IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEBRASKA

MIXING & MASS TRANSFER TECHNOLOGIES, LLC, and PETER KOS, Ph.D.,	)	4:11CV3068
Plaintiffs,	)	**MEMORANDUM AND ORDER**
v.	)	
CITY OF LINCOLN, NEBRASKA, and HDR ENGINEERING, INC.,	)	
Defendants.	)	

U. S. Patent 5,811,009 ("the '009 Patent"), concerning a "Method and System for Improved Biological Nitrification of Wastewater at Low Temperature," was issued to the inventor, Peter Kos, Ph.D., in 1998. The patent is licensed (by an assignment executed in 2001) to Mixing & Mass Transfer Technologies, LLC ("m^2t"). Dr. Kos and m^2t allege that HDR Engineering, Inc., designed a wastewater treatment facility for the City of Lincoln, Nebraska, which infringes the '009 Patent. Specifically, the plaintiffs contend HDR and the City have infringed Claim 18 of the '009 Patent, which requires:

> 18. An activated sludge biological wastewater treatment process having enhanced biological nitrification comprising the steps of:
>
> (a) directing wastewater through a mainstream nitrification process including at least one aerobic treatment zone and a final clarifier that separates purified supernatant from settled sludge;
>
> (b) returning at least a portion of the settled sludge from the final clarifier to the mainstream treatment process;
>
> (c) producing supplemental biological nitrifiers in a sidestream by directing a stream having a relatively high concentration of ammonia into a sidestream biological nitrification system and nitrifying the same

and in the process producing the supplemental biological nitrifiers in the sidestream biological nitrification system;

(d) transferring the supplemental biological nitrifiers produced in the sidestream nitrification system to the mainstream nitrification process where the supplemental nitrifiers assist in nitrifying the wastewater passing through the mainstream nitrification process; and

(e) m[a]intaining sludge age within the mainstream nitrification process at a value of less than 200% of the critical sludge age of a conventional nitrification process.

('009 Patent, 14:10-34[1] (filing 58-2 at 13)) (underlining supplied).[2]

On October 22, 2012, the court held a *Markman*[3] hearing regarding certain terms and phrases used in Claim 18 the '009 patent that were identified by the parties in filing 50 as being disputed. Now, after considering the parties' evidence, briefs, and oral arguments, and applying accepted claim-construction principles, the court construes the disputed terms and phrases as follows:

Disputed Terms and Phrases	Court's Construction
"mainstream nitrification process"	"The portion of the mainstream treatment process in which mainstream wastewater is nitrified, meaning ammonia nitrogen in the mainstream, NH_3—N, is converted to nitrite or nitrate, both referred to NO_x. This portion of the mainstream treatment process takes place in the aerobic treatment zone(s)."

[1] References are to column and line numbers in the patent.

[2] The meaning of underlined terms and phrases are disputed by the parties.

[3] *Markman v. Westview Instruments, Inc.*, 517 U.S. 370, 373 (1996) (holding that claim construction is a matter of law for the court).

Disputed Terms and Phrases	Court's Construction
"mainstream treatment process"	"a biological suspended growth wastewater treatment process designed to treat a wastewater stream and produce treated or purified effluent, which may include a series of treatment zones, but which excludes any sidestream or sidestream treatment process"
"return activated sludge"	Not construed
"sludge"	Not construed
"sidestream biological nitrification system"	"a system in which nitrification occurs (i.e., ammonia nitrogen, NH_3—N, is converted to nitrite or nitrate, both referred to as NO_x) that is separate from the zone in which nitrification occurs during the mainstream treatment process"
"sidestream"	"The 'mainstream' is the wastewater stream flowing through the wastewater treatment plant. Any stream other than the mainstream, auxiliary to treatment of the wastewater stream, is a 'sidestream.'"
"relatively high concentration of ammonia"	Not construed
"sludge age"	Not construed
"sludge age within the mainstream nitrification process"	"the average amount of time nitrifying bacteria remain in the oxic (aerated) portion of the mainstream reactor tank, determined by dividing the mass of suspended solids in the oxic (aerated) portion of the mainstream reactor tank by the mass of suspended solids discharged from the overall system per day"

Disputed Terms and Phrases	Court's Construction
"maintaining sludge age within the mainstream nitrification process"	Not construed
"critical sludge age of a conventional nitrification process"	"the minimum solid retention time (sludge age) in days at which conventional nitrification ceases for a given pH, temperature and dissolved oxygen level, which is equal to 1 divided by the difference between the maximum daily nitrifier growth rate for conditions and the decay rate." The equation is as follows: $\theta_c^m = \frac{1}{{}^{\mu}N - k_d}$ where: θ_c^m = minimum solids retention time, days, for nitrification at pH, temperature and dissolved oxygen (mg/L); ${}^{\mu}N$ = maximum possible nitrifier growth rate, per day, for environmental conditions of pH, temperature and dissolved oxygen (mg/L) (as calculated by equation 5 of U.S. Patent No. 5,811,009); and k_d = endongenous decay coefficient"
"conventional nitrification process"	Not construed

DISCUSSION

"[A] patent must describe the exact scope of an invention and its manufacture to 'secure to [the patentee] all to which he is entitled, [and] to apprise the public of what is still open to them.'" *Markman*, 517 U.S. at 373 (quoting *McClain v. Ortmayer*, 141 U.S. 419, 424 (1891)). These objectives are served by two distinct elements of every patent application: (1) "a specification describing the invention 'in such full, clear, concise, and exact terms as to enable any person skilled in the art . . . to make and use the same'"; and (2) "one or more 'claims,' which 'particularly poin[t] out and distinctly clai[m] the subject matter which the applicant regards as his invention.'" *Markman*, 517 U.S. at 373 (quoting 35 U.S.C. § 112). A patent "claim" defines the scope of a patent and serves to prohibit exact copies of an invention, as well as a product that goes to "'the heart of an invention but avoids the literal language of the claim by making a noncritical change.'" *Id.* (quoting H. Schwartz, *Patent Law and Practice* 1, 82 (2d ed. 1995)).

In order to prevail in a patent infringement lawsuit, a patent "claim" must "'cover[] the alleged infringer's product or process,' which in turn necessitates a determination of 'what the words in the claim mean.'" *Markman*, 517 U.S. at 374 (quoting Schwartz, *supra*, at 80). Here, the parties dispute the meaning of several terms used in the claims of the '009 Patent. The court, and not the jury, must resolve claim-construction disputes. *Markman*, 517 U.S. at 388-89; *O2 Micro Intern. Ltd. v. Beyond Innovation Tech. Co., Ltd.*, 521 F.3d 1351, 1362 (Fed. Cir. 2008) ("When the parties present a fundamental dispute regarding the scope of a claim term, it is the court's duty to resolve it.").

Claim Construction Principles

In construing claims of a patent, the court examines intrinsic evidence, including the language of the claims themselves, the specification, and the prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1314 (Fed. Cir. 2005). Words of a

claim are generally given their "ordinary and customary meaning," which "is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention." *Id.* at 1312-13. Further, the claim terms must be read "in the context of the entire patent, including the specification." *Id.* at 1313. While a patentee may give special definitions to claim terms in the patent's specification, "the specification cannot support a definition that is contrary to the ordinary meaning of a claim term unless it communicates a deliberate and clear preference for this alternative definition." *Kumar v. Ovonic Battery Co., Inc.*, 351 F.3d 1364, 1368 (Fed. Cir. 2003).

The prosecution history, which is part of the "intrinsic evidence" to be considered by the court in construing patent terms, "consists of the complete record of the proceedings before the PTO [Patent and Trademark Office] and includes the prior art cited during the examination of the patent." *Phillips*, 415 F.3d at 1317. Like the specification, the prosecution history "was created by the patentee in attempting to explain and obtain the patent," and this history "provides evidence of how the PTO and the inventor understood the patent." *Id.* However, "because the prosecution history represents an ongoing negotiation between the PTO and the applicant, rather than the final product of that negotiation, it often lacks the clarity of the specification and thus is less useful for claim construction purposes." *Id.*

Finally, a district court may also consider "extrinsic evidence" consisting of "all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises." *Id.* (internal quotation marks omitted). However, extrinsic evidence "is less significant than the intrinsic record in determining the legally operative meaning of claim language" because (1) such evidence "is not part of the patent and [was not] created at the time of patent prosecution for the purpose of explaining the patent's scope and meaning"; (2) "extrinsic publications may not be written by or for skilled artisans and therefore may not reflect the understanding of a skilled artisan in the field of the patent"; (3) "there is a virtually unbounded universe of potential extrinsic evidence of some marginal

relevance that could be brought to bear on any claim construction question" from which each party will select the evidence that most favors them, leaving the court "with the considerable task of filtering the useful extrinsic evidence from the fluff"; and (4) "undue reliance on extrinsic evidence poses the risk that it will be used to change the meaning of claims in derogation of the indisputable public records consisting of the claims, the specification and the prosecution history, thereby undermining the public notice function of patents." *Id.* at 1318-19 (internal quotation marks omitted).

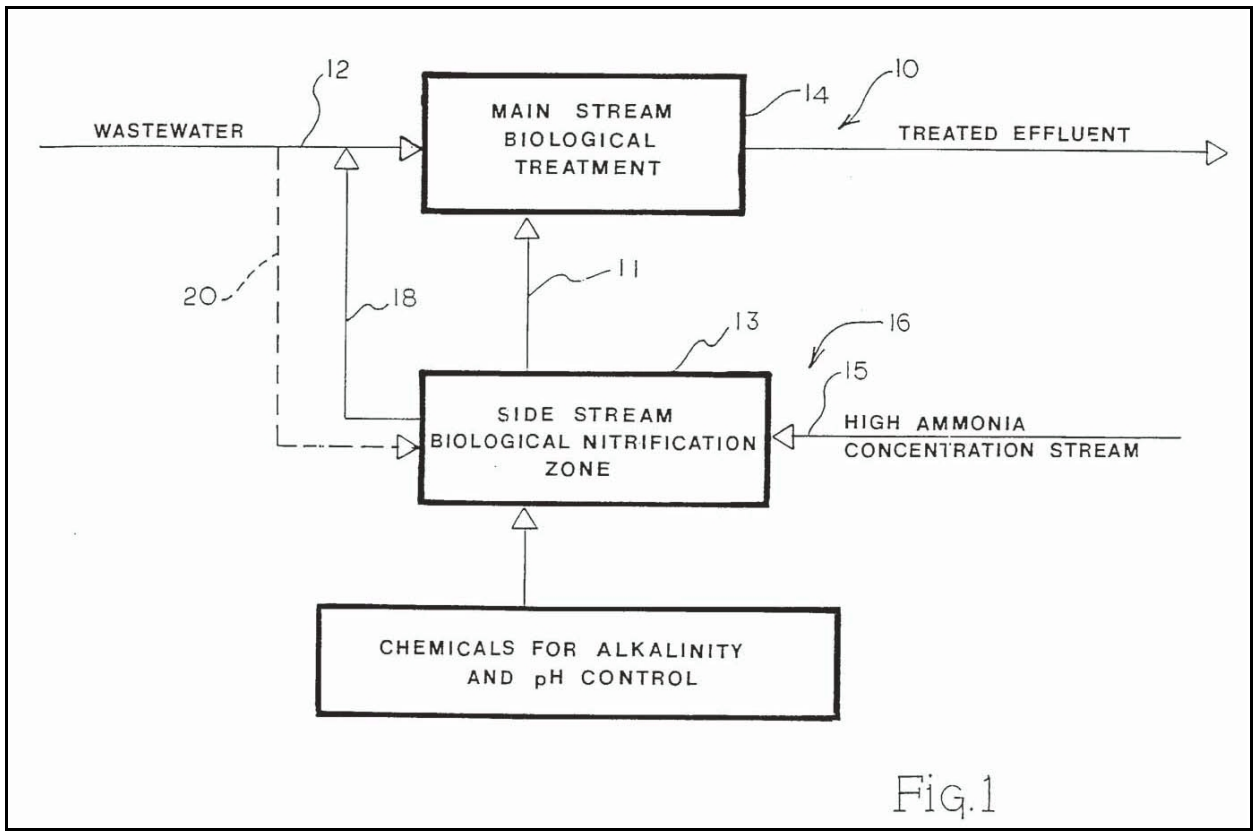
A district court may decline to construe a patent term for the reason that it carries its plain and ordinary meaning; however, failing to construe a patent term for this reason "may be inadequate when a term has more than one 'ordinary' meaning or when reliance on a term's 'ordinary' meaning does not resolve the parties' dispute." *O2 Micro*, 521 F.3d at 1361 (in deciding that "only if" needed no construction because term was well-understood, district court failed to resolve parties' dispute, which centered upon the *scope* that should be encompassed by the claim language; proper claim construction required district court to determine what claim scope was appropriate in context of patents-in-suit).

> "Ultimately, the interpretation to be given a term can only be determined and confirmed with a full understanding of what the inventors actually invented and intended to envelop with the claim. The construction that stays true to the claim language and most naturally aligns with the patent's description of the invention will be, in the end, the correct construction."

Phillips, 415 F.3d at 1316 (quoting *Renishaw PLC v. Marposs Societa' per Azioni*, 158 F.3d 1243, 1250 (Fed. Cir. 1998)).

Overview of the '009 Patent

"The present invention entails a method and system for enhancing biological nitrification in a wastewater treatment process" ('009 Patent, abstract (filing 58-2 at 1)). Depicted below is "a schematic illustration of the enhanced biological nitrification process and system of the present invention" ('009 Patent, 3:29-31 (filing 58-2 at 8)), which is identified in the '009 Patent as Figure 1:



('009 Patent, Figure 1 (filing 58-2 at 2)).

"[T]he biological nitrification process of the present invention is indicated generally by the numeral **10**" in Figure 1 ('009 Patent, 4:15-17 (filing 58-2 at 8)) (boldface in original).

> In this process influent wastewater is directed along a mainstream **12** through a mainstream biological treatment process **14**. The mainstream biological treatment process can include a series of various treatment zones including one or more anaerobic zones, one or more aerobic (oxic) zones, or one or more anoxic zones. However, it is contemplated that in the present process, the mainstream biological treatment process **14** would include at least a nitrification zone for converting ammonia nitrogen NH_3—N to NO_x. Basically, the mainstream biological treatment area or zones **14** would produce a treated or purified effluent that could be discharged into a creek, river, lake, etc.

('009 Patent, 4:17-28 (filing 58-2 at 8)) (boldface in original).

In addition to the mainstream biological treatment area or zones, "the present invention entails a sidestream nitrification system indicated generally by the numeral **16**" ('009 Patent, 4:36-37 (filing 58-2 at 8)) (boldface in original).

> Basically, the sidestream nitrification system **16** produces supplemental nitrifiers that are conveyed or transferred to the mainstream **12** where the supplemental nitrifiers aid or assist in the mainstream nitrification process.
>
> To produce the supplemental biological nitrifiers, the present invention entails directing a sidestream **15** into a sidestream nitrification zone or reactor **13**. It is contemplated that the sidestream being fed or directed into the sidestream nitrification zone **13** would have a relatively high ammonia concentration compared to the ammonia concentration found in the influent wastewater being directed into and through the mainstream process.

('009 Patent, 4:38-49 (filing 58-2 at 8)) (boldface in original).

Figure 2 of the '009 Patent is "a schematic illustration of the enhanced biological nitrification process and system of the present invention showing a particular process and system design" ('009 Patent, 3:32-39 (filing 58-2 at 8)). It is depicted below:

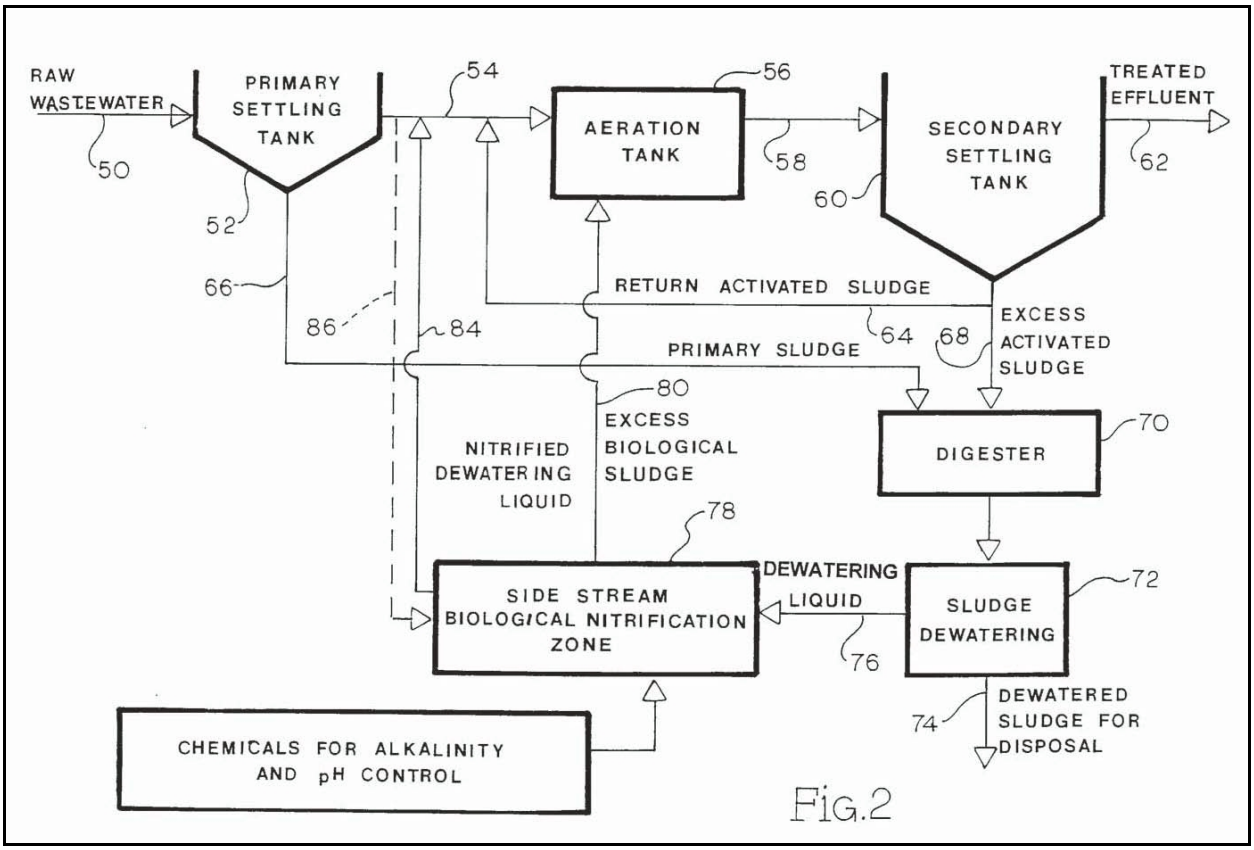


Fig.2

('009 Patent, Figure 2 (filing 58-2 at 3)).

The patent specification describes this particular process and system design in the following manner:

> Now turning to FIG. **2** and the process shown therein, it is seen that wastewater is directed into inlet line **50** which leads to a primary clarifier **52**. Primary clarifier **52** produces settled sludge and primary clarifier effluent which is directed into a mainstream inlet line **54**. From inlet line **54** the primary clarifier supernatant is directed into a mainstream treatment area or a series of mainstream treatment zones. In the case of the present disclosure, the mainstream treatment area includes at least one aeration tank **56**. This of course is utilized for mainstream nitrification. As pointed out above, it should be appreciated that the mainstream treatment area could include any number of other treatment zones such as anaerobic, aerobic, or anoxic. From the main

treatment area or the main treatment zone or zones, the treated wastewater is directed through a secondary clarifier **60** that directs a treated or purified effluent out outlet line **62**. Separated sludge is directed out the bottom of secondary clarifier **60** and a portion of it is returned to the mainstream via a return activated sludge line **64**. The return activated sludge is mixed with the incoming influent wastewater in line **54** to form a mixed liquor that is subsequently treated in the mainstream treatment area or the mainstream treatment zone or zones (in this case the aeration tank **56**).

Some of the sludge directed from the secondary clarifier **60** is referred to as excess activated sludge or waste sludge and that is directed through line **68** to a digester **70** or another sludge stabilization process. Also, primary sludge collected by the primary clarifier **52** is directed into line **66** and into the digester **70**. . . . Once the digestion process has been completed the digested sludge is directed to a sludge dewatering station **72**. There the sludge is separated into dewatered sludge which is directed out line **74** and dewatering liquid which is directed through line **76** to a sidestream nitrification system or zone **78**. There the dewatering liquid is subjected to nitrification and . . . would have a high concentration of ammonia nitrogen and would typically be at an elevated temperature compared to the influent wastewater passing through the mainstream of the process. . . . [S]upplemental biological nitrifiers are produced in the sidestream nitrification system **78** and these supplemental nitrifiers are conveyed to the mainstream via line **84**. There the supplemental nitrifiers combined with nitrifiers produced in the aeration tank **56** and the combined nitrifiers act to effectuate complete and effective nitrification in the mainstream and particularly in aeration tank **56** of the example shown. It should be also noted that excess biological sludge full of nitrifiers held in the sidestream nitrification system **78** can be conveyed to the mainstream and particularly through the aeration tank **56** via line **80**.

. . . [I]n the event there is a need to dilute the solution contained in the sidestream nitrification system **78** or need additional organic substrate that a portion of the primary supernatant leaving the primary clarifier or treated effluent can be directed into the sidestream nitrification system **78** via line **86**. As also discussed in the preceding

> example [FIG. **1**], it is appreciated that chemicals can be directed into the sidestream nitrification system **78** for the purpose of controlling pH and alkalinity.

('009 Patent, 5:39-6:33 (filing 58-2 at 9)) (boldface in original).

Overview of Claim 18

Before explaining the court's construction of each of the disputed terms and phrases contained in Claim 18 of the '009 Patent, it may be helpful to discuss the patent claim more generally. It will be seen that the claim promises to "reduce the size of nitrification treatment basins and . . . accordingly reduce the overall cost of building adequate treatment facilities for nitrification" in a wastewater treatment process ('009 Patent, 2:43-46 (filing 58-2 at 7)).

"[T]he nitrification step [in a wastewater treatment process] basically entails converting the ammonia nitrogen, NH_3–N, to nitrite or nitrate, both referred to as NO_x." ('009 Patent, 3:57-60 (filing 58-2 at 8)). "[M]any conventional activated sludge wastewater treatment processes accomplish nitrification in an aerobic or oxic treatment zone" where "the wastewater containing the ammonia nitrogen is subjected to aeration and this gives rise to a microorganism culture that effectively converts the ammonia nitrogen to NO_x." (*id.*).[4] The '009 Patent utilizes this nitrification method. Thus, paragraph (a) of Claim 18 specifies that the so-called "mainstream nitrification process" must include "at least one aerobic treatment zone" ('009 Patent, 14:13-16 (filing 58-2 at 13)).

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[4] "Once the ammonia nitrogen has been converted to NO_x then the NO_x containing wastewater is typically transferred to an anoxic zone for the purpose of denitrification. . . . Here, a different culture of microorganisms operate to consume the oxygen from the NO_x and thereby freeing [*sic*] the nitrogen to escape to the atmosphere" ('009 Patent, 3:66-4:8 (filing 58-2 at 8)).

In addition to the mainstream nitrification process, the invention calls for a "sidestream process" which "includes directing a liquid stream . . . having a high ammonia concentration at an elevated temperature into a sidestream nitrification zone which is operated at conditions which maximize production of nitrifiers [*i.e.*, nitrifying bacteria] therein" ('009 Patent, abstract (filing 58-2 at 1)). This process is described in paragraph (c) of Claim 18 (and in subsequent dependent claims).[5]

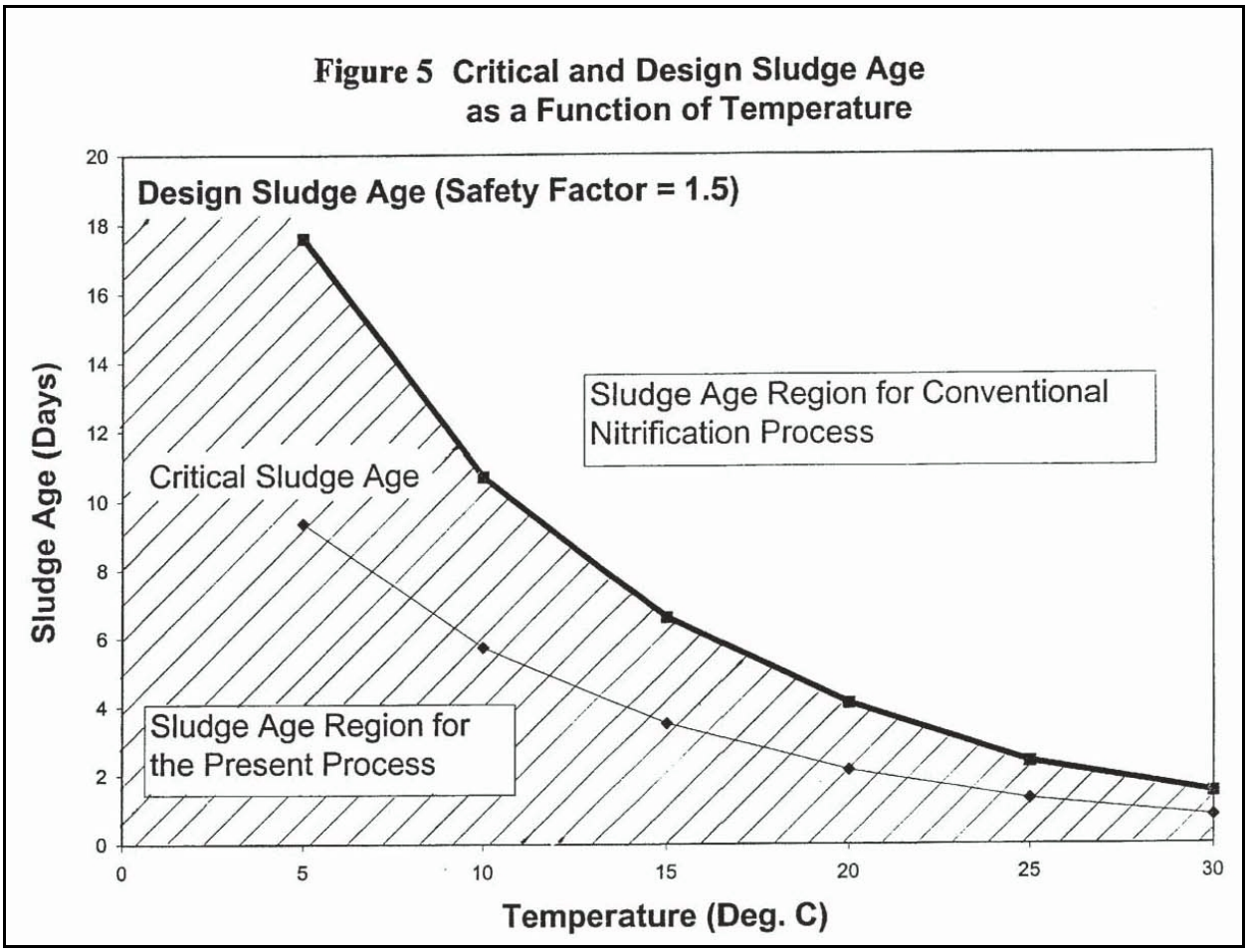
"Afterwards, the resulting nitrifiers produced in the sidestream nitrification zone are directed into the mainstream where the nitrifiers function to enhance nitrification in the mainstream and allows [*sic*] operation at low sludge retention time conditions where nitrification otherwise could not be sustained" (*id.*). Paragraph (d) of Claim 18 describes this step.

"Normally, the process design for sludge age [*i.e.*, average retention time] in a conventional nitrification process calls for the sludge age to be designed to be at least 200% of the critical or minimum sludge age [for nitrification]" ('009 Patent, 2:50-53 (filing 58-2 at 7)). The present invention allows a wastewater treatment system to be designed using a smaller safety factor because "the sidestream process produces an abundant supply of supplemental nitrifiers that . . . assist[ ] in carrying out the nitrification process in the mainstream" ('009 Patent, abstract (filing 58-2 at 1)). "Thus, in the case of the present process, the upper boundary line for design sludge age is fixed at 200% of the critical or minimum sludge age for a conventional nitrification process operated under the same temperature conditions" ('009 Patent, 12:1-5 (filing 58-2 at 12)). In other words, the minimum design sludge age for a

[5] The "temperature within the sidestream nitrification system [is maintained] higher than the temperature of the wastewater passing through the mainstream nitrification system" ('009 Patent, Claim 20, 14:40-41 (filing 58-2 at 13)) and "chemicals are added] to the sidestream biological nitrification system for controlling pH and alkalinity" ('009 Patent, Claim 22, 14:45-47 (filing 58-2 at 13)). "[B]iological nitrification is carried out in the sidestream through any conventional nitrification process" ('009 Patent, 5:13-15 (filing 58-2 at 9)).

conventional nitrification process becomes the maximum design sludge age for the present invention. This improvement is reflected in paragraph (e) of Claim 18.

Figure 5 of the '009 Patent is "a graphic illustration showing various relationships between sludge age and temperature for a conventional nitrification process" ('009 Patent, 3:44-46 (filing 58-2 at 8)). It is depicted below:



('009 Patent, Figure 5 (filing 58-2 at 6)). The values plotted in Figure 5, "show[ing] the minimum sludge age (i.e. critical or minimum sludge age or SRT [sludge retention time]) and design sludge age for a conventional nitrification process as a function of temperature" ('009 Patent, 10:24-27 (filing 58-2 at 11)), are also listed in the first three columns of Table 3 of the '009 Patent:

TABLE 3

Minimum SRT And Design SRT As A Function Of Temperature

Temperature (°Centigrade)	Minimum SRT (Days)	Lowest Design SRT (SF = 1.5)	Lowest Design SRT (SF = 2.0)
5	9.4	17.6	23.6
10	5.7	10.7	14.2
15	3.5	6.6	8.8
20	2.2	4.1	5.6
25	1.3	2.4	3.2

('009 Patent, Table 3, 10:31-43 (filing 58-2 at 11)). These values were obtained using equations 5, 6, and 7 as set out in the patent specification.

The maximum specific growth rate of Nitrosomonas was defined in the U.S. Environmental Protection Agency Technology transfer manual entitled *Process Designs Manual For Nitrogen Control,* October 1975, by the following relationship:

$$\mu N = 0.47[e^{0.098(T-15)}]\left[\frac{DO}{DO+1.3}\right][1-0.833(7.2-pH)] \quad (5)$$

Where:

μN=maximum possible nitrifier growth rate, day^{-1}, environmental conditions of pH, temperature, and DO,

T=Temperature in degrees centigrade

DO=Dissolved oxygen, mg/l

This process design method also defines the minimum solids retention time at which conventional nitrification ceases by:

$$\theta_c{}^m = \frac{1}{\mu N - k_d} \quad (6)$$

where: $\theta_C{}^m$=minimum solids retention time, days, for nitrification at pH, temperature and DO.

It also defines the design solids retention time by:

$$\theta_c{}^d = SF\,\frac{1}{\mu N\frac{N}{N+0.5} - k_d} \quad (7)$$

where:

$\theta_c{}^d$=design solids retention time, days.

SF=safety factor

N=desired effluent ammonia concentration, mg/l

('009 Patent, 8:20-51 (filing 58-2 at 10)).[6]

[6] The subtrahend "k_d" shown in equations 6 and 7 is an "endogenous decay coefficient" ('009 Patent, 8:11 (filing 58-2 at 10)).

The significance of this data, and its relationship to paragraph (e) of Claim 18, is explained in the patent specification as follows:

> Table 3 and the graph illustration of FIG. **5** explores the critical or minimum sludge age at various temperatures for conventional nitrification processes. As discussed herein, the determination of critical or minimum sludge age for a conventional mainstream nitrification process, such as that disclosed in the Barnard patent (U.S. Pat. No. 3,964,998), is highly dependent upon temperature. As Table 3 aptly illustrates, in a conventional nitrification process, the minimum sludge age increases with temperature. For example, at a wastewater design temperature of 5° C., the minimum or critical sludge age for a conventional nitrification process is 9.4 days. On the other hand, for a wastewater design temperature of 15° C., the minimum or critical sludge age for the mainstream of a conventional nitrification process is 3.5 days. These are critical or minimum sludge ages—not design sludge ages. It is well-accepted in the wastewater industry that one cannot base a nitrification process design on minimum or critical sludge age. A safety factor (SF) must be applied. Universally, the applied safety factor (SF) is typically 2.0 or at least 1.5.
>
> Turning to FIG. **5**, there is shown a plot of critical or minimum sludge age (critical SRT) as a function of temperature. As Table 3 illustrates, the critical or minimum sludge age for a conventional nitrification process decreases as the wastewater design temperature increases. Taking the minimum acceptable safety factor of 1.5, and assuming an effluent ammonia concentration of 2 mg/l, a shaded region is formed below the design sludge age line of FIG. **5** based on a 1.5 safety factor. Consequently, beginning with design wastewater temperatures of 5° C., the design sludge age for conventional nitrification processes begins at 17.6 days. For wastewater temperatures of 10° C., the design SRT for a conventional nitrification process begins at approximately 10.7 days. Similarly for a wastewater design temperature of 15° C., the design sludge age for a conventional nitrification process begins at approximately 6.6 days. It is important to appreciate that this is the lower boundary line (i.e. a safety factor of 1.5 or 150%) for design criteria relating to design sludge age in conventional nitrification processes. It can be seen that for each temperature, that

these design sludge age values are approximately twice (200%) of the critical or minimum sludge age.[7]

Thus, in the case of the present process, the upper boundary line for design sludge age is fixed at 200% of the critical or minimum sludge age for a conventional nitrification process operated under the same temperature conditions. In many cases, the design sludge age of the present invention would be substantially below this boundary line. Accordingly, the facilities for handling the wastewater influent to be treated by the present process will be substantially less in size and cost than the facilities that would be required in cases involving conventional nitrification processes.

('009 Patent, 11:5-12:10 (filing 58-2 at 12)) (boldface in original).

Construction of Disputed Terms and Phrases

The disputed terms and phrases will be addressed in the same order in which they are listed in the table set forth in the introductory section of this opinion.

1. "Mainstream nitrification process"

This term appears in paragraphs (a), (d), and (e) of Claim 18 of the '009 Patent. Because it establishes the measuring point for the "sludge age" value which paragraph (e) says must be maintained at "less than 200% of the critical sludge age of a conventional nitrification process," the meaning of this term could be crucial to the outcome of this litigation.

The defendants contend a "mainstream nitrification process" is "[a] process for treating wastewater by directing it through any combination of (a) a primary settling

[7] It is mathematically possible for a safety factor of 150% to result in design sludge ages that approach 200% of the critical sludge age because the maximum possible nitrifier growth rate (μ_N) is reduced by a fraction in equation 7.

or clarifying tank, (b) a Mainstream Treatment Process, (c) a secondary settling or clarifying tanks [*sic*], and circulating Return Activated Sludge" (filing 50 at 2). The "Mainstream Treatment Process" which is identified as item (b) of this definition is a disputed term which appears in paragraph (b) of Claim 18. It is defined by the defendants to mean "[a] portion of the Mainstream Nitrification Process where wastewater is treated by directing it through any combination of aerobic, oxic, anaerobic, and anoxic zones" (filing 50 at 3). "Return Activated Sludge" is another disputed term, although it does not appear anywhere in Claim 18. The defendants define it as "[s]ludge produced in the Mainstream Treatment Process that is recycled as a part of the Mainstream Nitrification Process" (filing 50 at 6). The defendants add that "during recycling, the Sludge may be subjected to additional treatments" (*id.*). The defendants also explain that "[a] Sidestream or Sidestream Biological Nitrification System (as defined in this patent) is not a part of a Mainstream Nitrification Process" (filing 50 at 2).

Referring to the particular process and system design illustrated in Figure 2 of the '009 Patent, the defendants' definition of "mainstream nitrification process" would include at least the following items: (1) the primary settling tank **52**; (2) the aeration tank **56**; (3) any mainstream anaerobic or anoxic treatment zone (not shown on Figure 2 but permitted by the accompanying description); (4) the secondary settling tank **60**; and (5) the return activated sludge line **64**. By contrast, the plaintiffs would include only the aeration tank **56** within the "mainstream nitrification process."

The plaintiffs contend the "mainstream nitrification process" is "[t]he portion of the mainstream treatment process in which mainstream wastewater is nitrified, meaning ammonia nitrogen in the mainstream, NH_3—N, is converted to nitrite or nitrate, both referred to NO_x" (filing 50 at 2). The plaintiffs further specify in their definition that "[t]his portion of the mainstream treatment process takes place in the aerobic treatment zone(s)" (*id.*)

The plaintiffs' proposed construction of "mainstream nitrification process" will be adopted by the court. The defendants' argument "that the '009 Patent uses the term 'mainstream nitrification process' broadly to encompass all of the mainstream portions of the wastewater process, and the term 'mainstream treatment process' to describe only a portion of the 'mainstream nitrification process'" (filing 62 at 11) defies common sense. Simply put, "nitrification" is part of wastewater "treatment," not the other way around.

For example, the description of Figure 2 states that while "the mainstream treatment area could include any number of other treatment zones such as anaerobic, aerobic or anoxic," it must include "at least one aeration tank **56**," which "of course is utilized for mainstream nitrification" ('009 Patent, 5:46-48 (filing 58-2 at 9)) (boldface in original). This description expressly recognizes that the mainstream nitrification process occurs within the aeration tank(s), and is a subpart of the mainstream treatment process (which could include other treatment zones). The defendants' proposed construction reverses this relationship.

As a practical matter, if settling tanks, anaerobic or anoxic treatment zones, and the return activated sludge line were to be considered part of the "mainstream nitrification process," as proposed by the defendants, then the "sludge age within the mainstream nitrification process" (referenced in paragraph (e) of Claim 18) would be skewed upward. The '009 Patent specifies that only sludge located in mainstream aerobic treatment zones should be included in the calculation of sludge age:

> Processes which employ biological phosphorous removal and/or denitrification require anaerobic or anoxic zones and proportional increases in sludge age to account for sludge in these anaerobic and anoxic zones. All of the descriptions and specifications herein of the sludge age refers to the so-called oxic sludge age, that is the sludge age necessary for nitrification *in the oxic or aerated zones only*.

('009 Patent, 12:11-17 (filing 58-2 at 12)) (emphasis supplied).

The first step of the treatment process described in Claim 18 involves "directing wastewater through a mainstream nitrification process including at least one aerobic treatment zone and a final clarifier that separates purified supernatant from settled sludge" ('009 Patent, 14:13-16 (filing 58-2 at 13)). The defendants contend this language (paragraph (a) of Claim 18) indicates that a final clarifier must be included in the "mainstream nitrification process." While it is possible to read paragraph (a) in this manner, it is more sensible to parse the language as requiring that wastewater be directed through two things: (1) a mainstream nitrification process that includes at least one aerobic treatment zone and (2) a final clarifier. The final clarifier (or settling tank) is simply a physical operation that uses gravity to separate purified effluent from sludge; it is distinct from the biological and chemical process of nitrification. (*See* Kos Depo., 50:15-51:5, 53:1-9, 60:23-61:14, 63:22-64:25 (filing 58-4 at 10-16)). It should also be noted that Claim 18 does not require a primary clarifier or settling tank.[8]

Claim 18 does require (in paragraph (b)) "returning at least a portion of the settled sludge from the final clarifier to the mainstream treatment process" ('009 Patent, 14:17-18 (filing 58-2 at 13)). The defendants claim this requirement serves to reinforce their argument that the "mainstream treatment process" is part of a larger "mainstream nitrification process," but a more reasonable interpretation is that the settled sludge is directed into a "sidestream" when it leaves the final clarifier. This is made clear in the description of Figure 2, which states that "[s]eparated sludge is directed out the bottom of secondary clarifier **60** and a portion of it is *returned to the mainstream* via a return activated sludge line **64**" ('009 Patent, 5:54-57 (filing 58-2

[8] The particular process and system design illustrated in Figure 2 includes a primary settling tank, but the description of this drawing states that the "[p]rimary clarifier **52** produces settled sludge and primary clarifier effluent which is directed into a mainstream inlet line **54** . . . [and from there] into a mainstream treatment area or a series of mainstream treatment zones . . . includ[ing] at least one aeration tank **56**." ('009 Patent, 5:41-47 (filing 58-2 at 9)) (boldface in original). The specification thus indicates that the primary clarifier shown in Figure 2 is an operation that occurs prior to the mainstream treatment and mainstream nitrification processes.

at 9)) (emphasis supplied). The same point is made in independent Claim 11 of the '009 Patent, which includes these steps: "(a) directing influent wastewater into and through a mainstream; (b) treating the influent wastewater in the mainstream by nitrifying the same in an aerobic zone; (c) directing the nitrified wastewater into a final clarifier and forming purified supernatant and settled sludge; [and] (d) returning a portion of the settled sludge back to the mainstream where it is mixed with the influent wastewater." ('009 Patent, 13:25-34 (filing 58-2 at 13)). The settled sludge would not need to be "returned" to the mainstream unless it had left the mainstream. It follows that the return activated sludge line is not a part of either the "mainstream" or the "mainstream nitrification process."

2. "Mainstream treatment process"

This term appears in paragraph (b) of Claim 18, which requires "returning at least a portion of the settled sludge from the final clarifier to the mainstream treatment process" ('009 Patent, 14:31-34 (filing 58-2 at 13)). For the reasons discussed in the preceding section, the court rejects the defendants' definition, which would subsume the treatment process under the nitrification process.

The '009 patent provides that "[t]he mainstream biological treatment process [identified as **14** in Figure 1] can include a series of various treatment zones including one or more anaerobic zones, one or more aerobic (oxic) zones, or one or more anoxic zones," but, at a minimum, for purposes of the present invention would "include at least a nitrification zone for converting ammonia nitrogen NH_3—N to NO_x." ('009 Patent, 4:17-26 (filing 58-2 at 8)). The specification further provides that "[b]asically, the mainstream biological treatment area or zones **14** would produce a treated or purified effluent that could be discharged into a creek, river, lake, etc." ('009 Patent, 4:26-28 (filing 58-2 at 8)) (boldface in original).

Consistent with this specification, the plaintiffs' proposed construction states that a "mainstream treatment process" is "a biological suspended growth wastewater

treatment process designed to treat a wastewater stream and produce treated or purified effluent, which may include a series of treatment zones, but which excludes any sidestream or sidestream treatment process" (filing 50 at 3). The court will adopt the plaintiffs' proposed construction.

3. "Return activated sludge"

This term does not appear in Claim 18 and does not require any construction. The construction proposed by the defendants, discussed above in connection with the term "mainstream nitrification process," is inaccurate.

4. "Sludge"

This term appears several times in Claim 18, but never on its own. Instead, the claim preamble refers to "activated sludge," paragraphs (a) and (b) refer to "settled sludge," and paragraph (e) refers to "sludge age." Each usage is different.[9]

The defendants propose to define "sludge" as "semi-liquid waste with some solid concentrations including biological nitrifying bacteria used to decompose waste and purify the wastewater" (filing 50 at 2). While it might be useful to define "sludge" for the jury, the defendants' proposed definition is not accurate. For example, sludge in the primary clarifier would not contain nitrifiers. As Dr. Kos testified, "that's [a] different kind of sludge." (Kos Depo. 115:8-9 (filing 58-4 at 30)). For another example, dewatered sludge cannot be described as "semi-liquid."

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[9] The term also appears in other contexts within the patent. For example, the portion of the specification describing Figure 2 identifies six different things that are referred to as sludge: primary sludge from the primary settling tank; return activated sludge from the secondary settling tank; excess activated sludge from the secondary settling tank; digested sludge from the digester; dewatered sludge for disposal from sludge dewatering; and excess biological sludge from the sidestream biological nitrification zone. ('009 Patent, 5:41-43, 5:54-57, 5:62-6:7, 6:19-22 (filing 58-2 at 9).

In addition to being inaccurate, the defendants' proposed construction would not assist the jury in understanding the meaning of "settled sludge" or "sludge age." It is not necessary to define "settled sludge" in order to understand Claim 18 because paragraph (a) states that the final clarifier "separates purified supernatant from settled sludge" and paragraph (b) states that "at least a portion of the settled sludge from the final clarifier" is returned to the mainstream treatment process (Ex. B at 14:13-18). There is no need to know the composition of the sludge in order to understand this step in the treatment process. The meaning of "sludge age," a disputed term which will be discussed subsequently, likewise can be understood without knowing the composition of the sludge.

For these reasons, the court will not accept the defendants' definition. The plaintiffs' request that the term "sludge" not be construed will be granted.

5. "Sidestream biological nitrification system"

This term appears twice in paragraph (c) of Claim 18. Paragraph (d) uses a similar term, "sidestream nitrification system." The proposals for construing this term do not vary significantly.

The defendants propose: "A system used to create Supplemental Biological Nitrifiers[10] separate from the Mainstream Nitrification Process" (filing 50 at 3). This would be acceptable were it not for the defendants' overly inclusive definition of "Mainstream Nitrification Process." (See the discussion above.)

The plaintiffs' proposed definition of a "sidestream biological nitrification system" is "a system in which nitrification occurs (i.e., ammonia nitrogen, NH_3—N, is converted to nitrite or nitrate, both referred to as NO_x) that is separate from the zone

[10] "The parties agree that "supplemental biological nitrifiers" are "nitrifying bacteria produced outside of the mainstream nitrification process" (filing 50 at 1).

in which nitrification occurs during the mainstream treatment process" (filing 50 at 3). This definition will be adopted by the court because it is consistent with the previously adopted definitions of "mainstream treatment process" and "mainstream nitrification process."

6. "Sidestream"

This stand-alone term appears in paragraph (c) of Claim 18 (which requires "producing supplemental biological nitrifiers in a sidestream"). The court will adopt the plaintiffs' proposed construction, which is that a "sidestream" refers to "[a]ny stream other than the mainstream, auxiliary to treatment of the wastewater stream" (filing 50 at 3), and that the "mainstream" is "the wastewater stream flowing through the wastewater treatment plant" (*id.*). Basically, the "mainstream" is the top line of the particular process and system design illustrated by Figure 2; the other lines shown in Figure 2, including the return activated sludge line **64**,[11] are sidestreams.[12]

7. "Relatively high concentration of ammonia"

Although identified as a disputed term in filing 50, the parties stipulated during the *Markman* hearing that it is not necessary for the court to construe "relatively high

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[11] The defendants' proposed construction would specify that "[a] Return Activated Sludge Line is not a 'sidestream' as defined in this patent" (filing 50 at 3). As previously explained, this is incorrect because the settled sludge that is conveyed by this line is being *returned* to the mainstream.

[12] In the biological nitrification process of the present invention, as illustrated in Figure 1, "influent wastewater is directed along a mainstream **12** through a mainstream biological treatment process **14**" to "produce a treated or purified effluent" ('009 Patent, 4:17-27 (filing 58-2 at 8)), while "a sidestream **15** [is directed] into a sidestream nitrification zone or reactor **13**" ('009 Patent, 4:43-44 (filing 58-2 at 8)) which "produces supplemental nitrifiers that are conveyed or transferred to the mainstream **12**"('009 Patent, 4:38-41 (filing 58-2 at 8)).

concentration of ammonia" as used in paragraph (c) of Claim 18 (describing the stream which is directed into a "sidestream biological nitrification system.").

8. "Sludge age"

Paragraph (e) of Claim 18 requires "m[a]intaining sludge age within the mainstream nitrification process at a value of less than 200% of the critical sludge age of a conventional nitrification process" ('009 Patent, 14:31-34 (filing 58-2 at 13)). The parties agree that the phrase "a value of less than 200%" means "a value of less than twice" (filing 50 at 2), but otherwise they are in disagreement. Five of the disputed terms and phrases which have been identified by the parties are found in this paragraph: (1) "sludge age," (2) "sludge age within the mainstream nitrification process," (3) "maintaining sludge age within the mainstream nitrification process," (4) "critical sludge age of a conventional nitrification process;" and (5) conventional nitrification process."

The defendants propose that the term "sludge age" be defined as "[t]he average amount of time Sludge remains in the system determined by dividing the total active microbial mass in the entire treatment system by the quantity of active microbial mass discharged per day" (filing 50 at 4). The plaintiffs contend it is unnecessary for the court to construe the term "sludge age." They also take issue with the defendants' formula because it calculates the average retention time of active sludge "in the entire system" rather than just "within the mainstream nitrification process" as required by paragraph (e) of Claim 18.

As previously discussed, the '009 Patent expressly states that "[a]ll of the descriptions and specifications herein of the sludge age refers to the so-called oxic sludge age, that is the sludge age necessary for nitrification in the oxic or aerated zones only" ('009 Patent, 12:14-17 (filing 58-2 at 12)). The defendants' proposed definition of "sludge age" does not conform to this specification.

The court agrees with the plaintiffs that it is not necessary to construe "sludge age" outside of the specific context in which it used in paragraph (e) of Claim 18. Providing the jury with a generic definition of "sludge age" would likely cause confusion, especially since paragraph (e) also uses the term "critical sludge age," which is a distinct concept (requiring calculation of a *minimum* solids retention time instead of an *average* time).

9. "Sludge age within the mainstream nitrification process"

The plaintiffs would calculate "sludge age within the mainstream nitrification process" by "dividing the mass of suspended solids in the oxic (aerated) portion of the mainstream reactor tank by the mass of suspended solids discharged from the overall system per day" (filing 50 at 4). The defendants, on the other hand, would calculate this average solids retention time by "dividing the total active microbial mass in the Mainstream Nitrification Process by the quantity of active microbial mass discharged from the Mainstream Nitrification Process per day" (*id*).

The parties' briefs establish that their dispute centers on the meaning of the term "mainstream nitrification process," with the plaintiffs contending that it only includes "the portion of the mainstream treatment process in which mainstream wastewater is nitrified . . . in the aerobic treatment zone(s)" (filing 50 at 2), and the defendants contending that the "mainstream nitrification process" also includes mainstream settling tanks and anaerobic treatment zones, plus the return activated sludge line.[13] The court has already resolved this dispute in the plaintiffs' favor. For this reason, the court also adopts the plaintiffs' proposed construction of "sludge age within the mainstream nitrification process" as meaning "the average amount of time nitrifying bacteria remain in the oxic (aerated) portion of the mainstream reactor tank, determined by dividing the mass of suspended solids in the oxic (aerated) portion of

[13] As discussed previously, the parties dispute whether the return activated sludge line is on the mainstream.

the mainstream reactor tank by the mass of suspended solids discharged from the overall system per day" (filing 50 at4).[14]

10. "Maintaining sludge age within the mainstream nitrification process"

The defendants argue that the term "maintaining" in paragraph (e) of Claim 18 "connotes an average over at least some period of time" (filing 62 at 27), and they propose that the phrase "maintaining sludge age within the mainstream nitrification process" be construed as "[o]perating the Mainstream Nitrification Process so that the thirty-day average age of all Sludge in the Mainstream Nitrification Process is within a predetermined range" (filing 50 at 4). The defendants have failed to provide a rational explanation for their proposal, and, in particular, have failed to justify using a 30-day average in connection with sludge age calculations.[15]

The court finds that "maintaining" is a common word which is used in its ordinary sense in paragraph (e) of Claim 18. Accordingly, the court will not construe the phrase "maintaining sludge age within the mainstream nitrification process."

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[14] The plaintiffs explain "it is essential that the denominator refer to the mass 'discharged from the overall system.' As illustrated by Figure 2 of the '009 patent, excess activated sludge may be discharged from a system after being separated in the secondary settling tank, rather than being directly wasted from the aeration tank. Thus, in the system illustrated by Figure 2, one controls sludge age in the aeration tank by varying the amount of activated sludge returned to the system via the return activated sludge line **64** versus the amount treated as excess activated sludge or waste sludge and directed through line **68** for further treatment and disposal. Accordingly, the definition should not specify that the suspended solids be discharged from a particular component of the mainstream system." (Filing 57 at 53) (record citations and footnote omitted). The defendants do not contest these statements.

[15] The defendants reference the "Barnard '998 Patent," but the measurements described in that patent concerned concentrations of nitrogen and phosphorous in the effluent, not sludge age. (Filing 58-7, Fig. 6 & 14:27-44) Moreover, there was no calculation of a 30-day average.

11. "Critical sludge age of a conventional nitrification process"

The defendants argue that "[t]his term is ambiguous as a matter of law and cannot be defined" (filing 69 at 37). The same argument was made by the defendants, and rejected by the court, in connection with a motion for summary judgment based on an affirmative defense of indefiniteness. *See* the court's Memorandum and Order entered on August 17, 2012 (filing 75).

In filing 50, the defendants proposed that the "critical sludge age of a conventional nitrification process" be construed as "the minimum amount of time, given various temperatures, that Sludge can remain in a Conventional Nitrification Process to achieve sufficient nitrification" (filing 50 at 5). This proposed construction is inaccurate because "critical sludge age" actually measures "the minimum solids retention time at which conventional nitrification ceases" ('009 Patent, 8:34-41 (filing 58-2 at 10)).

As discussed earlier, the specification of the '009 Patent includes an equation for calculating the "critical sludge age of a conventional nitrification process." The jury will be provided the detailed equation along with a simplified explanation that the critical sludge age of a conventional nitrification process for environmental conditions of pH, temperature, and dissolved oxygen is equal to 1 divided by the difference between the maximum daily nitrifier growth rate for conditions and the decay rate. (*See* filing 57 at 61)

12. "Conventional nitrification process"

Finally, the defendants propose that the court separately construe the term "conventional nitrification process" to mean "[a] Mainstream Nitrification Process utilizing Return Activated Sludge, such as the Bardenpho process and the processes disclosed in U.S. Pat. Nos. 3,964,998; 4,056,465; and 4,874,519" (filing 50 at 5). For several reasons, the court will not adopt this proposal.

First, this construction relies on the defendants' proposed construction of the term "mainstream nitrification process," which the court has rejected. Second, the jury's understanding of the term would not be enhanced by mere references to the "Bardenpho process" or to a series of patents. Third, and perhaps most importantly, the jury does not need to identify the components of a "conventional nitrification process" in order to calculate the critical sludge age of the process in accordance with the equation set out above. The only variables in the equation are environmental conditions (*i.e.*, pH, temperature, and dissolved oxygen levels).

The court agrees with the plaintiffs' assessment that it is not necessary to construe the term "conventional nitrification process." If clarification were needed, however, the court would instruct the jury that it is "a suspended growth biological nitrification process that does not utilize supplemental biological nitrifiers produced outside of the mainstream reactor(s) during ongoing operations" (filing 67 at 52).

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IT IS ORDERED that the disputed terms and phrases identified by the parties in filing 50 are construed in accordance with the foregoing memorandum opinion.

November 8, 2012. BY THE COURT:

Richard G. Kopf
Senior United States District Judge

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