Internal distribution code:
(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 21 January 2015

Case Number: T 1088/12 - 3.3.05

Application Number: 05254781.7

Publication Number: 1734011

IPC: C02F3/12, C02F1/56, B01D61/04, B01D61/16

Language of the proceedings: EN

Title of invention:
A method for improving flux in a membrane bioreactor

Applicant:
Nalco Company

Headword:
Bioreactor/NALCO COMPANY

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - (yes) - unexpected improvement shown

Decisions cited:

Catchword:

European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 1088/12 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 21 January 2015

Appellant: (Applicant)
Nalco Company
1601 W. Diehl Road
Naperville, IL 60563-1198 (US)

Representative:
Chalk, Anthony John
HGF Limited
Saviour House
9 St Saviourgate
York YO1 8NQ (GB)

Decision under appeal:
Decision of the Examining Division of the European Patent Office posted on 9 December 2011 refusing European patent application No. 05254781.7 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman G. Raths
Members: H. Engl
C. Vallet

Summary of Facts and Submissions

I. European patent application EP 05254781.7 is concerned with a method of improving flux in a membrane bioreactor.

II. The documents cited in the examination procedure were the following:

D1: US-A-2003/0159990
D2: US-A-5 114 576
D3: JP-A-62 221 494
D4: US-A-2005/0109694

III. The following document was filed with a first appeal against the decision of the examining division dated 27 January 2011 to refuse the application.

Annex A1: Annex to appellant's letter dated 27 May 2011.

IV. The Examing Division informed the applicant on 16 June 2011 that the (first) appeal was well founded and granted interlocutory revision pursuant to Article 109(1) EPC. Examination was resumed resulting in the decision posted on 9 December 2011 to refuse the application on grounds of lack of inventive step having regard to documents D1 and D4.

V. The present, second, appeal is directed against the decision posted on 9 December 2011. The applicant's (henceforth: appellant's) notice of appeal was received by letter dated 08 February 2012. The statement of grounds of appeal, dated 13 April 2012, was accompanied by a

Technical Report (4 pages, 6 Figures).

VI. Claim 1 of the appellant's main request (filed with letter dated 28 October 2011) is worded as follows:

"1. A method for improving flux in a membrane bioreactor system comprising at least one anoxic reactor followed by at least one aeration tank, wherein the aeration tank contains a submerged membrane, comprising adding one or more cationic polymers to said anoxic reactor to prevent inorganic scaling or fouling, wherein said membrane bioreactor system has mixed suspended solids of 3,000 to 30,000 mg/L, wherein said cationic polymer has a molecular weight greater than 50,000 Da and a mole charge of greater than 10%."

Dependent claims 2 to 4 represent particular embodiments of the method of claim 1.

VII. The appellant argued in writing essentially as follows:

D1 represented the closest prior art. To demonstrate the effect associated with the claimed introduction of a cationic high MW polymer in the anoxic tank of a membrane bioractor (MBR), a "Technical Report" had been prepared and submitted. Figure 6 of said report showed the substantial improvements in terms of reactor flux obtained throughout the filtration cycle. To achieve such an improvement was non-obvious in view of documents D1 and D4.

VIII. Requests

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main request filed with letter dated 28 October 2011.

Reasons for the Decision

1. Amendments

Claim 1 is based on claim 1 as originally filed in combination with the disclosure of Figure 2 and the paragraph of the description on page 10 pertaining to Example 2 and said Figure 2.

The value of mixed liquor suspended solids (MLSS) of 3,000 to 30,0000 mg/L was originally disclosed in the paragraphs pertaining to Examples 1 and 4. However, as already noted by the examining division in the contested decision (reasons point 3.1), the skilled person would understand that the same range of MLSS applies throughout Examples 1 to 4.

Claims 2 to 4 are based on original claims 2, 8 and 9, respectively.

The claims thus meet the requirements of Article 123(2) EPC.

2. Novelty

The subject-matter of claim 1 is novel because none of the available documents discloses a method of operating a bioreactor system as claimed, wherein a cationic polymer having a molecular weight greater than 50,000 Da and a mole charge of greater than 10% is added to the anoxic reactor.

More speficically, D1 and D4 do not disclose membrane bioreactor systems comprising anoxic reactors.

D2 and D3 do not disclose adding the specific cationic high MW polmyers to a MBR.

The requirements of Article 54 EPC are thus met.

3. Inventive step

3.1 The claimed invention is concerned with a method for improving flux in a mebrane bioreactor (MBR) which comprises an anoxic reactor followed by an aeration tank containing a submerged membrane. More precisely, the invention aims at providing a process for preventing inorganic scaling and fouling occurring in these types of MBRs (see description, page 3, line 19 to page 4, line 2).

3.2 Closest prior art

Document D1 is considered to represent the closest prior art. The membrane bioreactor of D1 includes an aeration tank, but not an anoxic reactor as part of the MBR system (see Figure 1; description, paragraphs [0085] to [0089]). Water-soluble polymers are added to condition the liquors in the membrane biological reactor, in order to reduce fouling and improving the flux through the submerged membrane (see paragraphs [0002], [0011]). Therefore, D1 deals with a similar problem as the present application.

According to D1, the molecular weight of the cationic, anionic, or zwitterionic polymers ranges from 2,000 to 10,000,000 daltons (Da), those of the amphoteric polymers from 5,000 to 2,000,000; those of the cationic polymers preferably from 2,000 to 500,000 Da (see claims 2 and 10; paragraphs [0072], [0077] and [0080]). In the case of a cationic polymer, polymers having a charge of at least 5 mole percent (claim 5), preferably 100 mole% (claim 9, [0074] and [0079]) are used.

3.3 Problem

According to the application in suit the problem was to provide a more effective and economic method which allows better performance and lower dosage of added polymers and which avoids scaling and inorganic fouling due to critical concentrations of salts of inorganic oxides (see paragraphs [0013] to [0016]).

The board has to consider whether this problem is actually solved in the light of document D1.

3.4 Solution

As a solution to the above-defined problem, the application proposes a method according to claim 1, characterized in that one or more cationic polymer is added to the anoxic reactor of a MBR system to prevent inorganic scaling or fouling, said cationic polymer having a molecular weight greater than 50,000 Da and a mole charge of greater than 10%.

3.5 Success of the solution

3.5.1 To assess the effectiveness of the proposed solution, additional experimental evidence was taken into account by the board, namely:

<u>Annex A1</u> and the "<u>Technical Report".</u>

3.5.2 Annex A1 demonstrates the results of using polymers with anoxic reactor MBR systems and the effectiveness of a high MW (molecular weight) cationic polymer, falling within the scope of claim 1, compared to low MW cationic polymers. To this end, experiments were performed in two different MBR plants with identical design parameters. The MBR plants included an anoxic reactor and an aerobic reactor having a membrane separator. The high MW cationic polymer had a molecular weight greater than the low MW cationic polymer by a factor of at least 2.

Conditions for the MBR plants:

Flux	= 17 L/m^2/hr average
Flow rate	= 250 m^3/day
Membrane area	= 600 m (flat sheet membrane from Yuasa Corp. of Japan)
Reactor volume	= 56 m^3 (anoxic) + 97 m^3 (aerobic)
MLSS	= 15,000 mg/L
High MW polymer dosage	= 260 mg/L
Low MW polymer dosage	= 350 mg/L

As seen in Figure 1 of Annex Al, high MW cationic polymers, falling within the scope of claim 1, were more effective at a lower dosage than low MW cationic polymers in preventing the trans-membrane pressure (TMP) rise, which is an indicator of membrane fouling.

3.5.3 In the experimental setup of the "Technical Report" filed with letter dated 13 April 2012, an activated sludge system consisting of an aeration and an anoxic tank as shown in Figure 2 was employed. Membranes were installed at the bottom of the bioreactor tanks. The effects of low MW cationic polymer (20,000 Da) and high MW cationic polymer (160,000 Da) added at a rate of

150 mg/L on sludge condition and reactor flux were investigated.

In all cases, the addition of cationic polymers improved the membrane performance measured by flux, with substantial differences in flux improvement existing depending on the polymer’s MW. As shown in Figure 6 of the report, a low MW cationic polymer improved flux only marginally except in the very initial period. In contrast, the sludge treated with a high MW cationic polymer showed much higher flux throughout the filtration cycle.

3.5.4 As to the question whether the effect was to be expected, the appellant argued that it would not have been obvious to add the polymeric coagulants of Dl to anoxic reactors because the biomass in an aerobic reactor was different from the biomass in anoxic reactors. The skilled person would thus have had no expectation that the polymeric coagulants used by D1 in aerobic reactors would have the same effect in an anoxic reactor or an anaerobic reactor. Even though Dl taught addition of a cationic, anionic or zwitterionic polymers (without discriminating between these types of polymers) to an aerobic reactor to improve flux and reduce fouling, the different biomass used in anoxic or anaerobic reactors would not necessarily behave or interact with added polymer coagulants the same way as taught in Dl.

The board considers that the beneficial effects of the addition of certain cationic polymer coagulants to anaerobic and anoxic reactors have been sufficiently established.

The claimed method improves flux and reduces fouling beyond what could be expected from D1 or D4, as shown in Examples 3 and 4 of the application and in the experimental evidence discussed.

3.5.5 The appellant also argued, in the board's view convincingly, that in the case of aerobic MBRs biopolymers reacted with cationic polymers and the resultant particles had considerably lower membrane fouling. If however, anoxic and anaerobic tanks were included in the MBR system, the biopolymer content would be higher than that in MBRs having only aeration tanks (see page 3, lines 10 to 17 of the application).

Therefore, the prior art method of preventing membrane fouling caused by biopolymers of using cationic polymers in contact with mixed liquor would be less effective in terms of flux improvement. Before this background, the results obtained by the instant invention must be considered surprising.

3.5.6 Based on these results, it can be said that the claimed method provides an improvement both in terms of reactor flux and reduced membrane fouling. For the board, there is no need to reformulate the problem in the light of document D1. The problem posed is considered to be solved.

3.6 Obviousness

It remains to be discussed whether the claimed solution is obvious having regard to the prior art.

D1 does not teach the addition of the specific high MW cationic polymers to MBR systems comprising an anoxic reactor.

D4 discloses a process for treating industrial or municipal wastewater by passing through an aerobic bioreactor and an anaerobic bioreactor, followed by a membrane separation reactor. D4 does not disclose a membrane bioreactor system having an anoxic reactor. According to D4, wastewater containing organic compounds may be purified in a denitrification procedure prior to feeding it into an anaerobic bioreactor. However, D4 does not disclose anoxic reactors for said denitrification procedure. More significantly, D4 does not teach the use of polymers to prevent membrane fouling.

D2 discloses a method of purifying a body of contaminated water by removing, treating and recirculating a first and a second side stream thereof; ozonation means are provided in the first side-stream to kill substantially all organisms; and wherein chemical filtration units comprising nano-flitration membranes are provided in said streams. The filtration capability of said chemical filtration units may be maintained by adding a polymer flocculant selected from among high MW anionic, cationic and non-ionic polyelectrolytes (see column 1, lines 29 to 34; column 2, lines 58 to column 3, line 4; column 3, lines 27 to 52; Figure 1). D2 is thus not concerned with a MBR and with the technical problem of improving the flux and reducing the fouling in such reactors. Therefore, D2 would not provide any guidance for the skilled person in solving the problem underlying the present application.

D3 discloses an apparatus and process for removal of BOD, COD and nitrogen from water. A Mg compound such as MgO and a cationic polymer flocculant are added to excessive sludge coming from a biological treatment plant in a separate mixing tank. The sludge is separated by a screen and dehydrated by a screw press. Thus, in the process of D3, the flocculant serves an entirely different purpose than in the present application.

Said documents D2 and D3, whether taken individually or in combination with D1, cannot therefore render the claimed subject-matter obvious.

3.7 The requirements of Article 56 EPC are thus met for all pending claims.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of claims 1 to 4 of the main request, filed with letter dated 28 October 2011, and a description and drawings to be adapted.

The Registrar: The Chairman:

C. Vodz G. Raths

Decision electronically authenticated