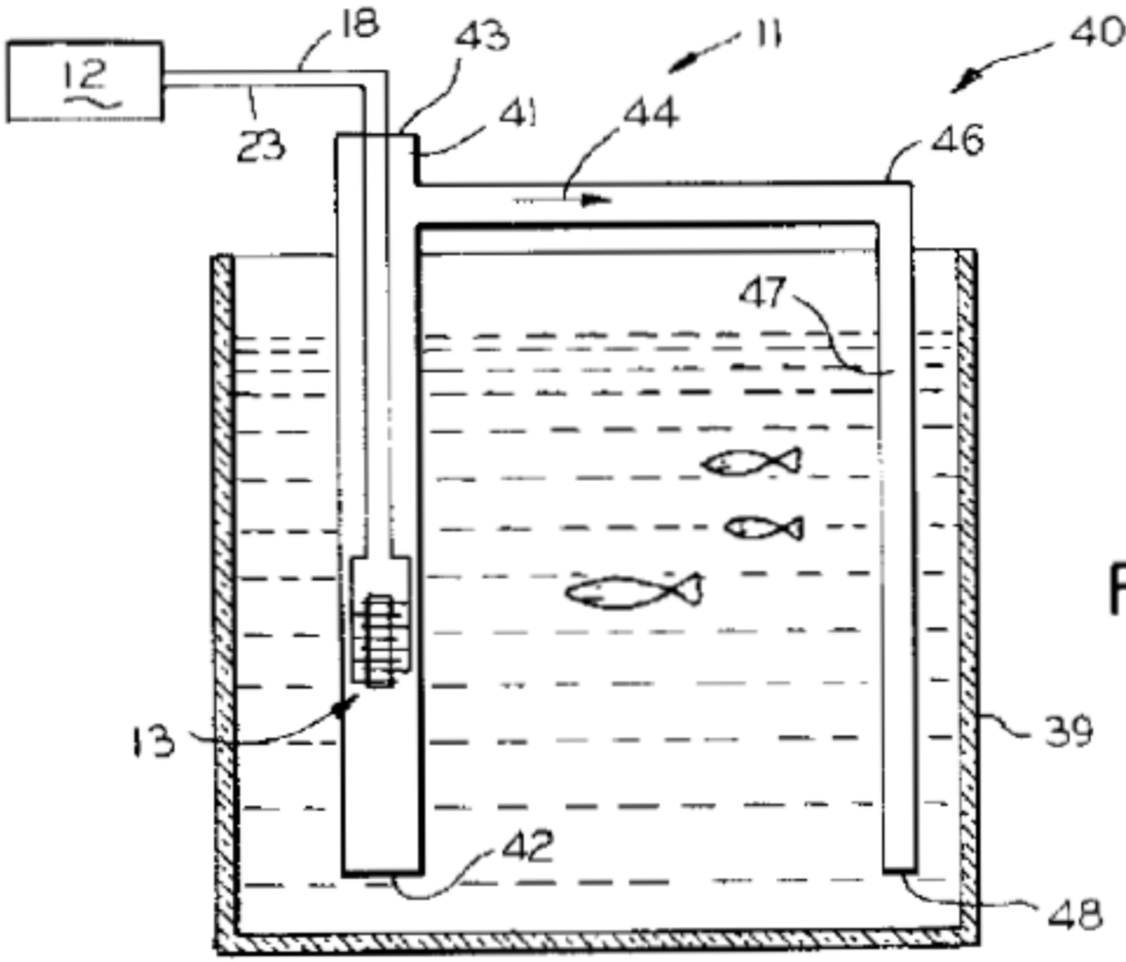


FIG.3

Wikey Outline

- **"Flowing Water . . . Through An Electrolysis Emitter"** (Response at 5-10, 18-19; Sur-Reply at 8-10.)

- **Microbubbles and Nanobubbles**
  - **No Evidence Wikey Creates Nanobubbles (Applies Equally to Davies)** (Response at 20-27; Paper 45 ("Sur-Reply") at 1-8.)
  - **Petitioner's Reproduction of Wikey Was Not Faithful** (Response at 27-30; Sur-Reply at 10-13.)

- **Dependent Claims 18, 21, and 25** (Response at 30-32; Sur-Reply at 13-15.)

Construction of Flowing Water Phrase

Claim 13:

"flowing water at a flow rate … through an electrolysis emitter"

'415 Patent at Claim 13

District Court's Construction:

"moving water through an electrolysis emitter by means other than electrolysis"

Ex. 2111 at 30, 34

Response at 5-10.

District Court Analysis Should Be Given Weight

District Court Opinion Analyzes:

- **Claim Language** – Ex. 2111 at 31.
- **Specification** – Ex. 2111 at 33-34.
- **Prosecution History** – Ex. 2111 at 32.

Record in Court was the same as in IPR

- Paper 34 at 9.

Need to construe phrase is the same

- Paper 34 at 10.

Response at 5-10.

Claim Language

- **"flowing water through the emitter" is recited as a separate step from "producing the composition… in the water"**

13. A method for producing an oxygenated aqueous composition comprising:

flowing water at a flow rate no greater than 12 gallons per minute through an electrolysis emitter comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns, wherein:

the anode electrode is separated at a critical distance from the cathode such that the critical distance is from 0.005 inches to 0.140 inches;

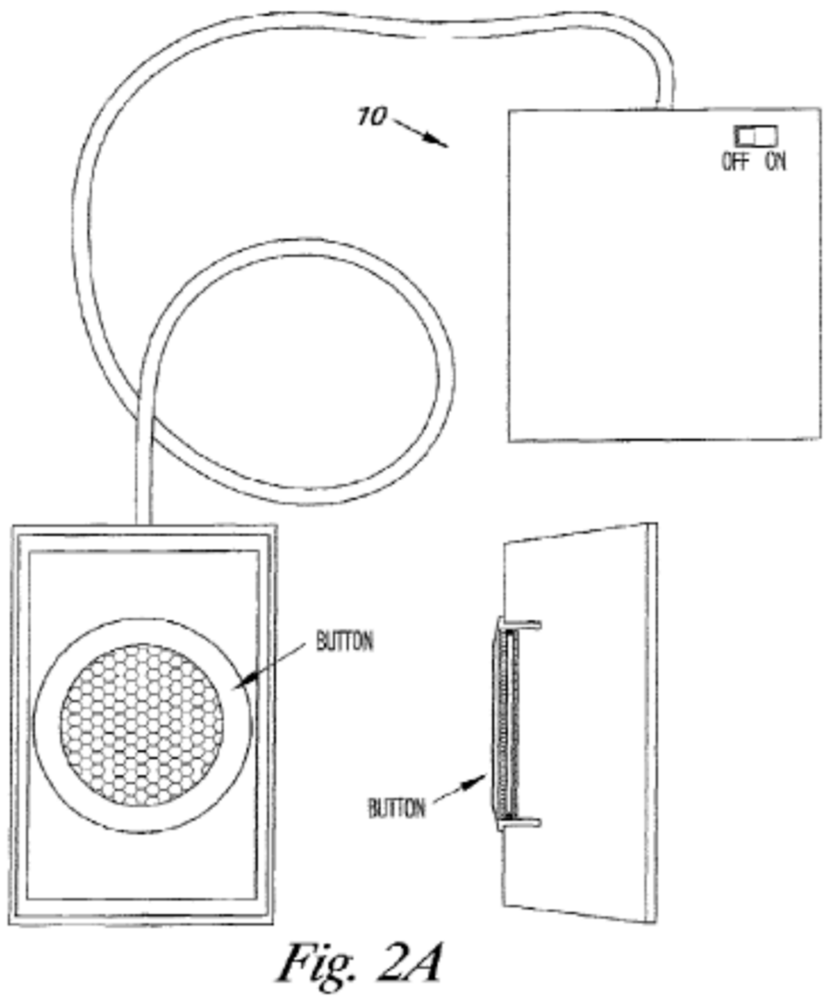
the power source produces a voltage no greater than about 28.3 volts and an amperage no greater than about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

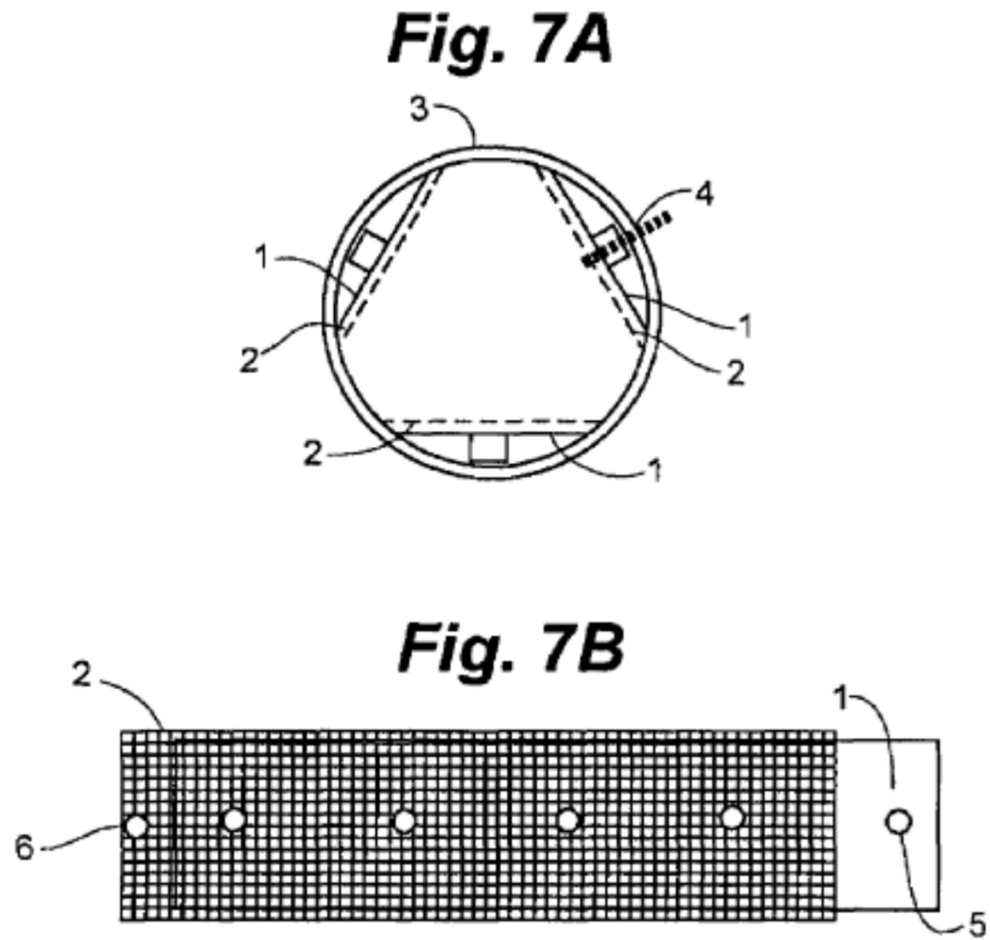
the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, and the water flowing into the inlet has a conductivity produced by the presence of dissolved solids such that the water supports plant or animal life.

Response at 7; Ex.1101 at 11:20-45.

Specification Describes Two Categories of Processes



Ex. 1101 at Fig. 2A



Ex. 1101 at Figs. 7A-7B

Response at 3-4.

Specification Distinguishes Flowing Water Processes

experiment was terminated because of predicted frost. All fruits, both green and red, were harvested and weighed at that point.

EXAMPLE 6

Flow-Through Emitter for Agricultural Use

In order to apply the findings of example 5 to agricultural uses, an emitter than can oxygenate running water efficiently was developed. In FIG. **7**(A), the oxygenation chamber is comprised of three anodes **1** and cathodes **2**, of appropriate size to fit inside a tube or hose and separated by the critical distance are placed within a tube or hose **3** at 120° angles to each other. The anodes and cathodes are positioned with stabilizing hardware **4**. The stabilizing hardware, which can be any configuration such as a screw, rod or washer, is preferably formed from stainless steel. FIG. **7**(B) shows a plan view of the oxygenation chamber with stabilizing hardware **4** serving as a connector to the power source and stabilizing hardware **5** serving as a connector to the power source. The active area is shown at **6**.

This invention is not limited to the design selected for this embodiment. Those skilled in the art can readily fabricate any of the emitters shown in FIG. **4** or **5**, or can design other embodiments that will oxygenate flowing water. One useful embodiment is the "T" model, wherein the emitter unit is set in a side arm. The emitted bubbles are swept into the water flow. The unit is detachable for easy servicing. Table III shows several models of flow through emitters. The voltage and flowrates were held constant and the current varied. The Dissolved oxygen (DO) from the source was 7.1 mg/liter. The starting temperature was 12.2° C. but the flowing water cooled slightly to 11 or 11.5° C. Without undue experimentation, anyone may easily select the embodiment that best suits desired characteristics from Table III or designed with the teachings of Table III.

TABLE III

MODEL	ACTIVE ELECTRODE AREA, SQ. IN.	VOLTAGE	CURRENT, AMPS.	FLOW RATE GAL/MINUTE	DO OF* SAMPLE AT ONE MINUTE
2-Inch "T"	2	28.3	0.72	12	N/A
3-inch "T"	3	28.3	1.75	12	N/A
2-plate Tube	20	28.3	9.1	12	8.4
3-Plate tube	30	28.3	12.8	12	9.6

*As the apparatus runs longer, the flowing water becomes milky, indicating supersaturation. The one-minute time point shows the rapid increase in oxygenation.

The following plants will be tested for response to superoxygenated water: grape vines, lettuce, and radishes in three different climate zones. The operators for these facilities will be supplied with units for drip irrigation. Drip irrigation is a technique wherein water is pumped through a pipe or hose with perforations at the site of each plant to be irrigated. The conduit may be underground or above ground. Since the water is applied directly to the plant rather than wetting the entire field, this technique is especially useful in arid climates or for plants requiring high fertilizer applications.

The superoxygenated water will be applied by drip irrigation per the usual protocol for the respective plants. Growth and yield will be compared to the same plants given only the usual irrigation water. Pest control and fertilization will be the same between test and control plants, except that the operators of the experiments will be cautioned to be aware of the possibility of fertilizer burn in the test plants and to adjust their protocols accordingly.

It is expected that the superoxygenated plants with drip irrigation will show more improved performance with more continuous application of oxygen than did the tomato plants of Example 5, which were given superoxygenated water only once a day.

EXAMPLE 7

Treatment of Waste Water

Waste water, with a high organic content, has a high BOD, due to the bacterial flora. It is desirable to raise the oxygen content of the waste water in order to cause the flora to flocculate. However, it is very difficult to effectively oxygenate such water. Using a 4 inch OEM (see Table I) with a 12 volt battery, four liters of waste water in a five gallon pail were oxygenated. As shown in FIG. **8**, the dissolved oxygen went from 0.5 mg/l to 10.8 mg/l in nine minutes.

Those skilled in the art will readily comprehend that variations, modifications and additions may in the embodiments described herein may be made. Therefore, such variations, modifications and additions are within the scope of the appended claims.

The invention claimed is:

1. A method for treating waste water comprising;

providing a flow-through oxygenator comprising an emitter for electrolytic generation of microbubbles of oxygen comprising an anode separated at a critical distance from a cathode and a power source all in electrical communication with each other,

placing the emitter within a conduit; and

passing waste water through the conduit.

[2. An emitter for electrolytic generation of microbubbles of oxygen in an aqueous medium comprising: an anode separated at a critical distance from a cathode, a nonconductive spacer maintaining the separation of the anode and cathode, the nonconductive spacer having a spacer thickness between 0.005 to 0.050 inches such that the critical distance is less than 0.060 inches and a power source all in electrical communication with each other, wherein the critical distance results in the formation of oxygen bubbles having a bubble diameter less than 0.0006 inches, said oxygen bubbles being incapable of breaking the surface tension of the aqueous medium such that said aqueous medium is supersaturated with oxygen.**]**

[3. The emitter of claim **2**, wherein the anode is a metal or a metallic oxide or a combination of a metal and a metallic oxide.**]**

[4. The emitter of claim **2**, wherein the anode is platinum and iridium oxide on a support.**]**

[5. The emitter of claim **2**, wherein the cathode is a metal or metallic oxide or a combination of a metal and a metallic oxide.**]**

[6. The emitter of claim **2**, wherein the critical distance is 0.005 to 0.060 inches.**]**

Flow-Through Emitter for Agricultural Use

In order to apply the findings of example 5 to agricultural uses, an emitter than can oxygenate running water efficiently was developed. In FIG. **7**(A), the oxygenation chamber is comprised of three anodes **1** and cathodes **2**, of appropriate size to fit inside a tube or hose and separated by the critical distance are placed within a tube or hose **3** at 120° angles to each other. The anodes and cathodes are positioned with stabilizing hardware **4**. The stabilizing hardware, which can be any configuration such as a screw, rod or washer, is preferably formed from stainless steel. FIG. **7**(B) shows a plan view of the oxygenation chamber with stabilizing hardware **4** serving as a connector to the power source and stabilizing hardware **5** serving as a connector to the power source. The active area is shown at **6**.

This invention is not limited to the design selected for this embodiment. Those skilled in the art can readily fabricate any of the emitters shown in FIG. **4** or **5**, or can design other embodiments that will oxygenate flowing water. One useful

Response at 4; Ex.1101 at 3:25-36.

Flowing vs. "At Rest" Water is Independent of Electrolysis

and nanobubbles of oxygen in an aqueous medium, which bubbles are too small to break the surface tension of the medium, resulting in a medium supersaturated with oxygen.

The electrodes may be a metal or oxide of at least one metal selected from the group consisting of ruthenium, iridium, nickel, iron, rhodium, rhenium, cobalt, tungsten, manganese, tantalum, molybdenum, lead, titanium, platinum, palladium and osmium or oxides thereof. The electrodes may be formed into open grids or may be closed surfaces. The most preferred cathode is a stainless steel mesh. The most preferred mesh is a {fraction (1/16)} inch grid. The most preferred anode is platinum and iridium oxide on a support. A preferred support is titanium.

In order to form microbubbles and nanobubbles, the anode and cathode are separated by a critical distance. The critical distance ranges from 0.005 inches to 0.140 inches. The preferred critical distance is from 0.045 to 0.060 inches.

Models of different size are provided to be applicable to various volumes of aqueous medium to be oxygenated. The public is directed to choose the applicable model based on volume and power requirements of projected use. Those models with low voltage requirements are especially suited to oxygenating water in which animals are to be held.

Controls are provided to regulate the current and timing of electrolysis.

A flow-through model is provided which may be connected in-line to a watering hose or to a hydroponic circulating system. The flow-through model can be formed into a tube with triangular cross-section. In this model, the anode is placed toward the outside of the tube and the cathode is placed on the inside, contacting the water flow. Alternatively, the anodes and cathodes may be in plates parallel to the long axis of the tube, or may be plates in a wafer stack. Alternately, the electrodes may be placed in a side tube ("T" model) out of the direct flow of water. Protocols are provided to produce superoxygenated water at the desired flow rate and at the desired power usage. Controls are inserted to activate electrolysis when water is flowing and deactivate electrolysis at rest.

This invention includes a method to promote growth and increase yield of plants by application of superoxygenated water. The water treated with the emitter of this invention is one example of superoxygenated water. Plants may be grown in hydroponic culture or in soil. The use of the flow-through model for drip irrigation of crops and waste water treatment is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is the O_2 emitter of the invention.

FIG. **2** is an assembled device.

FIG. **3** is a diagram of the electronic controls of the O_2 emitter.

FIG. **4** shows a funnel or pyramid variation of the O_2 emitter.

FIG. **5** shows a multilayer sandwich O_2 emitter.

FIG. **6** shows the yield of tomato plants watered with superoxygenated water.

FIG. **7** shows an oxygenation chamber suitable for flow-through applications. FIG. **7**A is a cross section showing arrangement of three plate electrodes. FIG. **7**B is a longitudinal section showing the points of connection to the power source.

FIG. **8** is a graph showing the oxygenation of waste water.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

For the purpose of describing the present invention, the following terms have these meanings:

"Critical distance" means the dista
and cathode at which evolved oxyg
and nanobubbles.
"Critical distance" means the dista
and cathode at which evolved oxyg
and nanobubbles.
"O_2 emitter" means a cell compri
and at least one cathode separated b
"Metal" means a metal or an allo
"Microbubble" means a bubble w
50 microns.
"Nanobubble" means a bubble w
that necessary to break the surf
Nanobubbles remain suspended in th
an opalescent or milky appearance.
"Supersaturated" means oxygen a
than normal calculated oxygen solub
perature and pressure.
"Superoxygenated water" means
content at least 120% of that calcul
temperature.
"Water" means any aqueous med
than one ohm per square centimeter;
support the electrolysis of water. In g
resistance for a medium that can sup
containing more than 2000 ppm tota
The present invention produc
nanobubbles of oxygen via the el
molecular oxygen radical (atomic w
reacts to form molecular oxygen, O
sions of the invention, as explaine
following examples, O_2 forms bubbl
break the surface tension of the flui
suspended indefinitely in the fluid an
up, make the fluid opalescent or m
hours do the bubbles begin to coal
container and the water clears. Duri
supersaturated with oxygen. In c
readily coalesces into larger bubble
into the atmosphere, as can be seen b
cathode.
The first objective of this inventio
emitter with low power demands, low
for use with live animals. For that
emitter was devised. The anode and cathode were set at varying distances. It was found that electrolysis took place at very short distances before arcing of the current occurred. Surprisingly, at slightly larger distances, the water became milky and no bubbles formed at the anode, while hydrogen continued to be bubbled off the cathode. At distance of 0.140 inches between the anode and cathode, it was observed that the oxygen formed bubbles at the anode. Therefore, the critical distance for microbubble and nanobubble formation was determined to be between 0.005 inches and 0.140 inches.

EXAMPLE 1

Oxygen Emitter

As shown in FIG. **1**, the oxygen evolving anode **1** selected as the most efficient is an iridium oxide coated single sided sheet of platinum on a support of titanium (Eltech, Fairport Harbor, Ohio). The cathode **2** is a (fraction (1/16)} inch mesh (size 8 mesh) marine stainless steel screen. The anode and cathode are separated by a non-conducting spacer **3** containing a gap **4** for the passage of gas and mixing of anodic and cathodic water and connected to a power source through a

A flow-through model is provided which may be connected in-line to a watering hose or to a hydroponic circulating system. The flow-through model can be formed into a tube with triangular cross-section. In this model, the anode is placed toward the outside of the tube and the cathode is placed on the inside, contacting the water flow. Alternatively, the anodes and cathodes may be in plates parallel to the long axis of the tube, or may be plates in a wafer stack. Alternately, the electrodes may be placed in a side tube ("T" model) out of the direct flow of water. Protocols are provided to produce superoxygenated water at the desired flow rate and at the desired power usage. Controls are inserted to activate electrolysis when water is flowing and deactivate electrolysis at rest.

Response at 3-4; Ex.1101 at 3:25-36.

Prosecution History Indicates "Flowing Water" Recitation Excludes Static Water Processes

The water is also characterized being in fluid and electrical communication with the electrodes and having a maximum flow rate of 12 gallons per minute. Because the water generally can be contained in a static state such as in an aquarium, the water such as the water of claim 2 and its dependent claims can have no flow rate so that the flow rate generally can be no flow to a maximum of 12 gallons per minute. For systems, methods and suspensions for which water is affirmatively recited as flowing through a tubular housing, such as claims 50-67, 68-71, 73-75, the water has a positive flow rate through the emitter at a maximum of 12 gallons per minute.

of these kinds of water are suitable for supporting plant or animal life and will contain dissolved solids.

The water is also characterized being in fluid and electrical communication with the electrodes and having a maximum flow rate of 12 gallons per minute. Because the water generally can be contained in a static state such as in an aquarium, the water such as the water of claim 2 and its dependent claims can have no flow rate so that the flow rate generally can be no flow to a maximum of 12 gallons per minute. For systems, methods and suspensions for which water is affirmatively recited as flowing through a tubular housing, such as claims 50-67, 68-71, 73-75, the water has a positive flow rate through the emitter at a maximum of 12 gallons per minute.

The flow rate for the system, method and suspension recited by the claims operates per device so that the flow rate for multiple systems would be a multiple of the flow rate per device. The electrode size and other features also interact with the flow rate. A unifying feature of these parameters is the current density per electrode area as shown by Tables I and III.

The phrase describing the electrodes in a tubular housing as recited by claims 50-67, 69-71, 73-86 is supported by the specification at 2:63-3:43 as well as by Example 6. These passages disclose the tubular housing containing the electrodes. The passage at col. 2 discloses that "the anode is placed toward the outside of the tube and the cathode is placed on the inside, contacting

Ex. 2118 at JA1143; Response at 9.

Prosecution History Indicates "Flowing Water" Recitation Excludes Static Water Processes

2. (Currently Amended) An emitter system ~~for production of oxygen~~ comprising:

an aqueous medium having a conductivity produced by dissolved solids so that the aqueous medium is capable of supporting plant or animal life, the aqueous medium containing oxygen microbubbles and nanobubbles having a bubble diameter of less than 50 microns and that are incapable of breaking the surface tension of the aqueous medium;

an anode separated at a critical distance from a cathode, a nonconductive spacer maintaining the separation of the anode and cathode, the nonconductive spacer having a spacer thickness such that the critical distance is from 0.005 inches to 0.140 inches,

a power source producing a voltage maximum of 28.3 volts and amperage maximum of about 13 amps, the electrodes, power source and aqueous medium all in electrical communication with each other; and,

the aqueous medium is ~~tap water~~ in fluid and electrical communication with the anode and cathode electrodes at no flow rate to a maximum flow rate of about 12 gallons per minute wherein the communication of the electrodes and the ~~tap water~~ aqueous medium results in the formation of the oxygen microbubbles and the nanobubbles in the ~~tap water~~ aqueous medium~~, the microbubbles having a bubble diameter of less than 0.0006 inches, said oxygen nanobubbles being incapable of breaking the surface tension of the aqueous medium such that the~~

55. (Currently Amended) A method for producing an oxygenated aqueous composition comprising:

flowing water at a maximum flow rate of 12 gallons per minute through an electrolysis emitter ~~system~~ comprising an electrical power source electrically connected to an anode electrode and a cathode electrode contained in a tubular housing,

causing electricity to flow from the power source to the electrodes, and,

producing the composition comprising a suspension comprising oxygen microbubbles and nanobubbles in the water, the microbubbles and nanobubbles having a bubble diameter of less than 50 microns and the microbubbles and nanobubbles being incapable of breaking the surface tension of the water, wherein:

the anode electrode is separated at a critical distance from the cathode ~~electrode by a nonconductive spacer maintaining the separation of the electrodes~~ such that the critical distance is from 0.005 inches to 0.140 inches;

the power source is ~~in electrical communication with the electrodes,~~ produces a voltage ~~of a~~ maximum of about 28.3 volts and a maximum amperage of about 13 amps,

the tubular housing has an inlet and an outlet and a tubular flow axis from the inlet to the outlet;

the water flows in the inlet, out the outlet, is in fluid connection with the electrodes, has a conductivity produced by [a maximum of about 2000 ppm total] the presence of dissolved solids such that the water supports plant or animal life

~~the combination of the critical distance, the voltage, amperage and the water conductivity results in the formation of a suspension comprising oxygen nanobubbles in the water, the nanobubbles having a bubble diameter of less than 0.0006 inches and the nanobubbles being incapable of breaking the surface tension of the tap water so that the suspension remains at least in part for a period of up to several hours.~~

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

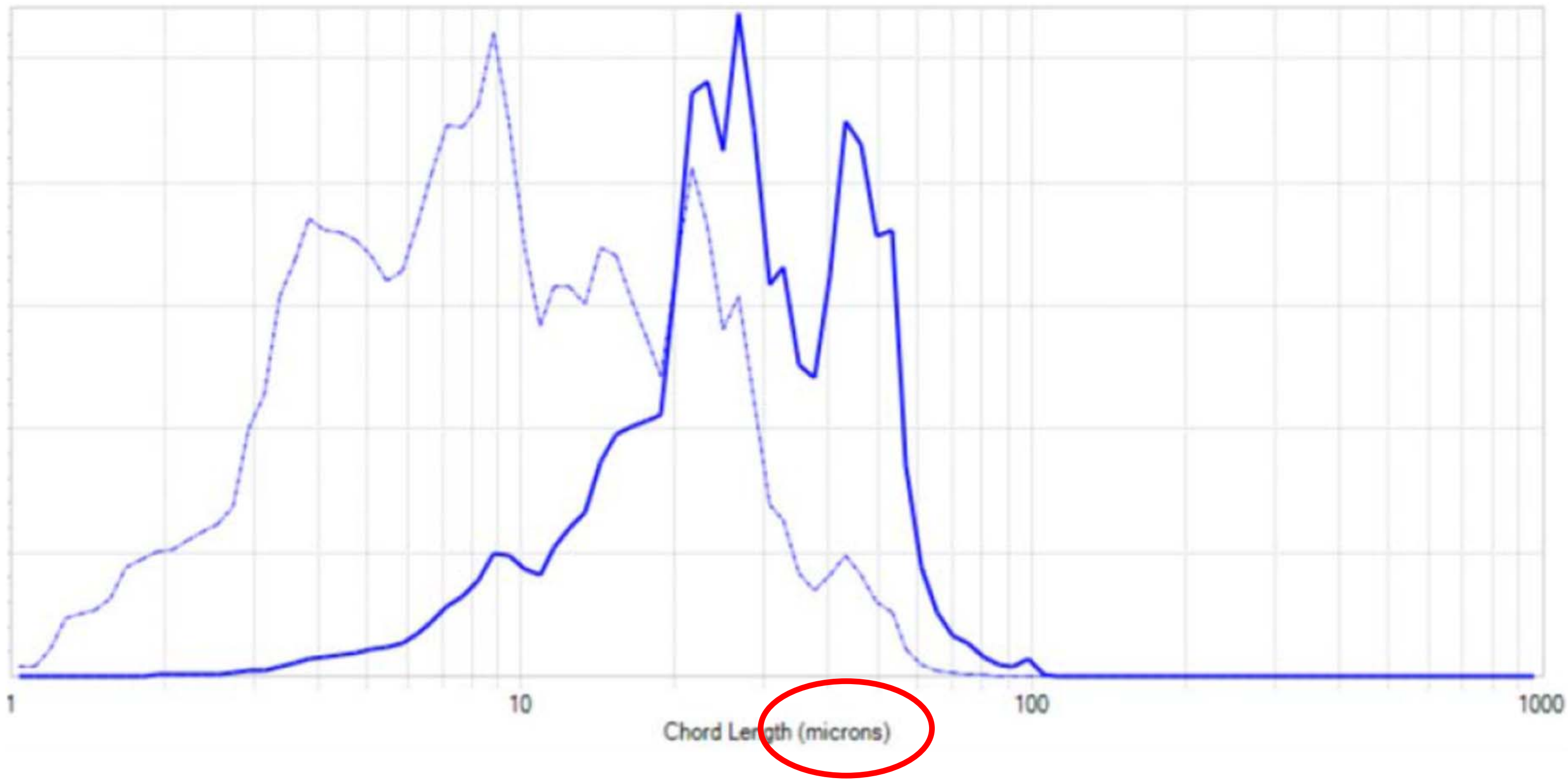
Ex. 2118 at JA1132-35; Response at 9.

Microbubbles and Nanobubbles: Inherency Standard

- **"Inherency may not be established by probabilities or possibilities. The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient."**
  - ***Cont'l Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1269 (Fed. Cir. 1991); see also *Transclean Corp. v. Bridgewood Servs.*, 290 F.3d 1364, 1373 (Fed. Cir. 2002)**

- **"[The patent challenger] urges us to accept the proposition that if a prior art reference discloses the same structure as claimed by a patent, the resulting property . . . should be assumed. We decline to adopt this approach because the proposition is not in accordance with our cases on inherency."**
  - ***Crown Operations Int'l, Ltd. v. Solutia Inc.*, 289 F.3d 1367, 1377 (Fed. Cir. 2002)**

No Evidence of Nanobubbles: Tremblay's Test



0.1

Size of Bubbles Dr. Tremblay Testified
Meet Definition of Nanobubbles

Response at 23; Ex. 1103, ¶64.

No Evidence of Nanobubbles: Tremblay's Admission

Page 69

behalf of Tennant?

A. No.

Q. Would you've expected him to tell you that in response to your -- during your conversations?

A. No.

Q. So is it accurate to say that both measurement tools you used for size are not capable of identifying submicron particles?

A. Yes.

Q. What's your understanding of how big nanobubbles are as that term is used in the '415 patent?

A. So I used the definition that was provided in the declaration.

Q. And that's a size that does not -- a diameter less than that necessary to break the surface tension of water; correct?

A. That's correct.

Q. Do you have an understanding of what the size of a bubble is that doesn't break the surface tension of water?

A. Yes.

Q. And what is that size?

A. Roughly 100 nanometers.

Page 70

Q. So do you agree that none of the testing you performed determined whether or not there were nanobubbles in the water?

A. Yes.

Q. All right. Let's go back to getting a better understanding of what this cord length probe actually does.

A. Okay.

Q. So is it correct to say that it doesn't directly measure -- well, strike that. Let's start with this. Can the cord length probe distinguish between bubbles and particles?

A. No.

Q. So it can tell you that something is in the water, but it can't tell you if it's a particle or a bubble?

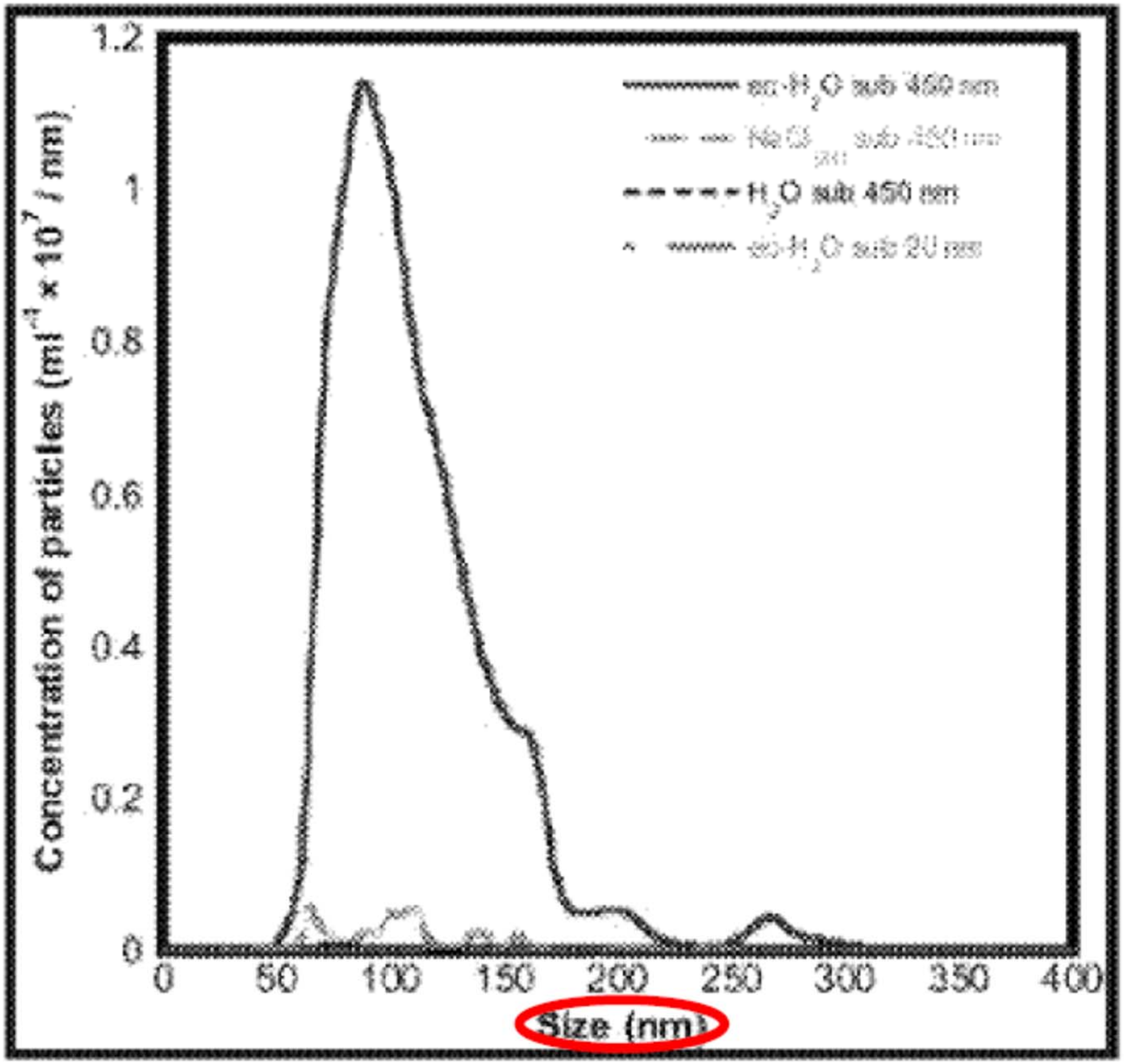
A. It has to go through the particle or the bubble, so there has to be some way for the light to penetrate to determine a cord length.

Q. So if there are particles in the water, will the cord length probe count it as something it's reading?

A. Will be an interference.

Q. So will it come back as a count just

No Evidence of Nanobubbles:
Petitioner Knew How to Test for Nanobubbles



Response at 24-25; Sur-Reply at 2; Ex. 2195.

Nanobubbles—Petitioner's Excuse 1: Burden Shifting

- **Burden Shifting Does Not Apply**
  - ***Fan Duel, Inc. v. Interactive Games LLC*, 966 F.3d 1334, 1341-42 (Fed. Cir. 2020)**
  - ***Tietex Int'l, Ltd. v. Precision Fabrics Group, Inc.*, IPR2014-01248, Paper 39 at 10-12 (P.T.A.B. January 27, 2016)**
  - ***Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1378-79 (Fed. Cir. 2015)**
  - ***In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1375 (Fed. Cir. 2016)**

- **Institution ≠ Prima Facie Case**
  - ***Fan Duel, Inc.*, 966 F.3d at 1340-41.**

Sur-Reply at 3-5.

Nanobubbles—Petitioner's Excuse 2: Test in Specification

Example Petitioner Relies On

EXAMPLE 2

Measurement of O_2 Bubbles

Attempts were made to measure the diameter of the O_2 bubbles emitted by the device of Example 1. In the case of particles other than gasses, measurements can easily be made by scanning electron microscopy, but gasses do not survive electron microscopy. Large bubble may be measured by pore exclusion, for example, which is also not feasible when measuring a gas bubble. A black and white digital, high contrast, backlit photograph of treated water with a millimeter scale reference was shot of water produced by the emitter of Example 1. About 125 bubbles were seen in the area selected for measurement. Seven bubbles ranging from the smallest clearly seen to the largest were measured. The area was enlarged, giving a scale multiplier of 0.029412.

Recorded bubble diameters at scale were 0.16, 0.22, 0.35, 0.51, 0.76, 0.88 and 1.09 millimeters. The last three were considered outliers by reverse analysis of variance and were assumed to be hydrogen bubbles. When multiplied by the scale multiplier, the assumed O_2 bubbles were found to range from 4.7 to 15 microns in diameter. This test was limited by the resolution of the camera and smaller bubbles in the nanometer range could not be resolved. It is known that white light cannot resolve features in the nanometer size range, so monochromatic laser light may give resolution sensitive enough to measure smaller bubbles. Efforts continue to

Ex. 1101 at 5:40-67.

Senkiw's Nanobubbles

"Nanobubble" means a bubble with a diameter less than that necessary to break the surface tension of water. Nanobubbles remain suspended in the water, giving the water an opalescent or milky appearance.

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

"Superoxygenated water" means water with an oxygen content at least 120% of that calculated to be saturated at a temperature.

"Water" means any aqueous medium with resistance less than one ohm per square centimeter; that is, a medium that can support the electrolysis of water. In general, the lower limit of resistance for a medium that can support electrolysis is water containing more than 2000 ppm total dissolved solids.

The present invention produces microbubbles and nanobubbles of oxygen via the electrolysis of water. As molecular oxygen radical (atomic weight 8) is produced, it reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is

Ex. 1101 at 4:12-37.

Nanobubbles—Petitioner's Excuse 3: New Proxy Tests Added in Reply

Proxy Test 1: Dissolved Oxygen/Supersaturation

TABLE III

MODEL	ACTIVE ELECTRODE AREA, SQ. IN.	VOLTAGE	CURRENT, AMPS.	FLOW RATE GAL/MINUTE	DO OF* SAMPLE AT ONE MINUTE
2-Inch "T"	2	28.3	0.72	12	N/A
3-inch "T"	3	28.3	1.75	12	N/A
2-plate Tube	20	28.3	9.1	12	8.4
3-Plate tube	30	28.3	12.8	12	9.6

*As the apparatus runs longer, the flowing water becomes milky, indicating supersaturation. The one-minute time point shows the rapid increase in oxygenation.

"Nanobubble" means a bubble with a diameter less than that necessary to break the surface tension of water. Nanobubbles remain suspended in the water, giving the water an opalescent or milky appearance.

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

"Superoxygenated water" means water with an oxygen content at least 120% of that calculated to be saturated at a temperature.

"Water" means any aqueous medium with resistance less than one ohm per square centimeter; that is, a medium that can support the electrolysis of water. In general, the lower limit of resistance for a medium that can support electrolysis is water containing more than 2000 ppm total dissolved solids.

The present invention produces microbubbles and nanobubbles of oxygen via the electrolysis of water. As molecular oxygen radical (atomic weight 8) is produced, it reacts to form molecular oxygen, O_2. In the special dimensions of the invention, as explained in more detail in the following examples, O_2 forms bubbles which are too small to break the surface tension of the fluid. These bubbles remain suspended indefinitely in the fluid and, when allowed to build up, make the fluid opalescent or milky. Only after several hours do the bubbles begin to coalesce on the sides of the container and the water clears. During that time, the water is

Based on flawed logic

Specification Says:

- Nanobubbles Build Up → Milky
- Milky → Supersaturation

This Does Not Mean:

- Supersaturation → Nanobubbles

Sur-Reply at 6-7; Ex. 1101 at 4:12-37.

Nanobubbles—Petitioner's Excuse 3: New Proxy Tests Added in Reply

Proxy Test 1: Dissolved Oxygen /Supersaturation

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Q. You also, as part of your testing, measured dissolved oxygen; correct?
A. Correct.
Q. What is dissolved oxygen a measure of?
A. The oxygen in the water matrix.
Q. Does it say anything about the form of that oxygen in the matrix?
A. No.
Q. Does dissolved oxygen tell us anything about whether there are bubbles in the water?
A. No.
Q. Does it tell us anything about the size of the bubbles that are in the water?
A. No.
Q. What does super saturated mean to you?
A. I used the definition in the declaration.
Q. I'm sorry. In the '415 patent?
A. Yes, I used that definition in '415 to put in my declaration so we can refer to that whatever is used.
Q. Well, I've got the '415 patent handy --
A. Yes, yes.
Q. -- so I'll just read it.
A. Yes.

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Q. Super oxygenated water means water with oxygen content at least 120 percent of that calculated to be saturated at a temperature.
A. I believe that's the -- I believe that's what we used.
Q. Okay. Thank you. All right. My cocounsel is correcting me. Thank you. It's correct that the term super saturated by itself in the '415 patent means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure; correct?
A. Yes.
Q. And the other definition that I read was of super oxygenated water, which means water with an oxygen content of at least 120 percent of that calculated to be saturated at any temperature?
A. Yes.
Q. And those are the definitions that you used in doing your analysis in this case?
A. Yes.
Q. If water is super saturated, does that mean there are bubbles in the water?
A. Possibly.

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Q. But not necessarily; correct?
A. Correct.
Q. And conversely, if the water is not super saturated, does that mean there are not bubbles in the water?
A. Not necessarily.
Q. Why did you measure dissolved oxygen in your testing?
A. To get -- to understand the amount of oxygen, if there was more oxygen or less oxygen.
Q. Was it relevant to the conclusions you drew in some way?
A. In the conclusion that I made and that I reported.
Q. Other than the fact that you reported them, can you think of any way in which they were relevant to a conclusion that you drew?
A. Well, it helps me determine if it has more oxygen and if it's more saturated than less saturated.
Q. Okay. Understood. One more question about oxygen saturation, and then we'll take a break.
A. Sure.

Response at 25-26; Ex. 2172 (Tremblay Dep.) at 76-78.

Nanobubbles—Petitioner's Excuse 3: New Proxy Tests Added in Reply

Proxy Test 2 (Wikey Only): Bubbles Survived to End of Tubes

- **Bubbles surviving seconds ≠ "bubble with a diameter less than necessary to break the surface tension of water"**

E-Cell 3

				Initial measurements			Sample measurements after 3 h				
Operation number	Water Type	Power supply Setpoint (V)	Current (Amp)	Dissolved Oxygen (%)	Conductivity (uS/cm)	pH	Time collected	Time measured	Dissolved Oxygen (%)	Conductivity (uS/cm)	pH
1	Tap water	6	6.2	69.8%	559.7	7.6	11:35 AM	2:35 PM	126.6%	552.9	8.7
2	Sodium bicarbonate+Tap water	6	11.2	72.3%	1986	8.2	1:51 PM	4:45 PM	116.4%	2241.0	9.3

- Lots of bubbles coat the side of the aquarium during electrolysis
- ~8 s for bubbles to travel through pipe to the other end
- No bubbles were able to be collected into the sample
- No bubbles appear after 3 h hold

- Lots of bubbles coat the side of the aquarium during electrolysis
- ~8 s for bubbles to travel through pipe to the other end
- No bubbles were able to be collected into the sample
- No bubbles appear after 3 h hold

Nanobubbles—Petitioner's Excuse 3: New Proxy Tests Added in Reply

- **Dr. Tremblay admitted none of his tests showed presence of nanobubbles**

> Q. So do you agree that none of the testing you performed determined whether or not there were nanobubbles in the water?
> A. Yes.

Ex. 2172 70:1-4; Sur-Reply at 7.

Nanobubbles—Petitioner's Excuse 4: Specification's Alleged Admissions

- **Nothing in the specification suggests microbubbles or nanobubbles are inherent**
- **"Critical distance" defined functionally, so the specifics of what distance will create nanobubbles depends on other factors**

> "Critical distance" means the distance separating the anode and cathode at which evolved oxygen forms microbubbles and nanobubbles.

> In order to form microbubbles and nanobubbles, the anode and cathode are separated by a critical distance. The critical distance ranges from 0.005 inches to 0.140 inches. The preferred critical distance is from 0.045 to 0.060 inches.

Ex. 1001 3:13-16, 4:1-3

- **Petitioner's witnesses and prosecution history show factors other than critical distance affect bubble size. *See* Response at 22.**

Response at 20-22.

Nanobubbles—Petitioner's Excuse 4: Specification's Alleged Admissions

- **Petitioner's expert agrees bubble size is not inherent result of electrode gap**

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A. No.
Q. Does the shape of the housing affect the size of bubbles that are created?
A. Possibly.
Q. Does the conductivity of the water affect whether or not bubbles will be formed in a particular system?
A. Yes.
Q. And does it also affect the size of bubbles that are created in a particular system?
A. Yes.
Q. Does the particular chemical makeup of impurities in the water affect whether bubbles are made in a particular system?
A. Yes.
Q. And does it also affect the size of bubbles that are made in a particular system?
A. Yes.
Q. All these things that we've discussed that affect whether and/or what size bubbles will be formed, was that all known in 2003?
A. Yes.
Q. So a person of skill in the art reading the '415 patent would understand while

Page 31

reading it that many things other than spacing of the electrodes are going to have an effect on the bubble size created using devices described in the patent; correct?
A. Yes.
Q. Now, I want to go back over and discuss a little bit about what effect will be had by changing various ones of these parameters. So let's start with amperage applied to the electrodes. Does increasing amperage result in larger or smaller bubbles?
A. So increasing the current density? The amperage would increase the current density. The current density has a direct impact on bubble size.
Q. Just so I understand, the effect is increasing the voltage increases current density, and that increases bubble size?
A. Correct.
Q. So higher current density, in your opinion, results in higher greater bubble size?
A. Correct.
Q. And so another thing that we talked about was the amperage affects bubble size.

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

Response at 20-22; Ex. 2172 at 30-31.

Nanobubbles—Petitioner's Excuse 4: Specification's Alleged Admissions

- **Prosecution History: many things affect bubble formation**

Application/Control Number: 13/247,241 Page 6
Art Unit: 1774

With respect to claims 2, 3, 5, 7, 9, 10, 50, 53, 60 and 63, the Murrell reference discloses (Claim 1) a device and a method of using the device wherein a flow is introduced that contains electrodes (anode and cathode 104 and 103 and 101) that form a grid pattern separated by a distance of 23mm or .09 inches (Column 7 line 53- column 8 line 2 and F

lines 55-68).

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of constructio

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etc.). The re

114(Column 1

(Abstract).

Genera

surface tension of an aqueous medium is not positively recited structure in the apparatus claim. The claim states it is a result of the disclosed configuration. The formation of bubbles is a function of flow rates, temperatures, liquid viscosity, voltage or current output of the electrodes etc., and not just of electrode spacing. The applicant try to define some of these parameters by claiming tap water. This does not limit flow rater or temperature or pressure.

The reference further discloses (figure 10) washer and spacer combination between each plate. The washer is 1.6 mm and the space is between around 23 mm

Exhibit 1102_0169

apparatus claim. The claim states it is a result of the disclosed configuration. The formation of bubbles is a function of flow rates, temperatures, liquid viscosity, voltage or current output of the electrodes etc., and not just of electrode spacing. The applicant try

Ex. 1102 at 169; Response at 22.

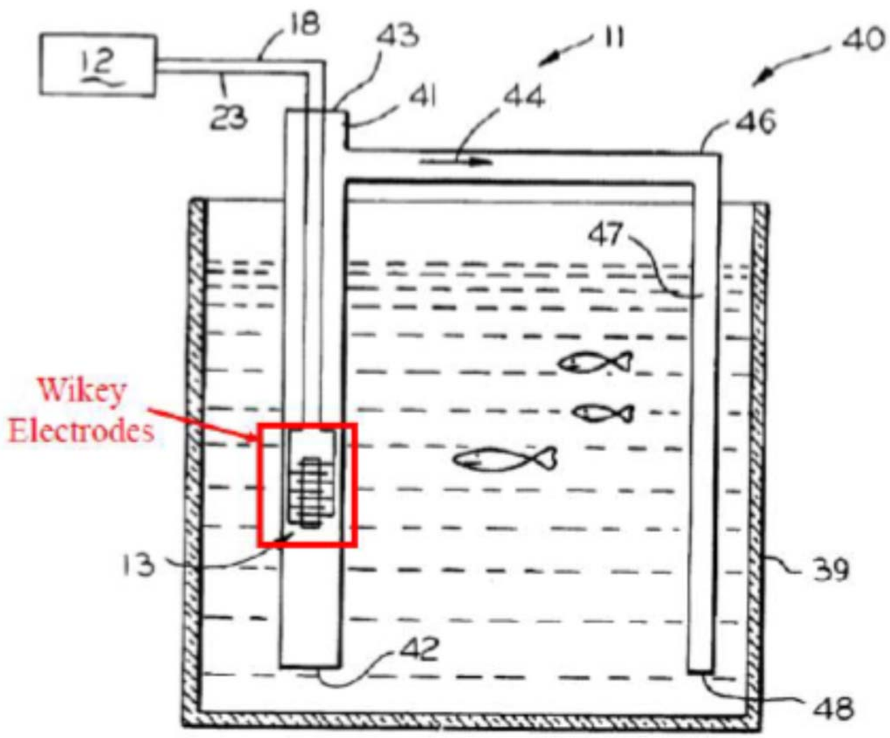
Nanobubbles—Petitioner's Excuse 4: Specification's Alleged Admissions

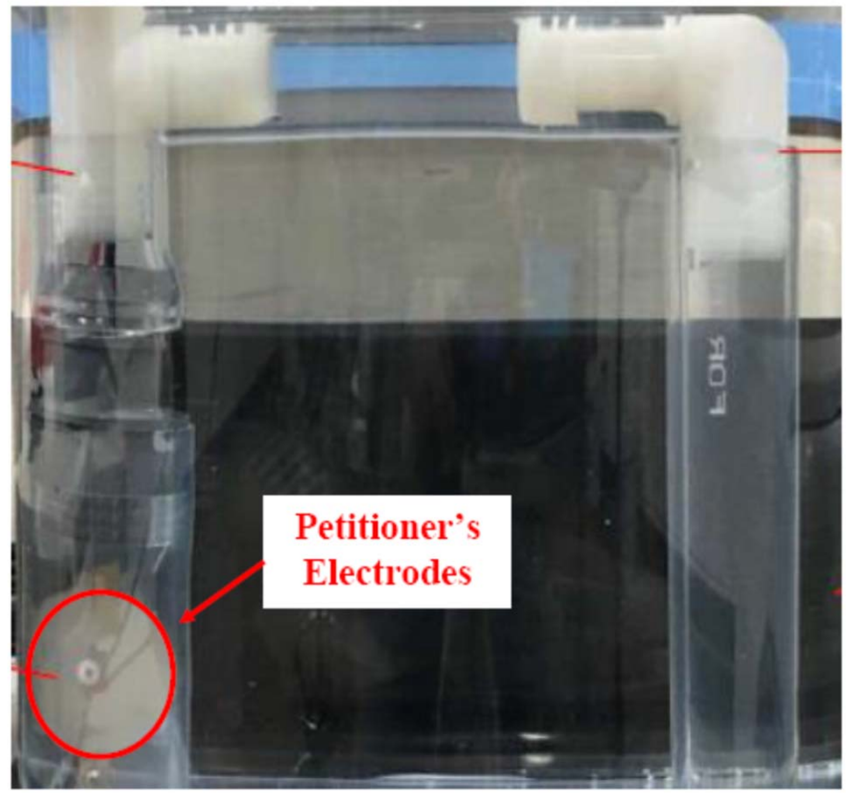
- **Petitioner's argument that meeting structural limitations of claims is sufficient is not supported by the specification.**

- **Argument was directly rejected by Federal Circuit:**
  - **"[The patent challenger] urges us to accept the proposition that if a prior art reference discloses the same structure as claimed by a patent, the resulting property . . . should be assumed. We decline to adopt this approach because the proposition is not in accordance with our cases on inherency."**
    - ***Crown Operations Int'l, Ltd. v. Solutia Inc.*, 289 F.3d 1367, 1377 (Fed. Cir. 2002).**

Sur-reply at 7-8.

Petitioner's Reproduction of Wikey Not Faithful: Opposite Electrode Orientation





Petitioner's Reproduction of Wikey Not Faithful: Opposite Electrode Orientation

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on average get bigger bubbles; correct?
A. Not necessarily.
Q. But it's possible; right?
A. Yes.
Q. Is it hard to predict the effect that flow rate will have or flow velocity will have on the size of bubbles?
A. Yes.
Q. Going back to just generally to things that affect whether bubbles are formed and the size, one of those is the spacing between the electrodes; correct?
A. Yes.
Q. And if we are in the situation where we have flowing water, does the size of bubbles also depend on the orientation of the electrodes relative to the flow? In other words, if the flow is kind of right into a flat electrode versus running parallel to and sheering the electrode, that's going to change the size of the bubbles; correct?
A. Yes.
Q. Does the shape or the housing of the container that the electrodes are put in affect whether bubbles are created?

Sur-reply at 12; Ex. 2172 at 29.

Petitioner's Reproduction of Wikey Not Faithful: Opposite Electrode Orientation

FIG. 5

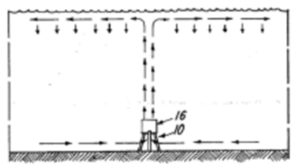
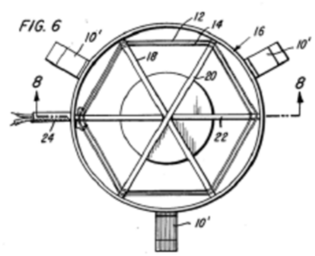


FIG. 6



The electrodes are mounted within the tubular collar in a generall

relationship at the periphery. *Id.*, Fig. 6, 9:8-14.

Clark indicates that his electrode arrangement causes bubbl

uniformly in a vertical path, apparently without colliding with each other. *Id.*, 8:58-63. In contrast, Clark says that bubbles from flat plate electrodes combine and form too large a bubble with accompanying erratic paths and turbulence. *Id.*

ii. Rationale for Combining Wikey and Clark

A POSITA would have been motivated to combine the teachings of Wikey and Clark because both address the same field (namely, generating bubbles in water) and both disclose similar structures. Ex. 1103, ¶ 184. Based on their

- 45 -

Clark indicates that his electrode arrangement causes bubbles to rise uniformly in a vertical path, apparently without colliding with each other. *Id.*, 8:58-63. In contrast, Clark says that bubbles from flat plate electrodes combine and form too large a bubble with accompanying erratic paths and turbulence. *Id.*

Petitioner's Reproduction of Wikey Not Faithful: Current 10x Too Large

3,891,535

1

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for improving the environment of the aquariums and the like.

Just as the death of natural bodies of water is caused by cultural and natural eutrophication, fish tanks and aquariums are also subject to the hazards of natural pollution. Among the most prominent characteristics of such nonusable polluted fish tank water are the high bacteria count and lack of oxygen. Of course, there are other characteristics, such as a putrid smell and/or algae, for example.

In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

Accordingly, an object of this present invention is to

water in which the electrodes are placed. Nonetheless, **the relative amperage of the preferred embodiment is in the order of ½ amp**. With the low voltage across the

vide electrolysis equipment, wherein such equipment utilizes a change of polarity to prevent residual insulation.

Yet another object of this invention is to provide an aerating and circulating pump with no moving parts for use on fish ponds or aquariums.

Yet a further object of the invention is to provide low voltage, low current flow electrolysis equipment that can be used to both aerate and sterilize water to overcome pollution.

A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic view of the inventive water aerating treatment apparatus;

FIG. 2 shows the apparatus of FIG. 1 adapted for use in fish ponds or aquariums; and

FIG. 3 shows a further refinement of the apparatus of FIG. 1.

In FIG. 1 the number 11 generally shows the electrolysis apparatus utilized for aerating and treating water

2

in fish tanks, aquariums and the like. A reversing power supply generally designated as 12 feeds power to the electrodes units 13 diagrammatically shown under water 14. The electrode unit comprises a plurality of juxtaposed plates or electrodes, such as electrodes 16 and 17. In a preferred embodiment of the invention, the electrodes are plates made of platinum coated titanium.

The consecutive plates are oppositely polarized. For example, when plate 16 is positively polarized, then plate 17 is negatively polarized. The conductor 18 is connected to plate 16 and 19 and then passes around or through plate 17. There is no electrical connection between plate 17 and conductor 18. The plate 21 is also connected to the alternate plates, Similarly, conductor 23 is coupled to the alternate plate commencing with plate 17 at 24.

The plates are all shown mounted on an insulated rod 26 and separated from each other with insulated washers, such as washer 27. In a preferred embodiment of the invention, the washers are made from teflon.

The power supply 12 is shown schematically as com-

known means for periodically or randomly changing the polarity of the alternate plates, such as plates 16 and 17, for example, can be used within the scope of this invention.

In a preferred embodiment of the invention, the plates are maintained at a distance of 1/64 inch apart by the insulators and a 6 volt D.C. source is utilized. The amperage between the plates, of course, depends on the size of the plates and the conductivity of the water in which the electrodes are placed. Nonetheless, **the relative amperage of the preferred embodiment is in the order of ½ amp**. With the low voltage across the alternate plates, the water tends to electrolyze and break into its constituent gases; i.e., two parts hydrogen and one part oxygen. With a platinum coated titanium plate, the bubbles of gas including oxygen are extremely small, and the plates themselves tend to resist any buildup of residue of impurities thereon. In addition, the reversing of the polarity also has tendencies to retain the plates in a clean condition so that they maximize the action of electrolysis obtained between the plates.

FIG. 2 shows utilization of the apparatus of FIG. 1 in a fish tank 39 where it is used for purifying and aerating the water. The size of the fish tank is of little consequence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit 13 is shown connected to a power supply 12. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. 1.

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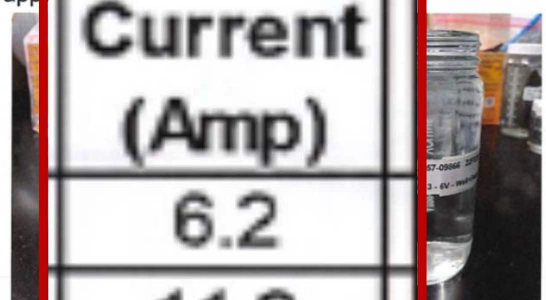
PROTECTIVE ORDER MATERIAL

Tennant Company v. OWT
OWT Ex. 2179
IPR2021-00625

E-Cell 3

Operation number	Water Type	Power supply Setpoint (V)	Current (Amp)	Initial measurements: Dissolved Oxygen (%)	Initial measurements: Conductivity (uS/cm)	Initial measurements: pH	Sample measurements after 3 h: Time collected	Sample measurements after 3 h: Time measured	Sample measurements after 3 h: Dissolved Oxygen (%)	Sample measurements after 3 h: Conductivity (uS/cm)	Sample measurements after 3 h: pH
1	Tap water	6	6.2	69.8%	559.7	7.6	11:35 AM	2:35 PM	126.6%	552.9	8.7
2	Sodium bicarbonate+Tap water	6	11.2	72.3%	1986	8.2	1:51 PM	4:45 PM	116.4%	2241.0	9.3

- Lots of bubbles coat the side of the aquarium during electrolysis
- ~8 s for bubbles to travel through pipe to the other end
- No bubbles wer
- No bubbles app



Current (Amp)
6.2
11.2

23

NALAS Engineering solutions that scale

TC_IPR_00000180

Petitioner's Reproduction of Wikey Not Faithful: Current 10x Too Large

Page 147

A. Could have been.
Q. Now, let's talk about the amperage. Unlike Davies Wykey does disclose a desired amperage, which it says is on the order of one half amp; correct?
A. Correct.
MR. JOHNSON: Objection to form.
Q. And in the tests that you ran on your Wykey reproduction the amps were over 6.
A. Yes.
Q. Six is not on the order of one half, is it?
A. No.
Q. Could you have created a Wykey reproduction that ran on the order of one-half amp?
A. Yes.
Q. And one way you could have done that would be to have gone significantly smaller than 2 inches in diameter for the electrodes; correct?
A. Correct.
Q. And I think we've discussed earlier that the size of the electrodes affects bubble size; correct?

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MR. JOHNSON: Objection to form.
A. Correct.
Q. So we don't have a measurement of what the bubble sizes would be if you made Wykey such that it would operate on the order of one-half amp?
A. No.
Q. Now, the other thing that jumped out at us is that you mounted the Davies electrodes so that the electrodes are oriented vertically within the tube, whereas figure 3 shows the electrodes horizontally in the tube; correct?
A. Correct.
Q. Why did you make that change relative to what's shown in figure 3 of Wykey?
A. Simply construction simplicity. This design was simpler, and it was difficult to mount them this way (indicating). This design was easier to mount.
Q. In your testing of Wykey you didn't use any external pump to create flow past the electrodes; right?
A. Right.
Q. Whatever flow was created was the result

Ex. 2172 at 147-148; Response at 28.

Petitioner's Reproduction of Wikey Not Faithful: Current 10x Too Large

Page 31

reading it that many things other than spacing of the electrodes are going to have an effect on the bubble size created using devices described in the patent; correct?
A. Yes.
Q. Now, I want to go back over and discuss a little bit about what effect will be had by changing various ones of these parameters. So let's start with amperage applied to the electrodes. Does increasing amperage result in larger or smaller bubbles?
A. So increasing the current density? The amperage would increase the current density. The current density has a direct impact on bubble size.
Q. Just so I understand, the effect is increasing the voltage increases current density, and that increases bubble size?
A. Correct.
Q. So higher current density, in your opinion, results in higher greater bubble size?
A. Correct.
Q. And so another thing that we talked about was the amperage affects bubble size.

Page 32

I assume that's for the same reason, because increasing the amperage increases current density and, therefore, bubble size?
A. Yes.
Q. How did electrode spacing affect bubble size?
A. The current density increases as you reduce the gap.
Q. So are you saying that the spacing affects bubble size in exactly the same way as voltage and amperage do?
MR. JOHNSON: Objection to form, compound.
A. Can you repeat that, please.
MR. VANDENBURGH: Can I have it read back.
(The requested portion of the record was read by the court reporter.)
MR. JOHNSON: Same objection as to compound.
A. Yes.
Q. How about the size and shape of the electrodes? How do those affect bubble size?
A. The greater surface of the electrode

Ex. 2172 at 31-32; Response at 28.

Dependent Claim 18

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

Response at 30-31, Sur-reply at 13-14.

Dependent Claim 18

12:14–17. Tennant proposes the following construction: "The method uses water temperature to determine whether or not a suspension can be formed." Joint Claim Construction Statement at 4. Oxygenator responds that the term should be given its plain and ordinary meaning but that "[t]he term does not require the temperature [to] be measured or evaluated." *Id.* Instead, it argues, the term "merely refers to the physical phenomenon of the water temperature being 'a factor for formation of the suspension.'" Oxygenator Br. at 41.

Tennant offers two persuasive reasons to conclude that use of water temperature is a required step in the method that Claim 18 describes. First, the specification's only

mention of temperature
embodiment that uses
process. *See* JA13 at 5:2
that use water temperat
only says that is "conver
some way for water temp
measured or evaluated
specification. *See* 35 U
1149, 1163 (Fed. Cir. 20
the actual measurement
in electrolysis, then the
patent protection. *Alice*

OWT Ex. 2111
Tennant Company v. OWT
IPR2021-00625

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

Ex. 2111 at 49; Response at 11-12.

Dependent Claim 21

21. A method according to claim 13 wherein the microbubbles and nanobubbles supersaturate the water.

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

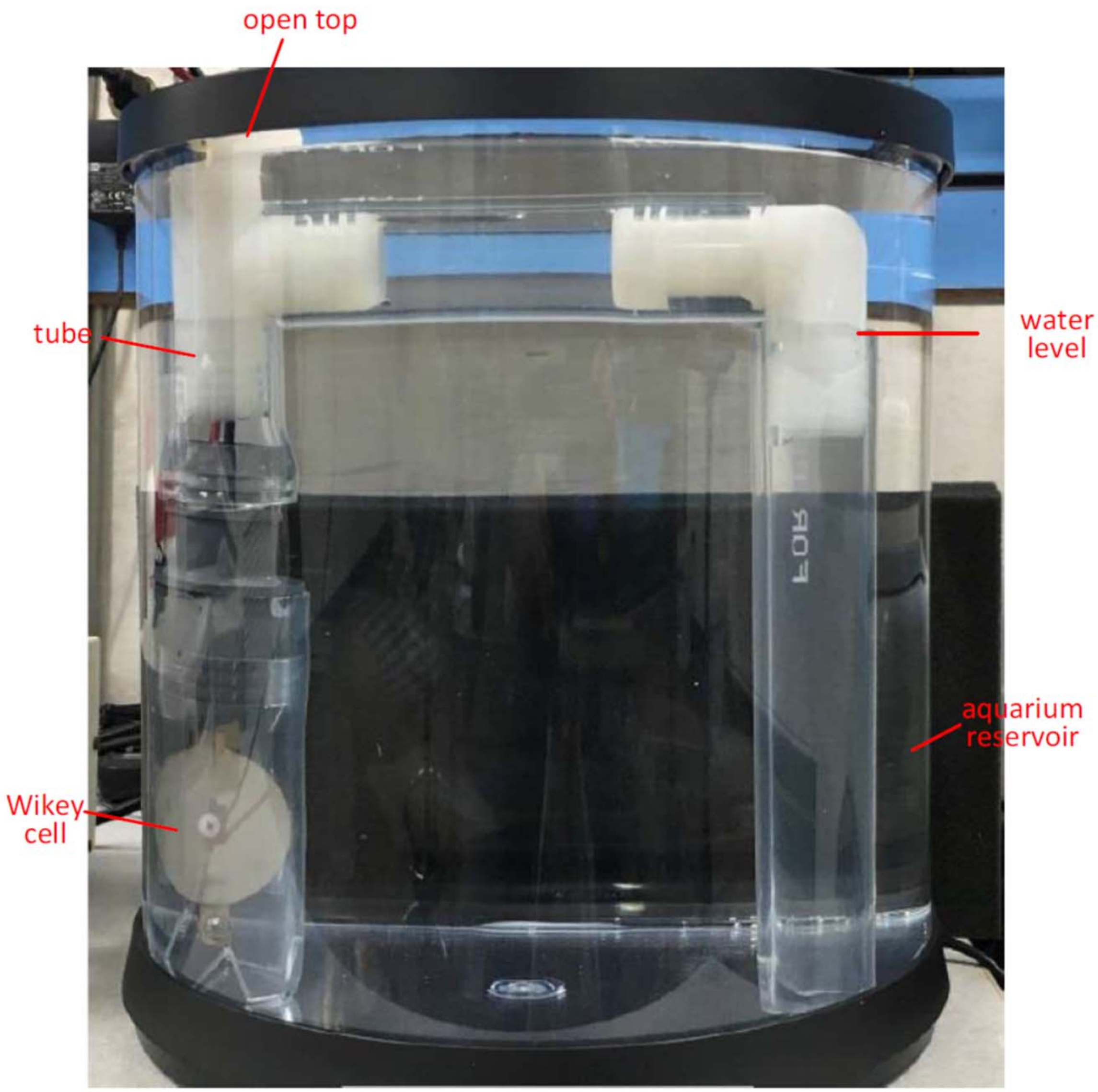
 Ex. 1101 at 4:16-18, 12:26-27; Response at 31-32; Sur-reply at 14-15.

Dependent Claim 21

- **Dr. Tremblay: Bubbles ≠ Supersaturation**
- **Specification does not say it is inherent**
- **Above identified flaws in Petitioner's Wikey testing prevent it from establishing Wikey necessarily and inevitably supersaturate**
- **Additionally, high dissolved oxygen content in Petitioner's small container not representative of larger Wikey fish tanks/ponds**

Response at 31-32, Sur-reply at 14-15.

Dependent Claim 21



Ex. 1103 at ¶45; Response at 31-32; Sur-reply at 14-15.

Dependent Claim 25

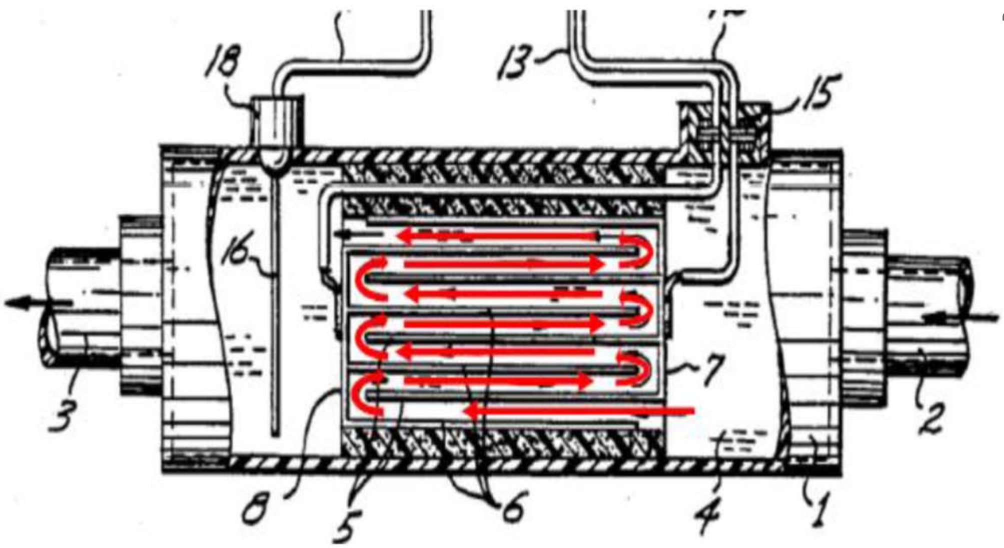
25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

Response at 32.

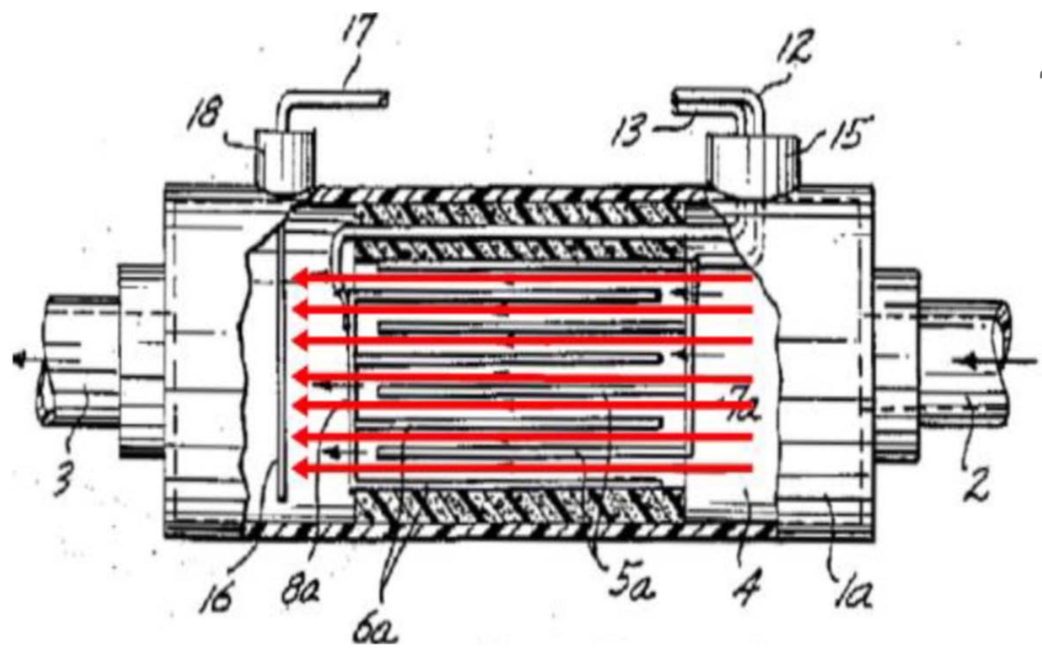
Ground 7:
Anticipation Based on Davies

Davies

Serpentine



Straight Through



Response at 33; Ex. 1105 at Figs. 2, 11.

Davies: Not Meant to Create Bubbles

Page 100

5 amps, your opinion is that would still create microbubbles less than 50 microns?
A. Yes.
Q. And what's your basis for that belief?
A. The four cases that describe the current densities and imaging and capabilities, almost all bubbles that are created with these ranges and current densities we are talking about, they have bubble ranging from 10 to 50 micron. And there is -- so --
Q. You didn't test any other spacings; correct?
A. Correct.
Q. And you didn't test any amperages below, say, 8; correct?
A. On the Davies cell?
MR. JOHNSON: Objection.
Q. Correct.
A. No, no.
Q. Now, Davies is concerned with removing impurities from water; correct?
A. Yes.
Q. Does Davies say anything about making bubbles?
A. I don't recall, but I would have to go

Page 101

through it to be certain, but I don't recall. It was about removing impurities.
Q. Is the current density required to move impurities the same as the current density required to create bubbles?
A. No.
Q. I think we established earlier that electrolysis doesn't necessarily create bubbles at all; right?
A. Right.
Q. Is the current density required to remove impurities higher or lower than the current density required to make bubbles?
A. So you can effectively remove impurities with less current than to make bubbles, because there is a minimum over potential you need to create bubbles that doesn't exist for the impurities. The impurities is not relevant to minimum over potential to create gas. For example, oxygen is 1.3 volt and --
Q. And so it would be possible, then, to make and use a device in accordance with the teachings of Davies for the purpose of Davies of removing impurities that would not create bubbles at all; correct?

Page 102

A. An effective design?
Q. I'll follow up on that one, but a design that would serve the purpose of removing impurities, as Davies says, you could design something that would do that in accordance with the teachings of Davies, removing impurities but not make bubbles; correct?
MR. JOHNSON: Objection to form.
A. It would be an ineffective design.
Q. When you say ineffective, do you mean it wouldn't work at all, or it would just be less effective than ideal?
A. It would be less effective than ideal.
Q. Does Davies give any guidance about the desired amperage of his device?
A. So I recall it was all volts stated, an implied current based on those voltage. Yes, you're correct.
Q. Does creating bubbles reduce the ability of impurities to adhere to the plates?
A. Can you repeat that?
Q. Does creating bubbles in the Davies reproductions reduce the ability for impurities to adhere to the plates?
A. Yes.

Ex. 2172 at 100-102; Response at 38-39.

Davies Outline

- **Microbubbles and Nanobubbles**
  - **No evidence Davies creates nanobubbles (see *slides* 15-28 *supra*)** (Response at 39, 47; Sur-Reply at 1-8.)
  - **Davies did not Disclose Petitioner's Creations** (Response at 39-49; Sur-Reply at 18-21.)
  - **Both Creations Have Independent Problems**
- **Davies does not teach electrodes separated by "0.005 inches to 0.140 inches"** (Response at 34-36, 47; Sur-Reply at 15-17.)
- **Davies does not teach an Amperage "No Greater than About 13 Amps"** (Response at 36-38, 47; Sur-Reply at 17-18.)
- **Davies Straight Through Embodiment Does Not teach "Flow Rate No Greater than 12 Gallons Per Minute"** (Response at 46-47, Sur-Reply at 20-21.)
- **Dependent Claims 18, 21, 22 and 25** (Response at 49-52; Sur-Reply at 21-22.)

No Evidence Davies Creates Nanobubbles

- ***See* Slides 15-28 *supra***
- **Petitioner failed to test for nanobubbles**
- **Petitioner's excuses fail**

Davies Did Not Disclose Petitioner's Creations

Page 86

mean, it sounds, if there was a chance you would produce it today, I think it would make sense to figure it out today during a break so that if you were to turn it over to me I could handle it today as opposed to, you know, if you're not going to turn it over even if it exists, I guess I would like to know that as soon as possible.

MR. JOHNSON: Yeah, I understand. We'll try our best to get you an answer as soon as possible.

MR. VANDENBURGH: All right. All right. On we go with the deposition.

BY MR. VANDENBURGH:

Q. Dr. Tremblay, I am going to start by showing you a copy of Exhibit 1105, which I hope you'll agree is the Davies patent that we've been discussing today.

A. Yes.

Q. Now, to start with, the Davies patent doesn't contain any specific examples that Mr. Davies said he specifically created and tested?

A. No specific examples, correct.

Q. Have you seen patents before that

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contain specific examples that are made by the patentee in the described -- in the patent?

A. Yes.

Q. So it's fair to say that the reproductions you designed are not of a specific example but rather were created based on preferred ranges of variables discussed in Davies?

A. Yes.

Q. If you'll look at page 57 of your declaration, in connection with the first Davies reproduction, you describe it as using figures 1 through 4 and the teachings of Davies as a guide; is that correct?

A. That's correct.

Q. So various things that you needed to decide. Let's start with the size of the electrodes. Davies gives a range; right?

A. Yes.

Q. And the range is 3 to 5 inches across, and I believe 5 to 10 inches in length; is that right?

A. That's correct.

MR. JOHNSON: Sorry for the noise.

Ex. 2172 at 86-87; Response at 39-42.

Davies Did Not Disclose Petitioner's Creations

Variable	Davies' Disclosure	Tremblay's Choice
Electrode dimensions	"For most purposes the plate width should be 3 to 5 inches" and the length of the plate is preferably "in the range of 5 to 10 inches" (Ex. 1105 at 3:43-59)	3" x 5"
Electrode gap	From one-eighth to one-quarter inch (*id.*)	One-eighth inch (0.125 inches)
Voltage	"[A] low voltage such as 12V or 24V, depending on the particular type of installation for which the clarifier is to be used" (*id.* at 8:68-9:9)	12V
Current	No guidance	10.2 amps (Operation 3) 8.8 amps (Operation 4)

Response at 40-41.

Davies Did Not Disclose Petitioner's Creations: The Variables Matter

Page 24

that. Based on what you know today, when you build an electrolysis cell, are there multiple factors that will affect whether or not oxygen bubbles are formed?
A. Yes.
Q. And are there multiple factors that affect the size of oxygen bubbles if they are formed that are formed?
A. Yes.
Q. Let's go through some of those. One would be the shape and size of the electrodes; correct?
A. Yes.
Q. And another would be the spacing of the electrodes; correct?
A. Yes.
Q. Another would be the voltage applied to the electrodes; correct?
A. Yes.
Q. And the amperage applied to the electrodes?
A. Yes.
Q. Is whether bubbles will be formed and the size of them depending on whether the electrodes are put in static or flowing

Ex. 2172 at 24; Response at 41-42.

Davies Does Not Disclose Petitioner's Creations: Federal Circuit Law – No Anticipation

***Galderma Labs., L.P. v. Teva Pharms. USA, Inc.*, 799 Fed. Appx. 838, 846 (Fed. Cir. 2020)**

This is not a case, as Teva suggests, of an anticipating reference disclosing non-anticipating alternatives. Teva's Br. 39–40. It is true that anticipation is not defeated by a showing that the allegedly anticipating reference also discloses non-anticipating alternatives. *See, e.g.*, *Perricone*, 432 F.3d at 1376. But that is not the question before us. The inquiry here is whether the claimed efficacy limitations are an inherent result of practicing McDaniel's disclosed methods. The answer is no because: (1) McDaniel does not disclose the specific Soolantra® formulation; and (2) as Teva's expert acknowledged, variation in formulation parameters will undoubtedly affect the results achieved from the use of McDaniel's disclosed formulations. Teva has provided no basis for us to conclude with certainty that all 1% formulations within the scope of McDaniel's disclosure will inevitably achieve the claimed efficacy limitations.

Response at 43-44.

Serpentine Creation:
What are the particles?

- **Straight Through Creation: 1400 counts**
- **Wikey Creation: 250 Counts**
- **Serpentine Creation: 40 counts**
- **No control, so no evidence 40 counts weren't in the water without electrolysis**

Response at 45-46.

Straight Through Creation: Tested the Wrong Flow Rate

Q. So in both sets of tests for the Davies serpentine embodiment described in your declaration, you used the 1 gallon per minute flow rate; correct?
A. Yes.
Q. And then in the two tests you report for the Davies straight-through embodiment, you use one at a flow rate of 1 gallon per minute and one at a flow rate of .3 gallons per minute; correct?
A. That's correct.
Q. Let me start with this. If you look at column 5 of the Davies patent, where he discloses the flow rate of 1 gallon per minute, that's in connection with the serpentine embodiment of figures 1 through 4; right?
A. Yes.
Q. Davies doesn't disclose a flow rate for his straight-through embodiment, does he?
A. No.
Q. Why did you run what is described as operation 6 in your declaration at .3 gallons per minute? And if it helps you, you look at paragraph 152 of your declaration, but I

Response at 46.

Straight Through Creation: Tested the Wrong Flow Rate

- **Dr. White explains that Davies suggests straight through uses higher flow rate than serpentine. Ex. 2116 at ¶¶ 65-66.**

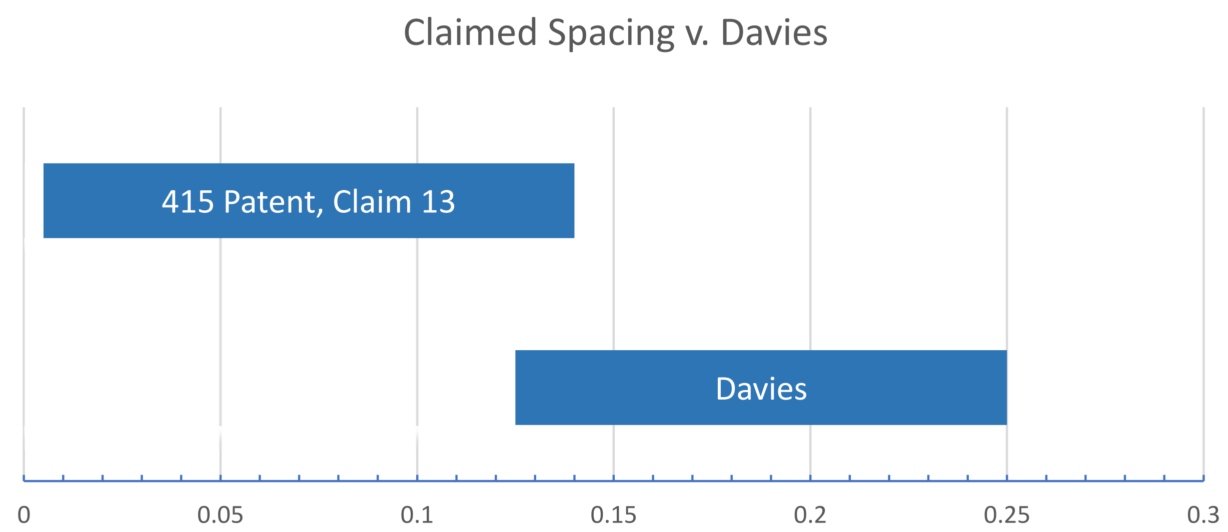
- **Petitioner's expert Dr. Tremblay agrees: Ex. 2172 at 105:16-107:20.**

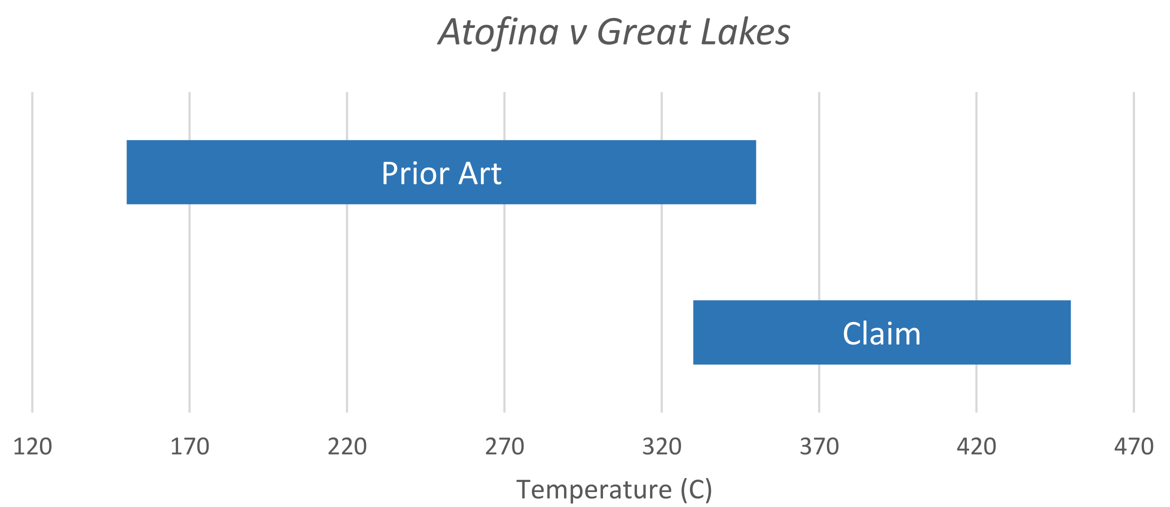
- **Nevertheless, Petitioner tested straight through at same or lower flow rates than serpentine**

- **Evidence suggests higher flow rates yields fewer bubbles**

Response at 47-48; Sur-Reply at 20-21.

Davies Does Not Teach Electrodes Separated By "0.005 inches to 0.140 inches"





Response at 34-36; Sur-Reply at 15-17.

Davies Does Not Teach Electrodes Separated By "0.005 inches to 0.140 inches"

4,917,782

3

5 project in parallel, equally-spaced, cantilever fashion from an end connecting plate 7. The cathode plates 6 project in parallel, equally-spaced, cantilever fashion from an end connecting plate 8.

The opposite edges of the plates in the stack are held by mounting blocks 9 located at opposite sides of the stack. The outer sides of such blocks are cylindrically convex to fit tightly against the inner wall of the cell casing 1 and the inner chordal faces of the blocks have equally spaced parallel grooves 10 extending lengthwise of the cell for receiving the opposite edges respectively of the plates 5 and 6 to hold the plates firmly in accurately spaced relationship.

The ends of the mounting blocks 9 fit against the end plates 7 and 8 respectively to close the sides of the channels between the plates of the stack. The edges of the mounting blocks 9 extend above the top and below the bottom of the stack of plates as shown in FIG. 3. The spaces above the stack of plates and below the stack of plates are closed by filler blocks 11 having outer cylindrically convex sides to fit snugly the inside of the cylindrical cell casing 1 and inner flat sides to fit contiguously against the upper and lower plates of the stack respectively.

The anode plates 5 and cathode plates 6 are interleaved with the free end of each cantilever plate spaced from the adjacent end plate a distance approximately equal to the spacing between adjacent plates of the stack so as to form within the stack a series of return bends between adjacent interplate spaces providing a sinuous passage from the entrance end of the casing to the exit end of the casing through the plate stack. The mounting blocks 9 and filler blocks 11 are made of material impermeable to liquid, such as closed cell foamed plastic material, which serves as a barrier to flow of liquid from the entrance end of the casing to the exit end of the casing other than through the sinuous passage between the interleaved plates and mounting blocks 9.

The capacity of the cell for flow of liquid through it will depend upon the width of the plates 5 and 6 in the stack, the space between adjacent plates and the space between each plate free end and the adjacent end connecting plate. For most purposes the plate width should be in the range of 3 to 5 inches (7.62 to 12.7 cm) and the spacing between adjacent plates should be one-eighth to one-quarter of an inch (3.5 to 7 mm). It is desirable for the space between adjacent plates to be small so as to provide a short path for travel of electricity between the plates. The time during which the liquid is subjected to the electric field between the anode and cathode plates can be regulated by selection of the length of the path between the liquid and the plates which is determined by the length of the plates, and by the velocity of the liquid flowing through the interplate passage. Preferably the length of the plates 5 and 6 is in the range of 5 inches to 10 inches (12.7 to 25.4 cm) and the velocity of the water may be 8 to 20 feet (2.4 to 6 m) per minute so that the water will be in contact with the plates for a period of 15 to 40 seconds.

The clarification of the liquid is accomplished by the transmission of electricity between the anode and cathode plates and the electric field which such transmission produces without the plates adding any material to the liquid. For that reason it is desirable for the plates to be made of inert material such as having a substrate of titanium coated with ruthenium oxide (RuO_4).

The clarifying electrolytic cell shown in FIGS. 1, 2, 3 and 4 has a long path of travel for the liquid between

The clarifying apparatus can be installed in a household water system by connecting the entering filter 21 to the cold water supply 23 for a sink or a wash bowl,

The capacity of the cell for flow of liquid through it will depend upon the width of the plates 5 and 6 in the stack, the space between adjacent plates and the space between each plate free end and the adjacent end connecting plate. For most purposes the plate width should be in the range of 3 to 5 inches (7.62 to 12.7 cm) and the spacing between adjacent plates should be one-eighth to one-quarter of an inch (3.5 to 7 mm). It is desirable for the space between adjacent plates to be small so as to provide a short path for travel of electricity between the plates. The time during which the liquid is subjected to the electric field between the anode and cathode plates can be regulated by selection of the length of the path between the liquid and the plates which is determined by the length of the plates, and by the velocity of the liquid flowing through the interplate passage. Preferably the length of the plates 5 and 6 is in the range of 5 inches to 10 inches (12.7 to 25.4 cm) and the velocity of the water may be 8 to 20 feet (2.4 to 6 m) per minute so that the water will be in contact with the plates for a period of 15 to 40 seconds.

Ex. 1105 at 3:43-49; Sur-Reply at 17.

Davies Does Not Teach Electrodes Separated By "0.005 inches to 0.140 inches"

81. Davies discloses providing an electrolytic cell in a cylindrical casing

1. Further, the cylindrical casing 1 is connected on one end to a supply pipe 2 and

is connected on the othe

POSITA would have un

having an inlet (via the s

tubular flow axis from th

82. Eight electrode plates 5, 6 are stacked in an interleaved configuration

in the tubular housing. *I*

sinuous passage through

83. Davies teac

12.7cm) and a plate leng

Id., 3:43-46 and 3:54-56

of inert material such as

oxide. *Id.*, 3:64-66.

84. Davies teaches that the electrode spacing for most purposes should be 1/8 inch to 1/4 inch (3.5 to 7 mm). *Id.*, 3:43-46. Moreover, Davies notes that it is

desirable for the space between adjacent electrodes to be small, so as to provide a short path for travel of electricity between the plates. *Id.* Therefore, a POSITA

5, 6 to also have an

hich is in a range of the

ied by the '415 patent.

lectrically connected by

wires 12, 13 to a power source 19. Electricity flows from the power source 19 to

30. A POSITA therefore

n electrical power source

lectrode and electricity

th through the housing 1

vater passes only once

SITA would understand

n with any fluid or water

harge, but can also be

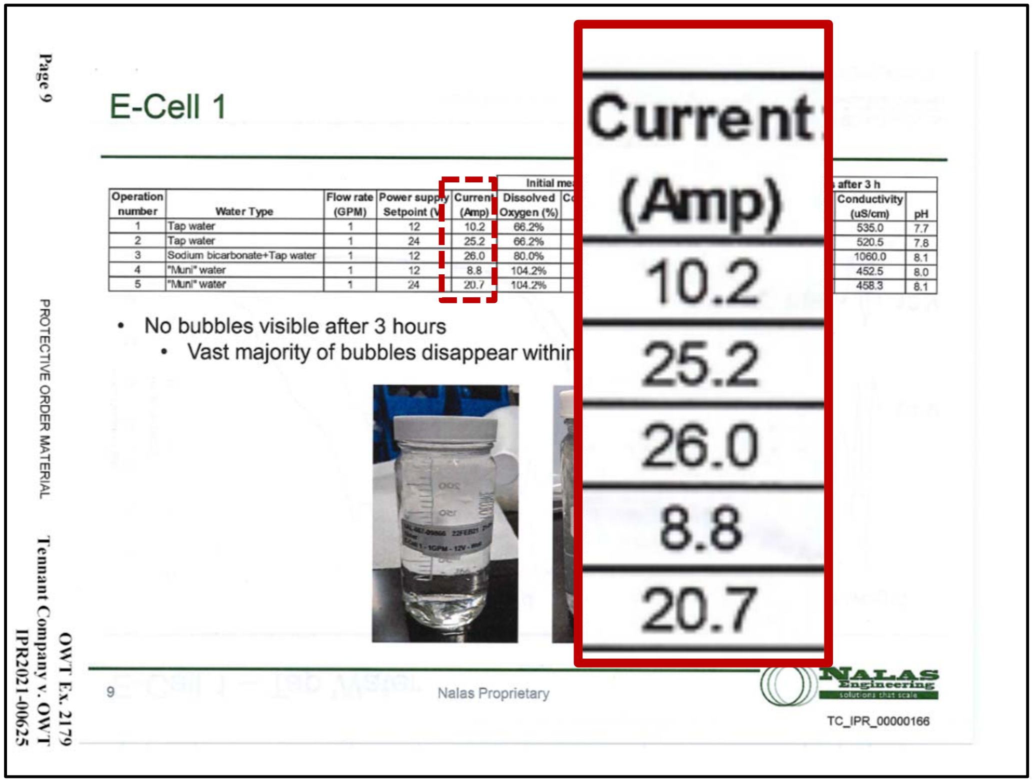
e device.

87. In Davies, water is in fluid contact with the electrodes 5, 6 as it flows from the supply pipe 2 to the discharge pipe 3. *Id.*, 2:60-63, 4:23-26 and Fig. 2. A

84. Davies teaches that the electrode spacing for most purposes should be 1/8 inch to 1/4 inch (3.5 to 7 mm). *Id.*, 3:43-46. Moreover, Davies notes that it is

desirable for the space between adjacent electrodes to be small, so as to provide a short path for travel of electricity between the plates. *Id.* Therefore, a POSITA would have understood that it was desirable for the plates 5, 6 to also have an electrode spacing of 1/8 inch to 1/4 inch (3.5 to 7 mm), which is in a range of the critical distance from 0.005 inches to 0.140 inches identified by the '415 patent.

Davies Does Not Teach Amperage "No Greater than About 13 Amps"



Page 9

E-Cell 1

Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V	Current (Amp)	Initial mea... Dissolved Oxygen (%)	...after 3 h Conductivity (uS/cm)	pH
1	Tap water	1	12	10.2	66.2%	535.0	7.7
2	Tap water	1	24	25.2	66.2%	520.5	7.8
3	Sodium bicarbonate+Tap water	1	12	26.0	80.0%	1060.0	8.1
4	"Muni" water	1	12	8.8	104.2%	452.5	8.0
5	"Muni" water	1	24	20.7	104.2%	458.3	8.1

- No bubbles visible after 3 hours
  - Vast majority of bubbles disappear within

Current (Amp)
10.2
25.2
26.0
8.8
20.7

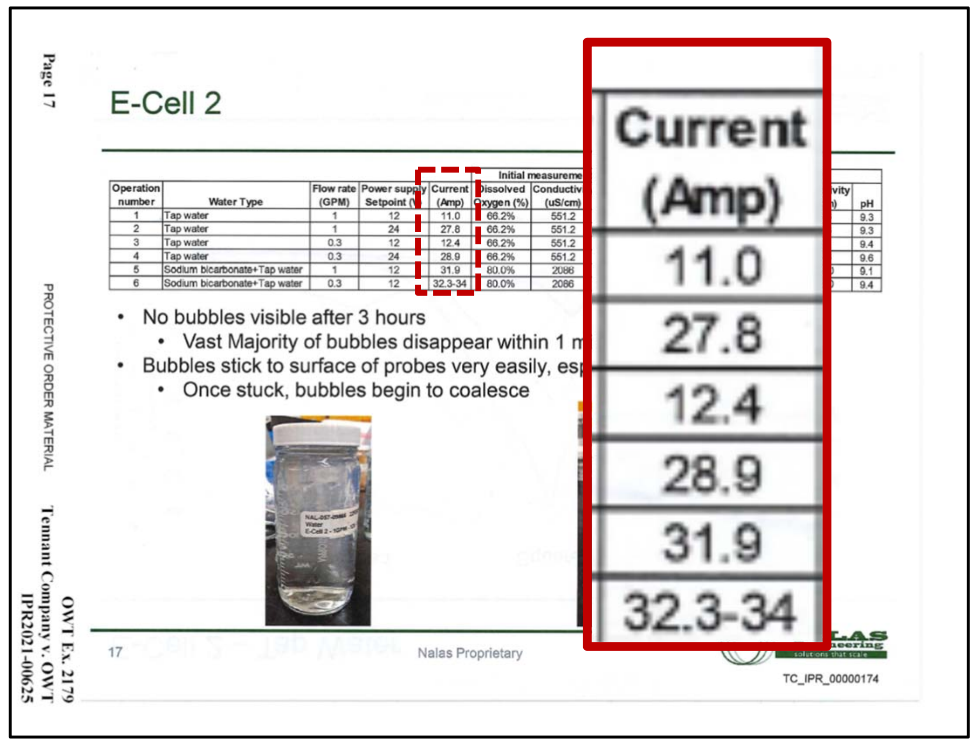
9 Nalas Proprietary

NALAS Engineering

TC_IPR_00000166

PROTECTIVE ORDER MATERIAL

OWT Ex. 2179
Tennant Company v. OWT
IPR2021-00625



Page 17

E-Cell 2

Operation number	Water Type	Flow rate (GPM)	Power supply Setpoint (V	Current (Amp)	Initial measureme... Dissolved Oxygen (%)	Conductiv... (uS/cm)	pH
1	Tap water	1	12	11.0	66.2%	551.2	9.3
2	Tap water	1	24	27.8	66.2%	551.2	9.3
3	Tap water	0.3	12	12.4	66.2%	551.2	9.4
4	Tap water	0.3	24	28.9	66.2%	551.2	9.6
5	Sodium bicarbonate+Tap water	1	12	31.9	80.0%	2086	9.1
6	Sodium bicarbonate+Tap water	0.3	12	32.3-34	80.0%	2086	9.4

- No bubbles visible after 3 hours
  - Vast Majority of bubbles disappear within 1 m
- Bubbles stick to surface of probes very easily, esp
  - Once stuck, bubbles begin to coalesce

Current (Amp)
11.0
27.8
12.4
28.9
31.9
32.3-34

17 Nalas Proprietary

TC_IPR_00000174

PROTECTIVE ORDER MATERIAL

OWT Ex. 2179
Tennant Company v. OWT
IPR2021-00625

Davies Does Not Teach Amperage "No Greater than About 13 Amps"

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to get into the two embodiments you made, we can get a shorthand, but the first Davies reproduction you made was made to be similar to figures 1 through 4 and what can be described as a serpentine embodiment; correct?
A. The first one, yes.
Q. And for discussion purposes we can call that the serpentine embodiment, and you'll know what I mean?
A. Yes.
Q. And then the second one basically has the same dimensions, but it's open on each face so that the water can flow straight through all sets of electrodes; correct?
A. Correct.
Q. So we can fairly call that the straight-through embodiment?
A. Yes.
Q. I think we've established that using the teachings of Davies as a guide does not necessarily result in a device that operates at less than 13 amps; right?
MR. JOHNSON: Objection to form.
A. All right. So can you repeat the

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question.
(The requested portion of the record was read by the court reporter.)
MR. JOHNSON: Objection, form.
A. Yes.
Q. Now, relative to bubble size, do you think it would be possible to make a device using the teachings of Davies as a guide that would have -- would not create bubbles less than 50 microns?
MR. JOHNSON: Objection to form.
A. No.
Q. So there is no combination of dimensions, voltage, amperage, materials, kind of within the scope of Davies that wouldn't create bubbles less than 50 microns?
MR. JOHNSON: Objection to form, asked and answered.
A. Any configuration, you said, that will not give 50 micron? No.
Q. So in your opinion, if you had taken your samples and increased the spacing to the top end of Davies' range, quarter inch, and then reduced the amperage down to, say,

Ex. 2172 at 98-99; Response at 37-38.

Straight Through Disclosure: Does Not Disclose Flow Rate Less Than 12 gpm

- **Slides 51-52 *supra.***
- **Response at 46-47.**

Dependent Claim 18

18. A method according to claim 13 wherein the water has a temperature no greater than about ambient temperature at the inlet and the water temperature is a factor for formation of the suspension.

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

Response at 49, Sur-reply at 21.

Dependent Claim 18

- ***See* slide 36 *supra.***
- **Davies straight through embodiment used in pools and hot tubs, no temperature disclosed. Response at 49.**

Response at 49, Sur-reply at 21.

Dependent Claim 21

21. A method according to claim 13 wherein the microbubbles and nanobubbles supersaturate the water.

"Supersaturated" means oxygen at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure.

Ex. 1101 at 4:16-18, 12:26-27; Response at 49, Sur-reply at 21-22.

Dependent Claim 21

- **Dr. Tremblay: Bubbles ≠ Supersaturation**
- **Specification does not say it is inherent**
- **Above identified flaws in Petitioner's Davies testing prevent it from establishing Davies necessarily and inevitably supersaturates**

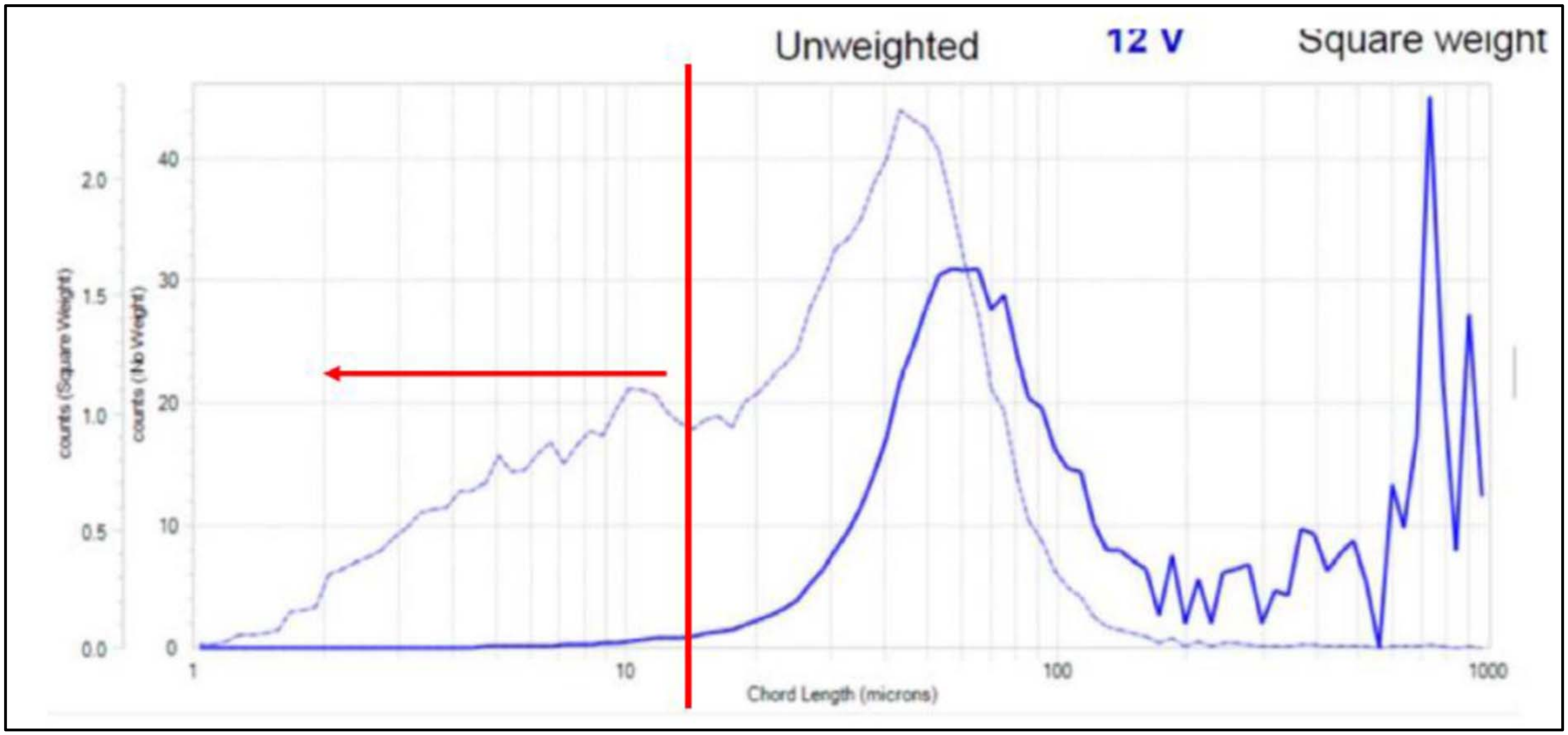
Response at 49; Sur-reply at 21-22.

Dependent Claim 22

22. A method according to claim 13 wherein the bubble diameter of the microbubbles and nanobubbles is less than 0.0006 inches.

Response at 50-52

Dependent Claim 22



Ex. 1103 at ¶131; Response at 51.

Dependent Claim 25

25. A method according to claim 13 wherein the microbubbles and nanobubbles are substantially incapable of breaking the surface tension of the water.

Response at 32.

Obviousness

Grounds 2-6 and 7-24

Obviousness Outline

- **Global Failures**
  - **No Prima Facie Case** (Response at 53-55; Sur-Reply at 22-23.)
  - **No Cure for Lack of Microbubbles and Nanobubbles** (Response at 56-57, 61-62; Sur-Reply at 23-34.)
  - **Unrebutted Objective Indicia of Non-Obviousness** (Response at 64-68; Sur-Reply at 24-25.)
- **Failures of Specific Combinations**
  - **Wikey + AFD** (Response at 55-57; Sur-Reply at 25-26.)
  - **Wikey + Clark** (Response at 57-59; Sur-Reply at 26-27.)
  - **Davies + Hough** (Response at 59-60; Sur-Reply at 27.)
  - **Davies + Erickson** (Response at 60-61; Sur-Reply at 27.)
  - **Davies + Scheoberl** (Response at 62-63; Sur-Reply at 27.)
  - **Davies + Peter** (Response at 63-64; Sur-Reply at 28.)
  - **Wikey/Davies + General Knowledge/Treatises** (Response at 56-57, 61-62; Sur-Reply at 23-34.)

No Prima Facie Case

Insufficient Rationale for Combining

IPR2021-00625
Patent RE45,415 E

Although Petitioner's arguments may show that the respective references are analogous art, *see Wyers v. Master Lock Co.*, 616 F.3d 1231, 1238 (Fed. Cir. 2010), simply demonstrating that a set of references are all directed to the same problem is not, by itself, a sufficient rationale to combine the references. *See id.* (upon finding that two references were directed to the same problem, the Court proceeded to analyze whether a person of ordinary skill in the art would have been motivated to combine the

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Paper 9 at 27; Response at 53-54.

No Prima Facie Case

Insufficient Explanation of Combination

IPR2021-00625
Patent RE45,415 E

references); *see also In re Kahn*, 441 F.3d 977, 987–88 (Fed. Cir. 2006) (noting that the inquiry as to whether a person of ordinary skill in the art would have sought to combine the references "picks up where the analogous art test leaves off"). It is also unclear, based on Petitioner's proffered reasoning, which portions of the cited secondary references would be combined with Wikey, how they would be combined with Wikey, and whether one of ordinary skill in the art would have had a reasonable expectation of success combining them with Wikey. Nevertheless, as directed by *SAS,* we institute *inter partes* review on all grounds raised in a petition, and, thus, Petitioner's obviousness-based Wikey grounds shall be part of the trial.

G. Asserted Anticipation ove

Petitioner argues that clai
Davies. Pet. 47–69.

1. Davies

Davies is a patent titled "E
Apparatus." Ex. 1105, code (54
for electrolytically treating wate
water to be used for drinking pu
at 1:7–10.

Davies's Figure 2 is repro

Paper 9 at 27; Response at 54-55.

New Argument is not Allowed

"Petitioner may not submit new evidence or argument in reply that it could have presented earlier, e.g., to make out a prima facie case of unpatentability."

Consolidated Trial Practice Guide at 73; Sur-Reply at 22.

No Cure for Lack of Microbubbles & Nanobubbles

None of the References Teach or Suggest Nanobubbles

Wendt is a general textbook on Electrochemical Engineering and confirms it was known that "radii of electrochemically evolved gas bubbles are usually relatively small (5-50 µm)." Ex. 1117, 103. Wendt was accessible to the public interested in the art in 1999.[5]

Han also confirms: "In EF, hydrogen and oxygen bubbles are generated when current is applied to the solution through metal electrodes. The average size range is reported to be around 20–40 µm." Ex. 1137 at pg. 77.[6]

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

Paper 1 at 40-41; Sur-Reply at 24.

No Cure for Lack of Microbubbles & Nanobubbles

None of the References Teach or Suggest Nanobubbles

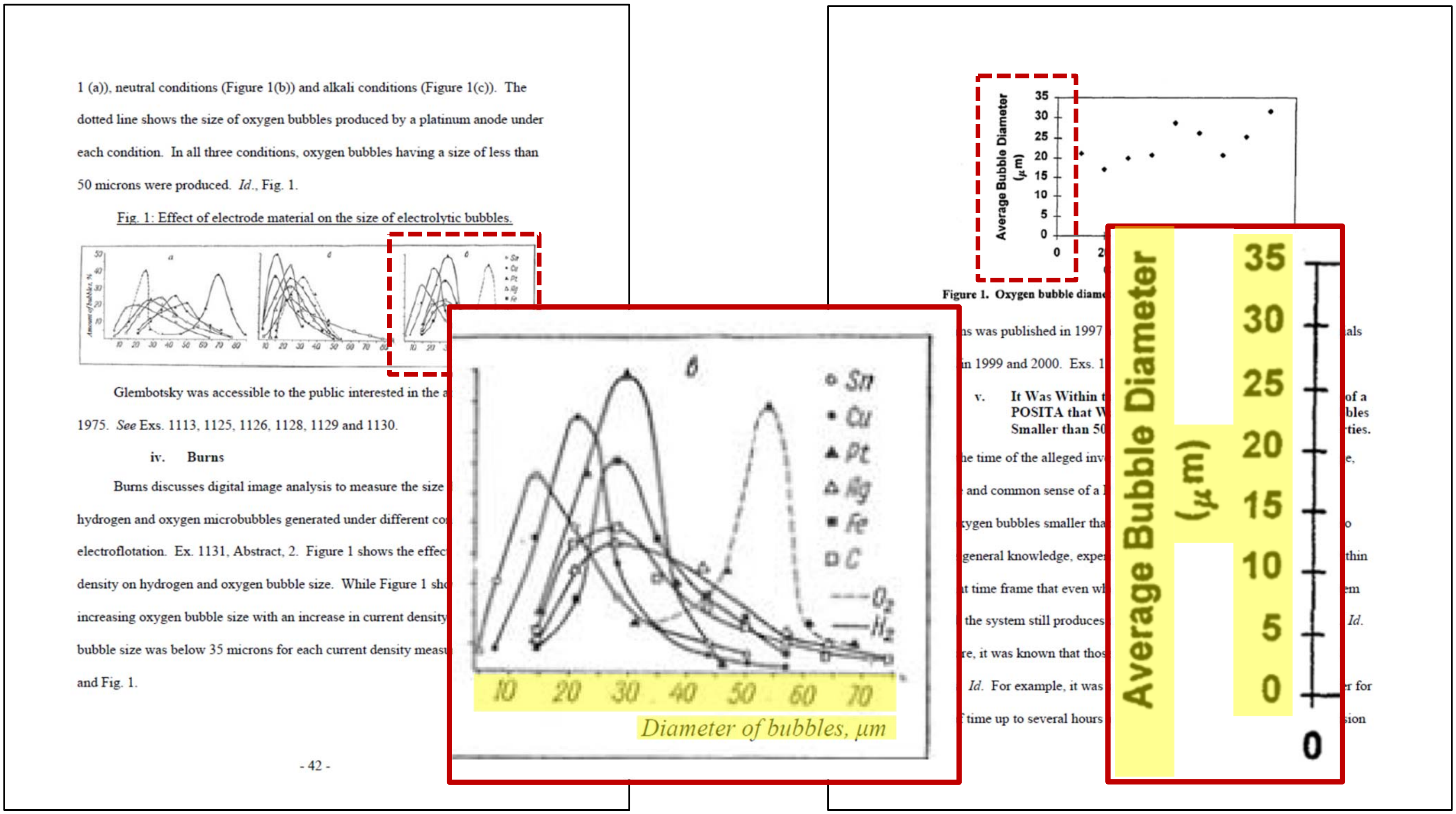
1 (a)), neutral conditions (Figure 1(b)) and alkali conditions (Figure 1(c)). The dotted line shows the size of oxygen bubbles produced by a platinum anode under each condition. In all three conditions, oxygen bubbles having a size of less than 50 microns were produced. *Id.*, Fig. 1.

Fig. 1: Effect of electrode material on the size of electrolytic bubbles.

Glembotsky was accessible to the public interested in the a 1975. *See* Exs. 1113, 1125, 1126, 1128, 1129 and 1130.

iv. **Burns**

Burns discusses digital image analysis to measure the size hydrogen and oxygen microbubbles generated under different co electroflotation. Ex. 1131, Abstract, 2. Figure 1 shows the effec density on hydrogen and oxygen bubble size. While Figure 1 sh increasing oxygen bubble size with an increase in current density bubble size was below 35 microns for each current density meas and Fig. 1.

- 42 -

Figure 1. Oxygen bubble diame

ns was published in 1997 als
in 1999 and 2000. Exs. 1

v. **It Was Within t of a POSITA that W bles Smaller than 50 ties.**

he time of the alleged inv e,
and common sense of a P
ygen bubbles smaller tha o
general knowledge, exper thin
t time frame that even wh em
the system still produces *Id.*
re, it was known that thos
Id. For example, it was r for
f time up to several hours sion

Paper 1 at 42-43; Sur-Reply at 24.

No Cure for Lack of Microbubbles & Nanobubbles

Petitioner Did Not Propose Any Modifications to Wikey/Davies to Create Microbubbles and Nanobubbles

PO argues that Clark's electrode configuration is inapplicable to Wikey's system. Resp. 58. Not true. Wikey's electrolysis unit is housed in a vertical tube,

Wendt, Han, Glembotsky and Burns ("the Treatises") are textbooks and other well-known resources reflecting the general knowledge and understanding of a POSITA. They are cited to show how a POSITA would have understood Wikey. Ex. 1103, ¶¶170-181, 191, 206; *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019). The Treatises show that a POSITA would have understood that

a POSITA. They are cited to show how a POSITA would have understood Wikey. Ex. 1103, ¶¶170-181, 191, 206; *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1373 (Fed. Cir. 2019). The Treatises show that a POSITA would have understood that

- 15 -

Reply at 15; Sur-Reply at 23.

Objective Evidence of Non-Obviousness

[redacted]

Ex. 2176 at 52-53; Response at 66.

Objective Evidence of Non-Obviousness

[redacted]

Ex. 2176 at 69-79; Response at 66.

Objective Evidence of Non-Obviousness

Petitioner's Product Matches Features in Patent

- separates its electrodes by between 0.045 and 0.060 inches which falls within the range for the "preferred critical distance" disclosed in the '415 patent (Ex. 1101 at 3:15-16; Ex. 2184; Ex. 2116 at ¶ 49;
- uses stainless-steel mesh electrodes, which the '415 patent discloses as "the most preferred cathode" (Ex. 1101 at 3:8-9; Ex. 2184; Ex. 2116 at ¶ 49;
- has a tubular configuration that is substantially the same as Fig. 7 (i.e. electrodes are placed toward the outside of a tubular housing, allowing water to flow through the middle of the tube without passing between electrodes as shown in Figure 7 of the '415 Patent) (Ex. 1101 at 3:8-9; Ex. 2184; Ex. 2116 at ¶ 49; and
- creates micro- and nanobubbles. *See* https://www.tennantco.com/content/dam/tennant/tennantco/products/Innovations/ec-h2o-nanoclean-brochure-tennant-en-noam.pdf (last visited Nov. 19, 2021); Ex. 2185 at 6-8.

Petitioner's admitted study of the specification underlying the '415 patent and the substantial similarity of its ultimate product to the one disclosed (and ultimately claimed) in the '415 patent is more than sufficient to establish that Petitioner copied the '415 patent. *See Liqwd, Inc. v. L'Oreal USA, Inc.*, 941 F.3d 1133, 1138 (Fed. Cir. 2019) (noting that "access" to the asserted patent together with "circumstantial evidence regarding changes to a competitor's design is

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PROTECTIVE ORDER MATERIAL

- separates its electrodes by between 0.045 and 0.060 inches which falls within the range for the "preferred critical distance" disclosed in the '415 patent (Ex. 1101 at 3:15-16; Ex. 2184; Ex. 2116 at ¶ 49;
- uses stainless-steel mesh electrodes, which the '415 patent discloses as "the most preferred cathode" (Ex. 1101 at 3:8-9; Ex. 2184; Ex. 2116 at ¶ 49;
- has a tubular configuration that is substantially the same as Fig. 7 (i.e. electrodes are placed toward the outside of a tubular housing, allowing water to flow through the middle of the tube without passing between electrodes as shown in Figure 7 of the '415 Patent) (Ex. 1101 at 3:8-9; Ex. 2184; Ex. 2116 at ¶ 49; and
- creates micro- and nanobubbles. *See* https://www.tennantco.com/content/dam/tennant/tennantco/products/Innovations/ec-h2o-nanoclean-brochure-tennant-en-noam.pdf (last visited Nov. 19, 2021); Ex. 2185 at 6-8.

Response at 67.

Wikey + AFD

Petition Relied on AFD for Flow Rate Only

the oxygen content of water in an aquarium to support plant and animal life. *Id.*
Based on their disclosure of similar structures and components to achieve similar
goals, a POSITA would have understoo
to Wikey. *Id.*

iii. Claims 13, 18-23 and 25

Wikey meets all limitations of claims 13, 18-23 and 25 for the reasons provided in Ground 1. However, to the extent that Wikey does not disclose the flow rate claimed in the '415 patent, the flow rate is taught in AFD. AFD teaches a flow rate of 1.33 gallons per minute. Ex. 1103, ¶ 71. AFD further discloses various container sizes and water no greater than about ambient temperature. *Id.*, ¶¶ 70, 72.

**C. GROUND 3: Wikey and
and 25 in View of the Ge
Common Sense of a POS
Glembotsky, and Burns**

i. Wendt

Wendt is a general textbook on E
was known that "radii of electrochemic

- 40 -

Petition at 40; Response at 55-56.

Wikey + AFD

Petitioner's New Argument in Reply

B. Obviousness Based on Wikey

i. AFD

PO wrongly contends that the Petition "does not suggest AFD could motivate a POSA to add a pump or any other means to create flow outside of the flow already created by Wikey's electrolysis m… Tremblay explained that a POSITA would have… and AFD because they address the same field, a… of a filtration system to help aerate the water *by*… 1103, ¶182. AFD teaches that filtration "*produ*… that mechanical filtration systems remove waste… materials." Ex. 1114, 22. AFD also teaches us… Similarly, Wikey teaches that electrolysis results in a "pumping action." Ex. 1112, 3:13-15.

A POSITA would have been motivated to add the filter or pump taught by AFD to Wikey and would have reasonably expected increased oxygen, water flow, and filtration. Ex. 1103, ¶182. PO argues that a POSITA would have lacked motivation to apply the teachings of AFD to Wikey because a benefit of Wikey is removing noisy, inefficient pumps. Resp. 55. On the contrary, a POSITA would have understood that combining a pump or filter with Wikey would yield additional water flow and filtration. AFD suggests combining filtration and

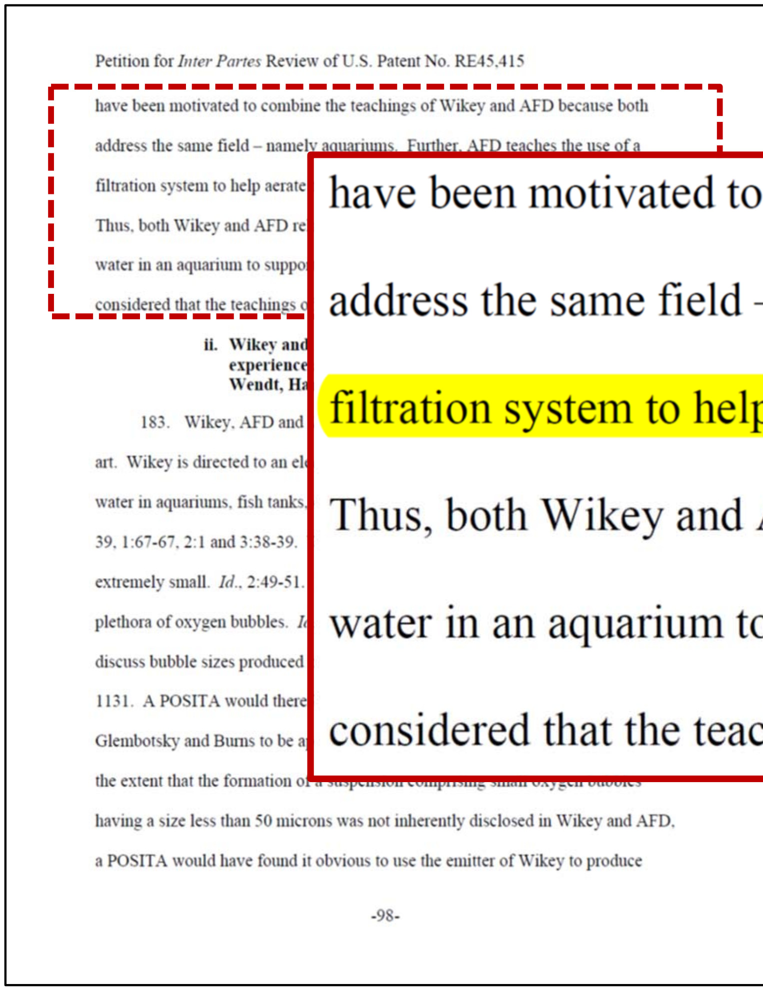
- 13 -

A POSITA would have been motivated to add the filter or pump taught by AFD to Wikey and would have reasonably expected increased oxygen, water flow, and filtration. Ex. 1103, ¶182. PO argues that a POSITA would have lacked

Paper 42 ("Reply") at 13; Sur-Reply at 25-26.

Wikey + AFD

No Support for New Argument in Expert Declaration


Petition for *Inter Partes* Review of U.S. Patent No. RE45,415

have been motivated to combine the teachings of Wikey and AFD because both address the same field – namely aquariums. Further, AFD teaches the use of a filtration system to help aerate
Thus, both Wikey and AFD re
water in an aquarium to suppo
considered that the teachings o

ii. Wikey and
experience
Wendt, Ha

183. Wikey, AFD and
art. Wikey is directed to an el
water in aquariums, fish tanks,
39, 1:67-67, 2:1 and 3:38-39.
extremely small. *Id.*, 2:49-51.
plethora of oxygen bubbles. *Id*
discuss bubble sizes produced
1131. A POSITA would there
Glembotsky and Burns to be a
the extent that the formation of a suspension comprising small oxygen bubbles
having a size less than 50 microns was not inherently disclosed in Wikey and AFD,
a POSITA would have found it obvious to use the emitter of Wikey to produce

-98-

have been motivated to combine the teachings of Wikey and AFD because both address the same field – namely aquariums. Further, AFD teaches the use of a filtration system to help aerate the water by producing flow and bubbles. *Id.*, 54. Thus, both Wikey and AFD relate to aerating or increasing the oxygen content of water in an aquarium to support plant and animal life. A POSITA would have considered that the teachings of AFD to be applicable to Wikey.

Ex. 1103 at ¶182; Sur-Reply at 25-26.

Wikey + AFD

Wikey Teaches Away from Newly Proposed Rationale for Combining

3,891,535

1

AQUARIUM WATER TREATMENT APPARATUS

This invention is a continuation in part of my prior application filed on Mar. 11, 1971, having Ser. No. 123,342, now U.S. Pat. No. 3,720,014 and entitled WATER TREATMENT APPARATUS AND METHOD. This invention relates to water treatment apparatus and more particularly to apparatus for improving the environment of the aquariums and the like.

Just as the death of natural bodies of water is caused by cultural and natural eutrophication, fish tanks and aquariums are also subject to the hazards of natural pollution. Among the most prominent characteristics of such nonusable polluted fish tank water are the high bacteria count and lack of oxygen. Of course, there are other characteristics, such as a putrid smell and/or algae, for example.

In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

Accordingly, an object of this present invention is to provide economical and efficient equipment for aerating fish tanks and the like.

A related object of the present invention is to provide the apparatus for aerating water while sterilizing the water.

A further object of this present invention is to provide electrolysis equipment for use in sterilizing water, wherein the electrolysis equipment is resistant to residual insulation.

Yet another object of the present invention is to provide electrolysis equipment, wherein such equipment utilizes a change of polarity to prevent residual insulation.

Yet another object of this invention is to provide an aerating and circulating pump with no moving parts for use on fish ponds or aquariums.

Yet a further object of the invention is to provide low voltage, low current flow electrolysis equipment that can be used to both aerate and sterilize water to overcome pollution.

A preferred embodiment of the present invention utilizes two or more plates spaced apart and insulated from each other. The plates are immersed in a fish tank or the like. A power source is provided for oppositely polarizing juxtaposed plates. A low voltage field is periodically reversed to prevent any buildup of impurities on the plates. Means may further be provided for carrying the released gases; i.e., the oxygen to the bottom of the bodies of waters to enhance the aerating effect along with the sterilization of the water.

The foregoing and other objects and advantages of this invention and the manner of obtaining them will be more apparent, and the invention itself will be best understood by reference to the following description of an embodiment of this invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic view of the inventive water aerating treatment apparatus;

FIG. 2 shows the apparatus of FIG. 1 adapted for use in fish ponds or aquariums; and

FIG. 3 shows a further refinement of the apparatus of FIG. 1.

In FIG. 1 the number 11 generally shows the electrolysis apparatus utilized for aerating and treating water

2

in fish tanks, aquariums and the like. A reversing power supply generally designated as 12 feeds power to the electrodes units 13 diagrammati[...] water 14. The electrode unit com[...] juxtaposed plates or electrodes, su[...] and 17. In a preferred embodime[...] the electrodes are plates made of p[...]nium.

The consecutive plates are oppo[...] example, when plate 16 is positiv[...] plate 17 is negatively polarized. T[...] connected to plate 16 and 19 and [...] or through plate 17. There is no el[...] between plate 17 and conductor [...] also connected to the alternate pla[...]ductor 23 is coupled to the alternate[...] with plate 17 at 24.

The plates are all shown mounted[...] 26 and separated from each other w[...]ers, such as washer 27. In a prefer[...] the invention, the washers are mad[...]

The power supply 12 is shown sch[...]prising a D.C. source, such as batte[...]nected to conductors 29 and 31.

Means are provided for periodical[...]larity of the electrodes. As schemati[...] 1, a small synchronous motor is coupled to a source of A.C. power. The motor 32 drives cam 33 through a drive shaft 34. As the cam rotates, it operates a pair of switches 36 and 37 simultaneously to interconnect conductors 29 and 31 to conductors 18 and 23, respectively.

It should be understood, of course, that any well known means for periodically or randomly changing the polarity of the alternate plates, such as plates 16 and 17, for example, can be used within the scope of this invention.

In a preferred embodiment of the invention, the plates are maintained at a distance of 1/64 inch apart by the insulators and a 6 volt D.C. source is utilized. The amperage between the plates, of course, depends on the size of the plates and the conductivity of the water in which the electrodes are placed. Nonetheless, the relative amperage of the prefer[...] in the order of ½ amp. With the low[...] alternate plates, the water tends [...] break into its constituent gases; i.e., [...] and one part oxygen. With a platinu[...] plate, the bubbles of gas includin[...]tremely small, and the plates thems[...] any buildup of residue of impuritie[...]tion, the reversing of the polarity als[...] retain the plates in a clean condition[...]mize the action of electrolysis obt[...] plates.

FIG. 2 shows utilization of the app[...] a fish tank 39 where it is used for pu[...] the water. The size of the fish tank[...]quence since more electrode units are added if required by the volume of water and number of fish in the aquarium.

The electrode unit 13 is shown connected to a power supply 12. The showing, of course, is schematic, and the plates of the unit are in actuality more closely packed together to be within the dimensions set forth in the description of the plates of FIG. 1.

> In the past, aeration of fish tanks and aquariums has been accomplished through the use of pumps and agitators. The pumps and agitators are relatively inefficient and noisy. Furthermore, they fail to reduce the bacteria in the tank.

> Yet another object of this invention is to provide an aerating and circulating pump with no moving parts for use on fish ponds or aquariums.

Ex. 1112 at 1:18-22, 1:37-39; Response at 55; Sur-Reply at 25.

Wikey + Clark

Only Asserted Against Claims 26 and 27

of water. *Id.* It was also known that those bubbles supersaturate the water because oxygen is present at a higher concentration than normal calculated oxygen solubility at a particular temperature and pressure. *Id.*

vi. Claims 13, 18-23 and 25

Wikey and AFD meet all limitations of claims 13, 18-23 and 25 for the reasons provided in Ground 2. However, to th suspension comprising small oxygen bubbles was not inherently disclosed in Wikey and AF obvious to use the emitter of Wikey to produc water because it was well known that water el reflected in Wendt, Han, Glembotsky, and Burns. Ex. 1103, ¶ 183. Further, it was known that oxygen bubbles smaller than 50 microns have the properties claimed in the '415 patent. *Id.*

D. GROUND 4: Wikey and Clark Render Obvious Claims 26 and 27

i. Summary of Clark

Clark is directed to a "method for generating hydrogen bubbles electrolytically in the lower reaches of a body of water . . ." Ex. 1106, Abstract. Clark discloses an emitter positioned within a vertical tubular collar 16, wherein water electrolysis by pairs of cathodes 12 and anodes 14 causes water to flow upwardly through the cylinder. *Id.*, Fig. 5, 9:8-20.

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D. GROUND 4: Wikey and Clark Render Obvious Claims 26 and 27

i. Summary of Clark

Petition at 44; Response at 57.

Wikey + Clark

Mere Similarity of Field is an Insufficient Rationale for Combining

FIG. 5

ii. Rationale for Combining Wikey and Clark

A POSITA would have been motivated to combine the teachings of Wikey and Clark because both address the same field (namely, generating bubbles in water) and both disclose similar structures. Ex. 1103, ¶ 184. Based on their disclosure of similar structures and components to achieve similar goals, a POSITA would have been motivated, and found it obvious, to combine them. *Id.*

and Clark because both address the same field (namely, generating bubbles in water) and both disclose similar structures. Ex. 1103, ¶ 184. Based on their

- 45 -

disclosure of similar structures and components to achieve similar goals, a POSITA would have been motivated, and found it obvious, to combine them. *Id.*

- 46 -

Petition at 45-46; Response at 57-58.

Wikey + Clark

Electrodes from Clark Create Bubbles Larger than 100 Microns

It is very important to understand that this method is not one of substituting gas produced by electrolysis for air in conventional aeration devices. In this method, the oxygen produced by electrolysis is not critical to the aeration process. The principal source of oxygen is from the atmosphere through the increase of natural re-aeration brought about by the method.

Oxygen and hydrogen are produced by electrolysis from electrodes placed near the bottom of a body of water. The oxygen normally goes into solution and is helpful but not as important to the method as the hydrogen. Hydrogen is less soluble in water than oxygen and the water in a stratified body of water is usually near saturation with hydrogen because of the release of hydrogen in anaerobic processes in this region of the water depth and from the bacterial activity in mud and sediment layers of the bottom of the body of water. As hydrogen gas is produced by electrolysis the volume of water in the immediate vicinity of the electrodes becomes bouyant and rises to the surface. As this volume of water reaches the surface, all of the vehicular hydrogen is not released to the atmosphere but some hydrogen remains suspended in the volume of water and due to continued bouyancy this water floats on top of the body of water, moving away from the point of vertical rise above the electrodes. Therefore, this volume of water from the bottom of the basin now floats along the surface of the water and natural reaeration is immediately increased as oxygen moves from the atmosphere to reach equilibrium with the new oxygen deficient (hydrogen-saturated) water at the surface. This process continues until all of the water is saturated with oxygen.

The size of the hydrogen bubble is critical in this method. If the hydrogen bubble is too large, the bubble leaves the surface of the water immediately above the electrode and does not cause the bottom water to spread out over the water surface. If the bubble is too small, little mixing occurs and the water near the electrodes merely becomes super saturated with hydrogen and this produces a flotation effect on particulate material suspended in the water in the vicinity of the electrodes. Due to super saturation, small bubbles form on the surface of particulate material and causes the material to be raised to the water surface. For the method to be effective, the size of the hydrogen bubble must be controlled between 100 and 600 microns. When the hydrogen bubbles are larger than 600 microns in diameter, the bubbles leave the surface too rapidly and the newly raised water volume does not continue to float across the water surface. If the hydrogen bubbles are less than 100 microns in diameter, little mixing surface exposure occurs and the natural reaeration is not as significantly increased.

Projected costs and available data reveal that prior art mechanical installations (although not presently satisfactory) cost about $1.00 per acre-foot for 50,000 acre-foot reservoir, while cost for the electrolysis pump system would be about $0.50 per acre-foot; accordingly, cutting installations costs in half. Operating costs in mechanical installations are about $0.25, annually, per acre-foot per year, while the electrolysis pump system contemplates about $0.03 per acre-foot per year under the same conditions.

The maintenance and noise problems cannot be overlooked in mechanical systems, while the projected maintenance and noise is relatively nil in the electrolysis pump system; the noise problem is completely eliminated, as compared with mechanical compressors in-

stalled in banks along a recreational reservoir, for example.

The electrolysis pump system provides another important benefit or result since oxidation of ferrous iron results in ferric iron and consequent chemical percipitation of phosphorous by the insoluble ferric iron and the formation of a barrier of insoluble iron-phosphate complexes in the top layer of the reservoir sediments which accordingly decreases the rate of defusion of chemicals from the bottom sediments. It is important that mixing be gentle to deter phosphate concentration of the overlying water as often happens in mechanical mixing contrary to that which occurs in the electrolysis pump system of the present invention.

The suppressing of phosphates is extremely important because of the major problems of lake enrichment resulting from detergent soaps, for example. The model analysis, using lake bottom sediments, at the end of 6 weeks, the orthophosphate content of the water without mixing was 2.10 mg/liter, while using the electrolysis pump system mixing, orthophosphate content was reduced to 0.15 mg/liter. The ferrous iron, during the same model analysis was 0.41 mg/liter, and with the electrolysis pump system mixing was 0.15 mg/liter during the same period of time.

In order to evaluate the operation of the electrolytic gas pumping device, the following tests were run:

all tests were conducted on a tank 20 ft. wide by 40 ft. long and approximately 6 ft. deep, with a depressed bottom drain of about 9 ft. deep at the center;

a 6 mill plastic sheet with slits at measuring stations was used to cover the water surface between runs;

the dissolved oxygen was removed from the water by the addition of sodium sulfite with cobalt chloride added as a catalyst;

the tank was completely mixed during the addition of chemicals with a closed pumping device. The tests were conducted starting on a one day and continued through the next day.

The current was adjusted to 4 amps. in each test but the surface area of the electrodes was changed to vary bubble sizes;

at the completion of each test, the plastic sheet was replaced and the dissolved oxygen profile measured with a standard D.O. probe. From this information the oxygen added by reaeration was calculated.

Test No. 1

D.O. at start: 1.2 mg/l.
Temp.: 19° C
Bubble Size: 160 Microns

Depth ft.	STATION 1	2	3	4	5	6	7	8
0.1	8.7	8.7	8.8	8.9	8.9	8.7	8.7	8.6
1	8.6	8.6	8.6	8.7	8.7	8.5	8.6	8.6
2	8.0	8.0	8.2	8.2	8.6	8.6	7.7	7.8
3	6.8	6.7	6.7	6.8	7.2	7.1	7.0	6.7
4	4.1	4.0	3.9	4.0	4.0	4.0	3.9	3.9
5	1.8	1.5	1.4	1.5	1.5	1.5	1.5	1.7
6	1.2	1.2	1.2	1.3	1.3	1.2	1.2	1.2

RUN No. 2

D.O. at start: 1.2 mg/l.
Temp: 19° C
No Electrolysis

	1	2	3	4	5	6	7	8
0.1	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
1	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

The size of the hydrogen bubble is critical in this method. If the hydrogen bubble is too large, the bubble leaves the surface of the water immediately above the electrode and does not cause the bottom water to spread out over the water surface. If the bubble is too small, little mixing occurs and the water near the electrodes merely becomes super saturated with hydrogen and this produces a flotation effect on particulate material suspended in the water in the vicinity of the electrodes. Due to super saturation, small bubbles form on the surface of particulate material and causes the material to be raised to the water surface. For the method to be effective, the size of the hydrogen bubble must be controlled between 100 and 600 microns. When the hydrogen bubbles are larger than 600 microns in diameter, the bubbles leave the surface too rapidly and the newly raised water volume does not continue to float across the water surface. If the hydrogen bubbles are less than 100 microns in diameter, little mixing surface exposure occurs and the natural reaeration is not as significantly increased.

Ex. 1106 at 5:33-53; Response at 58.

Davies + Hough

Does Not Remedy Missing Elements of Davies Identified re: Ground 7 (anticipation)

identified four reasons the combination fails
elements obvious. Response at 57-59. Petitio
4. **Ground 8: Davies and H**
PO's Response explained that Petition
any of the deficiencies PO raised with respec
the creation of microbubbles and nanobubble
0.005 to 0.140 inches, and the use of an amp
at 32-49, 59. Petitioner's reply does not addr
that Petitioner did not cite Hough to "physica
Thus, the combination of Davies and Hough
remedy any of the issues identified with resp
5. **Grounds 9-12: Davies a**
PO's response explained why Grounds
Petitioner's reply did not address these grou
6. **Ground 13: Davies and**
PO's response provided numerous rea
Davies and Schoeberl would not have been o
not resolve Davies failure to meet the elemen
Petitioner's reply did not dispute any of them

27

PO's Response explained that Petitioner does not contend Hough resolves any of the deficiencies PO raised with respect to anticipation by Davies, including the creation of microbubbles and nanobubbles, the use of electrodes separated by 0.005 to 0.140 inches, and the use of an amperage less than 13 amps. *See* Response at 32-49, 59. Petitioner's reply does not address these failures, and instead states that Petitioner did not cite Hough to "physically modify Davies." Reply at 22. Thus, the combination of Davies and Hough fails at least because it doesn't remedy any of the issues identified with respect to Ground 7.

Sur-Reply at 27.

Davies + Hough

Mere Similarity of Field is an Insufficient Rationale for Combining

ii. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Davies and Hough because both address the same field – namely, electrolytically treating water to kill biological materials so the water may be used for drinking. Ex. 1103, ¶ 187. Based on their disclosure of similar structures and components to achieve similar goals, a POSITA would have been motivated, and found it obvious, to combine them. *Id.*

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Petition at 71; Response at 59.

Davies + Hough

No Explanation of What Would be Modified

The patent makes no mention of a "control" photograph, or any effort to confirm that the "assumed O_2 bubbles" were in fact oxygen. *Id.* Petitioner's testing thus confirms that this limitation is n
'415 patent discloses it for the a

viii. "Substantia
the Water"

The patent asserts that ina
inherent attribute of bubbles in t
range. Ex. 1101, 4:27-41; Ex. 1
described and enabled by the '4
law of nature – it is inherently p
bubbles as the alleged invention

D. Obviousness Base

i. Hough

Petitioner cites Hough to
about Davies's teachings, not to
was known that electrolysis incr
water. Pet. 70-71; Ex, 1103, ¶1
POSITA would have found it ob
dissolved oxygen and purify water with a reasonable expectation of success.

- 22 -

Petitioner cites Hough to show what a POSITA would have understood about Davies's teachings, not to physically modify Davies. Hough shows that it was known that electrolysis increases dissolved oxygen, which purifies drinking water. Pet. 70-71; Ex, 1103, ¶187; Ex. 1141, 1:13-47. Hough demonstrates that a POSITA would have found it obvious to use the Davies apparatus to increase dissolved oxygen and purify water with a reasonable expectation of success.

Reply at 22; Response at 60.

Davies + Erickson

Mere Similarity of Field is an Insufficient Rationale for Combining

amperes are desirable to break down the chem
and hence increase the oxygenation of the wat
bacteria. *Id.*, 11:14-19.

ii. Motivation to Combine

A POSITA would have been motivated to combine the teachings of Davies and Erickson because they address the same field – namely, treating water by electrolysis to remove contaminants and kill biological material. Ex. 1103, ¶¶ 188-89. Moreover, Davies and Erickson each disclose an electrolytic water treatment cell having a tubular housing containing a stack of plate electrodes. *Id.* Based on their disclosure of similar structures and components to achieve similar goals, a POSITA would have understood that the systems are easily compatible, and would have found it obvious to combine them. *Id.*

iii. Claims 13, 14, 17-23 and

Davies meets all limitations of claims 1
provided in Ground 7. However, to the extent
Davies, it is provided in Erickson.

Davies does not expressly identify the c
However, as shown in Dr. Tremblay's testing
current is inherent. Ex. 1103, ¶¶ 124, 127, 13
expressly teaches that a voltage of 24 volts or

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Petition at 73; Response at 60.

Davies + Schoeberl

Only Asserted Against Claim 24

well known in the art that water electrolysis produces those small oxygen bubbles, as reflected in Wendt, Han, Glembotsky and Burns. Ex. 1103, ¶ 191.

L. GROUND 12: Davies, Erickson and Hough Render Obvious Claims 13, 14, 17-23, and 25 in View of the General Knowledge, Experience and Common Sense of a POSITA, as Reflected in Wendt, Han, Glembotsky, and Burns

Davies, Erickson and Hough mee

23 and 25 for the reasons stated in Grou

a suspension comprising small oxygen b

was not inherently disclosed in this com

obvious to use the combined references

well known in the art that water electrolysis produces those small oxygen bubbles, as reflected in Wendt, Han, Glembotsky and Burns and discussed in Ground 11. Ex. 1103, ¶ 192.

M. GROUND 13: Davies and Schoeberl Render Obvious Claim 24

i. Summary of Schoeberl

Schoeberl discloses a method and apparatus for sterilizing water by anodic oxidation. Schoeberl also discloses that molecular oxygen and gas bubble formation occurs on the electrode surfaces. Ex. 1108, 2:5-15. Figure 2 shows an anode and cathode in a tubular housing separated by a gap 25.

- 75 -

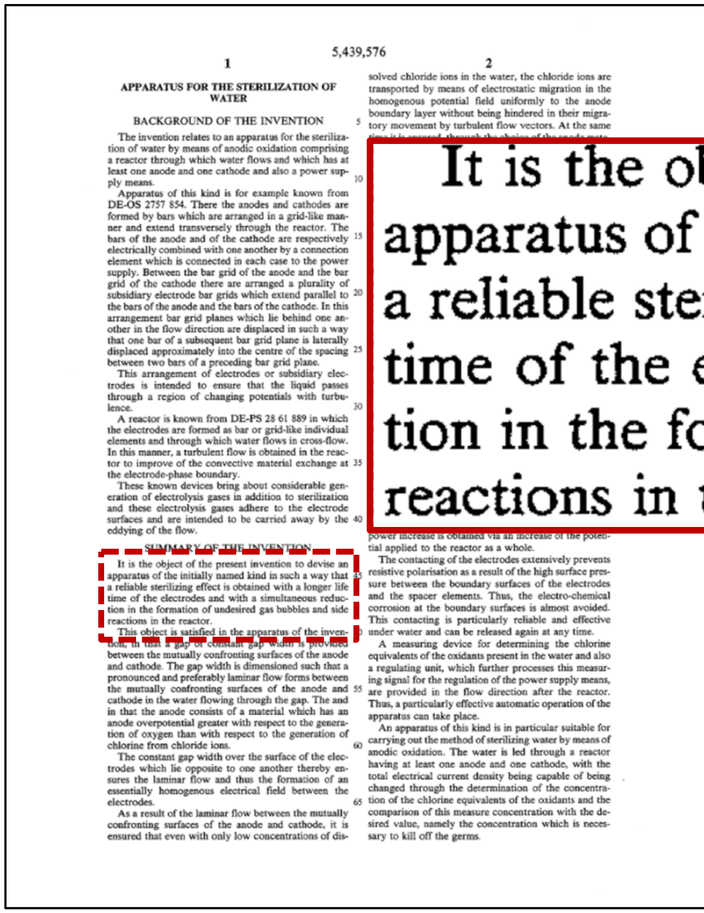
M. GROUND 13: Davies and Schoeberl Render Obvious Claim 24

i. Summary of Schoeberl

Petition at 75; Response at 62.

Davies + Schoeberl

Schoeberl Teaches Away from Creating Microbubbles and Nanobubbles



5,439,576

1

APPARATUS FOR THE STERILIZATION OF WATER

BACKGROUND OF THE INVENTION

The invention relates to an apparatus for the sterilization of water by means of anodic oxidation comprising a reactor through which water flows and which has at least one anode and one cathode and also a power supply means.

Apparatus of this kind is for example known from DE-OS 2757 854. There the anodes and cathodes are formed by bars which are arranged in a grid-like manner and extend transversely through the reactor. The bars of the anode and of the cathode are respectively electrically combined with one another by a connection element which is connected in each case to the power supply. Between the bar grid of the anode and the bar grid of the cathode there are arranged a plurality of subsidiary electrode bar grids which extend parallel to the bars of the anode and the bars of the cathode. In this arrangement bar grid planes which lie behind one another in the flow direction are displaced in such a way that one bar of a subsequent bar grid plane is laterally displaced approximately into the centre of the spacing between two bars of a preceding bar grid plane.

This arrangement of electrodes or subsidiary electrodes is intended to ensure that the liquid passes through a region of changing potentials with turbulence.

A reactor is known from DE-PS 28 61 889 in which the electrodes are formed as bar or grid-like individual elements and through which water flows in cross-flow. In this manner, a turbulent flow is obtained in the reactor to improve of the convective material exchange at the electrode-phase boundary.

These known devices bring about considerable generation of electrolysis gases in addition to sterilization and these electrolysis gases adhere to the electrode surfaces and are intended to be carried away by the eddying of the flow.

SUMMARY OF THE INVENTION

It is the object of the present invention to devise an apparatus of the initially named kind in such a way that a reliable sterilizing effect is obtained with a longer life time of the electrodes and with a simultaneous reduction in the formation of undesired gas bubbles and side reactions in the reactor.

This object is satisfied in the apparatus of the invention, in that a gap of constant gap width is provided between the mutually confronting surfaces of the anode and cathode. The gap width is dimensioned such that a pronounced and preferably laminar flow forms between the mutually confronting surfaces of the anode and cathode in the water flowing through the gap. The and in that the anode consists of a material which has an anode overpotential greater with respect to the generation of oxygen than with respect to the generation of chlorine from chloride ions.

The constant gap width over the surface of the electrodes which lie opposite to one another thereby ensures the laminar flow and thus the formation of an essentially homogenous electrical field between the electrodes.

As a result of the laminar flow between the mutually confronting surfaces of the anode and cathode, it is ensured that even with only low concentrations of dis-

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solved chloride ions in the water, the chloride ions are transported by means of electrostatic migration in the homogenous potential field uniformly to the anode boundary layer without being hindered in their migratory movement by turbulent flow vectors. At the same

power increase is obtained via an increase of the potential applied to the reactor as a whole.

The contacting of the electrodes extensively prevents resistive polarisation as a result of the high surface pressure between the boundary surfaces of the electrodes and the spacer elements. Thus, the electro-chemical corrosion at the boundary surfaces is almost avoided. This contacting is particularly reliable and effective under water and can be released again at any time.

A measuring device for determining the chlorine equivalents of the oxidants present in the water and also a regulating unit, which further processes this measuring signal for the regulation of the power supply means, are provided in the flow direction after the reactor. Thus, a particularly effective automatic operation of the apparatus can take place.

An apparatus of this kind is in particular suitable for carrying out the method of sterilizing water by means of anodic oxidation. The water is led through a reactor having at least one anode and one cathode, with the total electrical current density being capable of being changed through the determination of the concentration of the chlorine equivalents of the oxidants and the comparison of this measure concentration with the desired value, namely the concentration which is necessary to kill off the germs.

It is the object of the present invention to devise an apparatus of the initially named kind in such a way that a reliable sterilizing effect is obtained with a longer life time of the electrodes and with a simultaneous reduction in the formation of undesired gas bubbles and side reactions in the reactor.

Ex. 1108 at 1:44-49; Response at 63.

Davies + Peter

Only Asserted Against Claims 26 and 27

that water electrolysis produces those small oxygen bubbles, as reflected in Wendt, Han, Glembotsky and Burns. Ex. 1103, ¶ 197.

R. GROUND 18: Davies, Erickson, Schoeberl and Hough Render Obvious Claim 24 in view of the General Knowledge, Experience and Common Sense of a POSITA, as Reflected in Wendt, Han, Glembotsky, and B

For the reasons stated in G

render claim 24 obvious. To the

comprising small oxygen bubble

inherently disclosed in this comb

use the combined references to p

the art that water electrolysis pro

Wendt, Han, Glembotsky and Burns. Ex. 1103, ¶ 198.

S. GROUND 19: Davies and Peters Render Obvious Claims 26 and 27.

i. Summary of Peters

Peters discloses an electrolytic cell with concentric electrodes. Ex. 1109, Title. With reference to Figures 2 and 3 below, Peters provides an outer tubular shell 10 and a hollow tubular anode member 18 disposed concentrically within a hollow tubular cathode member 14. *Id.*, Figs. 2 and 3 (emphasis added).

S. GROUND 19: Davies and Peters Render Obvious Claims 26 and 27.

i. Summary of Peters

DEMONSTRATIVE EXHIBIT-NOT EVIDENCE

Petition at 79; Response at 63.

Davies + Peter

Significantly Different Structures and Objectives

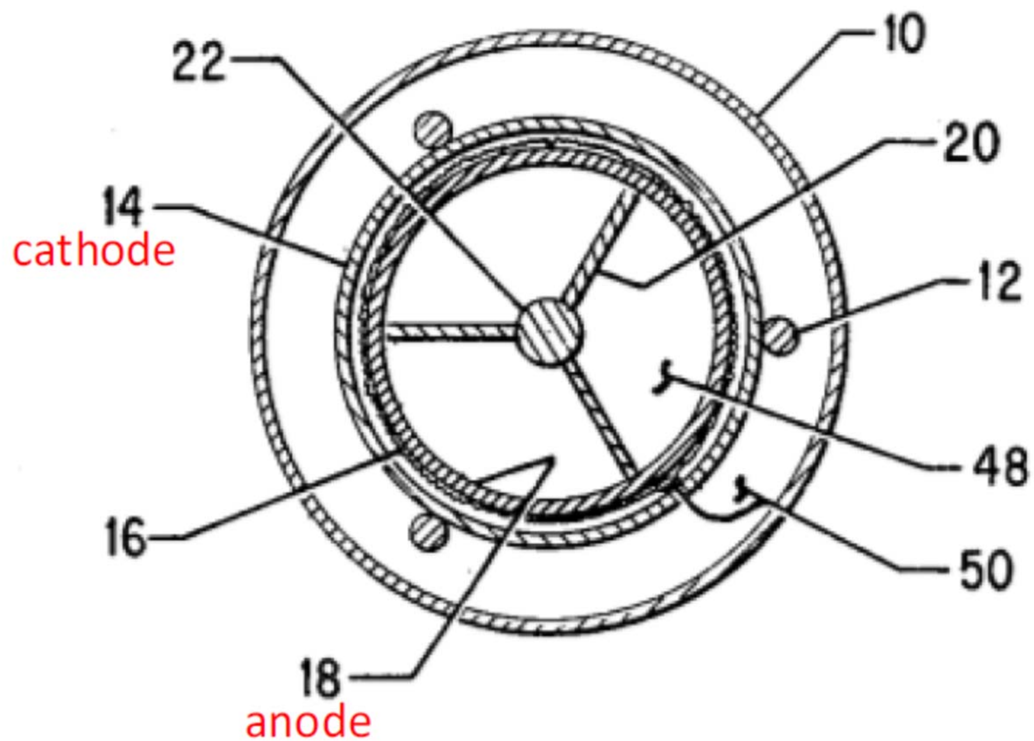

Fig. 2

Ex. 1109 at FIG. 2; Response at 63.

Wikey/Davies + General Knowledge/Treatises

None of the References Teach or Suggest Nanobubbles

See, Slides 70-71 *Supra*.

Petitioner Did Not Propose Any Modifications to Wikey/Davies to Create Microbubbles and Nanobubbles

See, Slide *72 Supra.*

Mere Existence of Microbubbles Insufficient to Prove They are Produced by Wikey/Davies

Response at 57.

Nothing Suggests Microbubbles are *Always* Produced

Sur-Reply at 24.

END