UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte
JELTE LANTING and JOHN L. MURPHY III

Appeal 2007-4475
Application 10/161,387
Technology Center 1600

Decided: June 10, 2008

Before TONI R. SCHEINER, DONALD E. ADAMS, and ERIC GRIMES, *Administrative Patent Judges*.

SCHEINER, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 from the rejection of claims 37, 38, and 40-51, all the claims pending in the application. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

STATEMENT OF THE CASE

"Anaerobic biological treatment has traditionally been applied to the digestion of primary and secondary sludge at municipal sewage treatment facilities, but is also applicable to municipal solid waste, agricultural manures and crop residues, or industrial solid wastes and slurries where a significant portion of the solids material is potentially degradable" (Spec. ¶ 3).

The present invention is directed to "a method for digesting a waste stream in an anaerobic solids digestion apparatus" (Spec. ¶ 17) using a "shearing nozzle . . . to impart energy to the digester contents so as to fracture solids particles and expose the maximum reactable surface area" (Spec. ¶ 29). "Shearing of the particles in the waste stream or waste slurry solids, occurs both within the nozzle, as well as in a turbulent mixing zone at the outlet of the nozzle, physically breaking down the solid biodegradable particles . . . into smaller particles, exposing more surface area of the biodegradable solids" (*id.*). The Specification also states:

> Biogas produced in the anaerobic digestion can be recycled in the two-phase [shearing] nozzle and mixed with the mixed liquor. Entrained biogas is dispersed throughout the circulating mixed liquor providing for maximum turbulence in the mixed liquor to ensure optimal contact of the biodegradable organics with the anaerobic bacteria. These factors improve mass transfer rates resulting in significantly improved reaction efficiency

(*id.*).

Claims 37, 38, and 40-51 are pending and on appeal. Claim 37 is representative of the claimed subject matter and reads as follows:

37. A method for digesting a waste stream in an anaerobic solids digestion apparatus, the method comprising:

(a) feeding a waste stream comprising anaerobically biodegradable solids to a digester;

(b) reacting the anaerobically biodegradable solids in the waste stream with anaerobic bacteria in the digester to reduce an amount of the biodegradable solids, thereby producing a mixed liquor and a biogas, wherein the biogas is the product of anaerobic digestion;

(c) introducing at least a portion of the mixed liquor to the digester through a shearing device; and

(d) mixing the mixed liquor within the digester;

wherein the shearing device in step (c) comprises a nozzle having a nozzle gas inlet and the method further comprises removing a portion of the biogas from the digester and introducing the portion of the biogas into the nozzle gas inlet.

Claims 37, 38, and 40-51 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Hess,[1] Clark,[2] Long, Jr.,[3] Menges,[4] Tomita,[5] and Srinivasan.[6]

FINDINGS OF FACT (FF)

1. The Examiner finds that "[a]nimal waste contains many types of anaerobic and aerobic microorganisms, and sewage may be digested either way" (Ans. 9), i.e., anaerobically or aerobically.

2. The Examiner also finds that "increasing the contact between the bacteria and the sewage particles accelerates the degradation of the

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[1] Application DE 24 00 416 of Hess, published July 24, 1975; reference is to the English translation of the original German document.
[2] U.S. Patent 5,409,610 to Clark, issued April 25, 1995.
[3] U.S. Patent 4,659,464 to Long, Jr., issued April 21, 1987.
[4] EP 0 130 499 to Menges, published January 9, 1985; reference is to the English abstract of the original German document.
[5] U.S. Patent 5,360,546 to Tomita, issued November 1, 1994.
[6] U.S. Patent 4,885,094 to Srinivasan, issued December 5, 1989.

particles," "[w]hether the sewage digestion is anaerobic or aerobic" (Ans. 13-14).

Clark

3. "Anaerobic digestion involves a complex microbiological community in which various groups of organisms . . . work together in a symbiotic relationship" (Clark, col. 1, ll. 21-25). "The end products of one group of anaerobic bacteria become food for the next group in the overall sequence . . . all the way to the final steps that produce stable end products and gas, largely methane" (Clark, col. 1, ll. 39-43). "[T]he food supply should be available on a steady state basis. This requires that the mass be mixed on a steady state basis" (Clark, col. 1, ll. 26-28).

4. "Mixing is more than moving masses of material around relative to the containment vessel . . . Mixing must provide differential displacement of masses relative to each other. As the displaced units of mass become smaller, mixing becomes more effective. Ideal process kinetics and rates of reaction can only be approached when the food for each bacterium is evenly distributed throughout the digesting mass" (Clark, col. 1, ll. 29-37). In other words, the digestion process becomes more efficient as the solids become more finely divided, and the digestion mass becomes more homogeneous.

5. Clark describes a method and apparatus for anaerobic digestion of sewage sludge which is designed to avoid problems associated with systems in which "naturally occurring digester gas" (Clark, col. 1, ll. 55-56), i.e., biogas, produced by anaerobic digestion, is "compressed mechanically and injected into the bottom zone of the digester with bottom supported diffusers or roof supported gas diffuser lances" (Clark, col. 1, ll. 56-59).

6. According to Clark, "mixing devices, such as the compressed gas energized gas lift tube and the propeller pump-activated draft tube, do not create maximum conditions for mixing. Such mixing devices provide mass movement that is more akin to plug flow with a nominal amount of actual micro-mass displacement created in the immediate area of gas injection or propeller motion" (Clark, col. 14, ll. 28-34). In addition, "gas mixing systems encourage foam and lighter than water materials to accumulate at the surface. As the surface foam layer increases it begins to develop some strength because of drying caused by the migrating gas . . . [and] reduce[s] the active volume of the digester . . . contribut[ing] to the eventual overload and failure of the process" (Clark, col. 2, ll. 14-21).

7. Clark's system, on the other hand, involves

> feeding a pressurized stream of liquid sludge through a first conduit to the inlet side of an upwardly directed [single-phase] jet pump nozzle operatively positioned and in communication with a vertical venturi tube having a lower inlet means and forming part of the draft tube lower end . . . thereby creating a suction at the venturi tube inlet means and producing a pumping action which causes a stream of liquid sludge in the vessel bottom space to flow into and upwardly in and out of the draft tube upper end and to thoroughly admix and disperse with the pressurized sludge stream supplied to the jet nozzle and also causing downward circulating flow of liquid sludge in the vessel.

(Clark, col. 3, ll. 14-27). Thus, "the combined liquids are thoroughly mixed to provide a homogeneous liquid sludge mass in the digester vessel" (Clark, col. 3, ll. 34-36).

8. "The use of jet pumps provides a . . . means for substantially improving the digester mass mixing by causing liquid *shearing* and other

physical phenomena that allow micro-volumes of digester mass to shift positions relative to each other . . . ensur[ing] that the food, raw sludge and any of the intermediate bacteria-produced food products of the various species of anaerobic bacteria, becomes available to the maximum number of bacteria that use it as food" (Clark, col. 14, ll. 19-27 (emphasis added)).

9. Gases from anaerobic digestion in Clark's system are not recycled, rather, they are vented through "[t]he upper portion of conduit **208** [which] projects through the gas-collecting top cylindrical shell **62** [of the digester] and has its upper end **212** open to the atmosphere" (Clark, col. 11, ll. 13-15).

Hess

10. Hess describes a method for aerobically digesting solids in a waste water/activated sludge mixture, with "the object of increasing the contact intensity between the 3 reaction partners (contaminants, oxygen and activated sludge [i.e., sludge containing live microorganisms]) by increasing the boundary surfaces" (Hess 3), thereby increasing the efficiency of digestion.

11. This object is achieved, in large part, by building up high shear rates in the waste water/activated sludge mixture, which both crushes the activated sludge mechanically (increasing its surface area and its contact with the microorganisms in the activated sludge), and promotes transfer of oxygen into the activated sludge (Hess 4).

12. The high shear fields responsible for "crushing of the activated sludge . . . are built up by the aeration assembly and/or in parts of the aeration system" (Hess 4). The aeration system is made up of a dual-phase jet nozzle "consist[ing] of a liquid nozzle **1** and a concentric ring nozzle **2** for the gas" and "a pulse exchanger pipe **3**" (Hess 4-5). "The air introduced into this

shear field at the nozzle mouth **4** is finely distributed with the activated sledge **5a** suctioned out . . . according to the laws of an open jet and is mixed intensively with high energy density in the pulse exchanger pipe **3** arranged after it" (Hess 5).

13. Activated sludge and a measured portion of the exhaust gases are recycled through the aeration system (Hess 3, 6).

Long, Jr.

14. Long, Jr. describes "an apparatus for use in a sewage treatment system comprising means for enhancing the surface area of the sludge to be treated and the time of interaction of finely divided sludge particles with [an] oxygen-rich atmosphere" (Long, Jr., col. 2, l. 65 to col. 3, l. 1). The means for enhancing the surface area of the sludge comprises

> a recycling means for recycling the gas from the upper portion of the vessel through a pumping means to pressurize the gas and into . . . [a] dispersing means comprising a plurality of gas dispersing nozzle assemblies, each nozzle assembly directing a stream of the pressurized gas toward . . . sludge being channeled from . . . [a] sludge dispersing means, divid[ing] the sludge into fine particles and dispers[ing] the sludge particles within the upper portion of the vessel to become oxygenated as they interact with oxygen in the upper portion of the vessel . . .

(Long, Jr., col. 3, ll. 22-37).

Menges

15. Menges describes an aerobic waste water treatment reactor vessel in which an oxygen containing gas and activated sludge-containing waste water are pumped through a shearing device (a dual-phase jet nozzle **6** similar to Hess's nozzle), and the resultant mixture, containing more finely divided particles, flows through a gas flow tube in a downward direction. The

mixture is recirculated to the top of the vessel, where volatile compounds (gases) are removed from the reactor.

Srinivasan

16. "Various methods are known for the processing and clean up of organic wastes, solids, semi-solids and liquids, to produce non-hazardous products for release to the environment . . . known techniques of fermentation . . . include[ ] both aerobic and anaerobic digestion processes, and processes which employ steps encompassing both aerobic and anaerobic digestion" (Srinivasan, col. 1, ll. 16-23).

17. Anaerobic digestion of sludge occurs at a pH of about 6.5 to about 8, and a temperature of about 30°-50° C (Srinivasan, col. 3, ll. 23-31).

Tomita

18. Tomita teaches that anaerobic digestion of sludge occurs at an alkaline pH of 7.3-9.3 and a temperature of 20°-60° C (Tomita, col. 5, ll. 64-66).

DISCUSSION

The Examiner rejected claims 37, 38, and 40-51 under 35 U.S.C. § 103(a) as unpatentable over Hess, Clark, Long, Jr., Menges, Tomita, and Srinivasan.

The Examiner reasoned that "increasing the contact between the bacteria and the sewage particles accelerates the degradation of the particles," "[w]hether the sewage digestion is anaerobic or aerobic" (Ans. 13-14). "[I]n all of the prior art methods, . . . pressurized gas is used to break up solid particles in the sewage to increase the surface area so that they can be digested more quickly" (Ans. 10), regardless of whether a "chemical reaction between the gas and the solids occurs" (Ans. 4).

The Examiner concluded that:

> One of ordinary skill in the art . . . would have been motivated to use the nozzle design of [Hess] or Menges in the digester of Clark for treating solids in an anaerobic waste digestion apparatus, because [Hess] and Menges disclose that when the two streams emerging from the nozzle are mixed, the gas stream and the waste stream, the solids are dispersed by the shear forces from the gas, which increases the surface area of the solid pieces, which, in turn, improves contact between the solid material to be digested and the digesting microorganisms, thereby accelerating the digestion process.

(Ans. 6-7).

Appellants contend that Clark, "the only reference . . . based on an anaerobic system" (App. Br. 10), "teaches away from gas-induced mixing using instead enhanced mixing through single-phase Venturi valves" (App. Br. 11), and that the waste digestion systems described by Hess, Long Jr., and Menges are aerobic, and therefore, "non-analogous" to the claimed anaerobic waste digestion system (App. Br. 7). In addition, Appellants contend that the use of a dual-phase jet provides an unexpected improvement in an anaerobic digestion system.

"Section 103 forbids issuance of a patent when 'the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.'" *KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1734 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences

between the claimed invention and the prior art; and (4) secondary considerations of nonobviousness, if any. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). "Often, it will be necessary . . . to look to interrelated teachings of multiple [references]; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed" (*KSR*, 127 S.Ct. at 1740-41), taking into account "the inferences and creative steps that a person of ordinary skill in the art would employ" (*id.* at 1741). To paraphrase *KSR*, if a technique has been used to improve one process, and a person of ordinary skill in the art would recognize that it would improve similar processes in the same way, using the technique is obvious unless its actual application is beyond his or her skill (*id.* at 1740).

The principal issue raised by this appeal, then, is whether incorporating a dual-phase (liquid and gas) shearing nozzle, conventionally used in aerobic digestion processes, into an anaerobic digestion process, would have been obvious at the time of the invention, given the scope and content of the prior art, the level of ordinary skill in the art, and the differences between the claimed invention and the prior art.

We conclude that the Examiner has properly applied the *Graham* factors, and the cited references provide a reason to combine their teachings, given the recognition in the art that mechanically increasing the surface area of sludge, and mixing the waste water/sludge mixture more thoroughly improves the efficiency of digestion, regardless of whether the process is anaerobic or aerobic (FF 2, 4, 8, 10, 14, 15), and that an effective way to

increase the surface area of the sludge, and to improve mixing, is to build up high shear rates in the waste water/activated sludge mixture, using a dual-phase jet nozzle to bombard a sludge stream with pressurized gas (FF 11, 12, 14, 15). We are not persuaded otherwise by Appellants' arguments.

Specifically, Appellants argue that Clark, "the only reference . . . based on an anaerobic system" (App. Br. 10), "does not teach recycling biogas from anaerobic respiration, and teaches away from gas-induced mixing using instead enhanced mixing through single-phase Venturi valves" (App. Br. 11).

A reference is said to "teach away" from a claimed invention when it "suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant" (*In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994)). That is not the case here. Clark discloses that the advantage of his method over the various prior art pressurized gas-injection methods is the shearing action provided by feeding a pressurized, high-velocity stream of liquid sludge into the reactor contents through a single-phase jet pump nozzle (FF 11, 12) which mechanically breaks up the sludge and increases its surface area (FF 10, 11). Appellants have not identified anything in Clark that would suggest that using a dual-phase (gas and liquid) shearing jet nozzle like the ones used by Hess, Long, Jr., and Menges, in an anaerobic system is unlikely to improve mechanical breakdown and mixing of sludge particles.

In addition, Appellants contend that the waste digestion systems described by Hess, Long Jr., and Menges are aerobic, and, therefore, "non-analogous" to the claimed anaerobic waste digestion system (App. Br. 7). Appellants argue that aerobic "bacteria require oxygen as food and the gas

being injected for enhanced mixing [in aerobic systems] is oxygen to increase exposure of the bacteria to oxygen" (App. Br. 8), and "one would not be motivated to look to an aerobic system and consider using a biogas formed from *anaerobic* digestion (i.e., methane, carbon dioxide, hydrogen sulfide and the like) and injecting such waste gases from processing back into the process. Such gases are waste products in aerobic digestion and are removed from the process while oxygen is pumped [in to] enhance aerobic respiration" (App. Br. 9).

This argument is not persuasive. As stated in *In re Clay*, 966 F.2d 656, 658-59 (Fed. Cir. 1992), the two criteria for evaluating whether a reference is sufficiently analogous to the invention are "(1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved." Here, all of the references are directed to the same field of endeavor: sewage digestion, whether aerobic (FF 10, 14, 15) or anaerobic (FF 3). Srinivasan even teaches that some sewage digestion processes combine both aerobic and anaerobic steps (FF 16). Moreover, all of the references are concerned with the same objectives: mechanically increasing the surface area of the sludge to increase its exposure to the microorganisms in the reactor, and promoting homogeneous mixing (FF 4, 7, 8, 10, 11). The fact that oxygenation is also an objective in the aerobic methods does nothing to detract from this. Therefore, we do not agree with Appellants that one of skill in the art of sewage digestion would not look to both aerobic and anaerobic methods for technical guidance.

Moreover, we note that Hess and Long, Jr., in addition to aerating the sludge by providing oxygen required by aerobic organisms for aerobic respiration, also recycle some of the waste gas produced during aerobic respiration in order to build up shear fields in the aerobic reactors to mechanically increase the surface area of the sludge (FF 13, 14). In any case, one skilled in the art of sewage digestion would have recognized that aerobic bacteria require oxygen for respiration, but anaerobic bacteria do not, and would not have fed oxygen into an anaerobic reaction.

Finally, Appellants argue that "[n]either [Hess], Menges nor Long suggests that the use of biogas from anaerobic digestion when used for shearing would provide unexpectedly increased activity in an anaerobic digestion system such as Clark" (App. Br. 13). Appellants argue that "[t]he biogas recycle[d] from the claimed invention was intended for use in mixing to enhance shear in order to improve energy efficiency" and "Appellants unexpectedly found that there was an increase in activity due to the increase in shear in an anaerobic digester as claimed and that this increase led to an increase in anaerobic reaction rate" (App. Br. 13).

However, Appellants have not pointed to anything in the Specification (or elsewhere) that characterizes the level of anaerobic activity obtained from the claimed invention as unexpected or surprising. In any case,

> [i]n order for a showing of "unexpected results" to be probative evidence of non-obviousness, it falls upon the applicant to at least establish: (1) that there actually is a difference between the results obtained through the claimed invention and those of the prior art; and (2) that the difference actually obtained would not have been expected by one skilled in the art at the time of the invention.

In re Freeman, 474 F.2d 1318, 1324 (CCPA 1973).

Here, even if we assume for the sake of argument that the examples in the Specification establish that there is a difference between the results obtained from the claimed invention and the results obtained in the prior art, Appellants have not established that the difference would have been unexpected to one of skill in the art at the time of the invention, especially given the recognition in the art that increasing the surface area of sludge increases its exposure to microorganisms in the reactor, enhancing digestion (FF 2, 4, 10). Accordingly, we find that Appellants have not established that the claimed invention produces unexpected results.

We find no error in the Examiner's conclusion that the claimed invention would have been obvious over the prior art relied on.

SUMMARY

The rejection of claims 37, 38, and 40-51 under 35 U.S.C. § 103(a) as unpatentable over Hess, Clark, Long, Jr., Menges, Tomita, and Srinivasan is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1)(iv)(2006).

AFFIRMED

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