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Datasheet for the decision of 21 June 2023

Case Number: T 1148/21 - 3.3.05

Application Number: 14769473.1

Publication Number: 2969978

IPC: C02F3/00, C02F3/30, C02F3/28

Language of the proceedings: EN

Title of invention:
METHOD AND APPARATUS FOR MAXIMIZING NITROGEN REMOVAL FROM WASTEWATER

Applicant:
D.C. Water & Sewer Authority
Hampton Roads Sanitation District

Headword:
Nitrogen removal/D.C. Water

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (no) - auxiliary request (no) - improvement not credible - obvious modification

Decisions cited:

Catchword:

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Case Number: T 1148/21 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 21 June 2023

Appellant: (Applicant 1)	D.C. Water & Sewer Authority 5000 Overlook Avenue SW Washington, DC 20032 (US)
Appellant: (Applicant 2)	Hampton Roads Sanitation District 1434 Air Rail Avenue P.O. Box 5911 Virginia Beach, VA 23471-0911 (US)
Representative:	Potter Clarkson Chapel Quarter Mount Street Nottingham NG1 6HQ (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 23 February 2021 refusing European patent application No. 14769473.1 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair	E. Bendl
Members:	T. Burkhardt
	P. Guntz

Summary of Facts and Submissions

I. The appeal is against the examining division's decision to refuse European patent application No. 14 769 473.1.

II. The following documents were among those discussed at the examination stage:

D1 CA 2 780 017 A1
(published as WO 2011/061084 A1)
D2 US 2010/0303695 A1

III. The examining division concluded, *inter alia*, that none of the requests then on file met the requirements of Article 56 EPC when taking D1 as the closest state of the art, in particular because of the absence of evidence for a surprising technical effect.

IV. The main request and the first and second auxiliary requests considered in the decision under appeal were maintained in the appeal procedure. In addition, auxiliary requests 3 to 5 were submitted.

V. The independent claim of the main and first auxiliary requests reads as follows:

"*1. A method of removing nitrogen from wastewater in a reactor comprising:*

a) oxidising a fraction of an influent ammonia load to produce nitrite and nitrate, wherein the oxidation is conducted by providing an amount of aeration that is sufficient to oxidise only a fraction of the influent ammonia for which there is a sufficient amount of

chemical oxygen demand (COD) in the reactor that will subsequently reduce the oxidised nitrogen species;

b) measuring a concentration of ammonia and a concentration of oxidised nitrogen in the reactor, wherein the concentration of oxidised nitrogen corresponds to a sum of a concentration of nitrite and a concentration of nitrate in the reactor in real time; and

c) performing a control operation in dependence on a ratio of the [concentration of ammonia] to the [sum of the concentrations of nitrite and nitrate],

wherein the control operation includes controlling a concentration of dissolved oxygen (DO) supplied to a reactor (10), based on a ratio of the [concentration of ammonia] to a [sum of the concentrations of nitrite and nitrate], and/or controlling a frequency at which aeration occurs in a reactor (10), and

wherein the control operation comprises increasing the concentration of dissolved oxygen and/or the frequency at which aeration occurs in and [sic] *reactor if the ratio of the [concentration of ammonia] to [the sum of the concentrations of nitrite and nitrate] is greater than 1 or decreasing the concentration of dissolved oxygen and/or the frequency at which aeration occurs in the reactor if the ratio of the [concentration of ammonia] to [the sum of the concentrations of nitrite and nitrate] is less than 1.*"

VI. In claim 1 of the second auxiliary request, the alternative that relates to the aeration frequency in the control algorithm has been omitted. As a result, the following features have been deleted:

- "*, and/or controlling a frequency at which aeration occurs in a reactor (10)*"
- "*and/or the frequency at which aeration occurs in and reactor*"

- "*and/or the frequency at which aeration occurs in the reactor*"

VII. Compared to the main request, the following feature has been inserted at the end of claim 1 of the third and fourth auxiliary request:

"*, to thereby achieve a ratio of [concentration of ammonia] to [sum of the concentrations of nitrite and nitrate] which is about 1*"

VIII. Claim 1 of the fifth auxiliary request combines the amendments of claim 1 of the second and third auxiliary requests.

IX. The appellants' arguments at the appeal stage relevant to the present decision can be summarised as follows.

All the requests met the requirements of Article 56 EPC.

Even in the absence of evidence for a surprising and unexpected effect, the control algorithm as defined in claim 1 of all requests was a non-obvious alternative to the process of D1.

The control of the ratio [concentration of ammonia] to the [sum of the concentrations of nitrite and nitrate] to a value of 1 guaranteed a balance of the concentrations of nitrate and nitrite and avoided a run-off of the concentration of nitrate.

X. The appellants requested that the decision be set aside and a patent be granted on the basis of the main request.

Alternatively, they requested that a patent be granted on the basis of one of five auxiliary requests. All these requests were filed with the statement setting out the grounds of appeal.

Reasons for the Decision

Main request

The main request is identical to the main request underlying the decision under appeal.

1. Inventive step

1.1 The invention relates to a method for removing nitrogen from wastewater.

1.2 The appellants agreed that **D1** was the closest prior art.

Figure 5 relates to an exemplary "nitrate-shunt" method (see also pages 26 to 28). The curves show that the concentrations of ammonia, nitrite and nitrate in the reactor are measured in real time. A fraction of the influent ammonia is oxidised into NO_2^- and NO_3^-.

The control algorithm comprises different sub-cycles which are stopped at different thresholds relating to the sum of the concentrations of ammonia and nitrite ("first threshold S1") or to the concentration of nitrite alone ("second/third/fourth thresholds S2/S3/S4") (page 27, lines 3 to 24).

Aeration (and thus oxidation of ammonia) occurs during the "aerated phase (1)" and the "aerated phase (2)" of each sub-cycle ("ss-cycle 1" to "ss-cycle 4" in Figure 5).

At the end of the "anoxic phase (4)", the concentrations of NO_2^- and NO_3^- attain values close to zero. There is thus a "sufficient amount of chemical oxygen demand (COD)". This has not been contested.

1.3 According to the application, the problem to be solved is to provide a method that maximises nitrogen removal while denitrification and ammonia oxidation balance each other and aeration and organic carbon requirements are minimised (paragraphs [0009] and [0024]).

1.4 Claim 1 proposes solving this problem by the method of claim 1 characterised in the control operation according to which:

- the concentration of dissolved oxygen is *increased* if the ratio of the [concentration of ammonia] to the [sum of the concentrations of nitrite and nitrate] is *greater* than 1
- the concentration of dissolved oxygen is *decreased* if the ratio of the [concentration of ammonia] to the [sum of the concentrations of nitrite and nitrate] ("the ratio") is *less* than 1

In D1, by contrast, the "dissolved oxygen concentration during the aerated phases is low (0.5 mg O_2/l)" and thus constant (page 26, lines 16 to 17).

1.5 There is, however, no evidence on file that the problem posed has been solved successfully.

No convincing reasons have been indicated why especially controlling the ratio to 1 by adjusting the dissolved oxygen concentration favours the formation of nitrite over nitrate. To the contrary, it becomes clear from the reaction mechanism (e.g. in Figures 1 and 2 of the application) that first ammonia is oxidised into nitrite, which in turn is oxidised into (undesired) nitrate. It is hence plausible that limiting the concentration of oxygen (as done in **D1**) limits the oxidation into nitrate.

In the appellants' view, the method of claim 1 also avoided the risk that the concentration of NO_3^- ran out of control. By contrast, D1 only focused on the amount of NO_2^- and could not avoid that the NO_3^- concentration ran out of control.

However, firstly, Figure 5 of D1 shows that the NO_3^- concentration is always significantly lower than the NO_2^- concentration and that the former does not run out of control. This is perfectly in line with the consecutive oxidation of ammonia into nitrite and then of nitrite into nitrate.

Secondly, given this consecutive oxidation, it is considered disadvantageous to "lump" NO_2^- and NO_3^- together as a sum in the ratio of claim 1. This does not allow determining whether the balance between the two types of nitrogen oxides has already disadvantageously shifted towards nitrate.

In the end, there is no comparison between the nitritation-denitritation process (or "nitrate-shunt" process) of Figure 5 of D1 and the process according to claim 1 of the application that shows a surprising effect. This has not been disputed.

Therefore, it can even not be excluded that the performance of the process of claim 1 is worse than that of Figure 5 of D1.

1.6 For these reasons, the problem to be solved has to be reformulated. The board concurs with the examining division that the objective problem to be solved is to provide, at best, an alternative method for removing nitrogen from wastewater.

1.7 However, the use of a ratio involving ammonia and nitrogen oxide as a control variable in processes for removing ammonia from wastewater as such is known from D1 (e.g. claim 15). While D1's ratio only involves NO_2^-, and not NO_3^-, the concentration of the latter in Figure 5 of D1 is negligible compared to that of NO_2^-. D1's ratio and the ratio of claim 1 of the main request are therefore very close.

It is also known to adjust the concentration of dissolved oxygen in processes for removing ammonia from wastewater (see, for example, paragraphs [0107] and [0108] as well as claim 4 of **D2**).

Even if the intention of the ratio of 1 was to improve the starting position for a subsequent deammonification process using anammox bacteria, this would be obvious. The skilled person knows that the ratio of 1 in this case would be in line with the equimolar anammox reaction $NH_4^+ + NO_2- \rightarrow N2 + 2\ H_2O$ (see, for example, claim 9 of **D2**).

In the appellants' view, the claimed method was a non-obvious alternative. However, the control algorithm of

claim 1 of the main request is, at best, arbitrary, and the distinguishing features are known as shown above.

Consequently, an inventive step has to be denied (Article 56 EPC).

Auxiliary requests

2. At the oral proceedings, the appellants had no further remarks on the auxiliary requests.

3. Claim 1 of the first auxiliary request is identical to that of the main request. The objection under Article 56 EPC against the main request hence also applies to this auxiliary request (Article 56 EPC).

4. The unique claims of the second and fifth auxiliary requests no longer contain the alternative of controlling the "frequency at which aeration occurs in a reactor".

However, because of the obviousness of the remaining alternative, i.e. "controlling a concentration of dissolved oxygen", this amendment cannot overcome the objection under Article 56 EPC.

5. With regard to the third auxiliary request, the appellants indicated that "the amendment has been made to more clearly define the invention".

With regard to the fourth and the already mentioned fifth auxiliary requests, the appellants referred to the third auxiliary request.

The new feature "to thereby achieve a ratio of [concentration of ammonia] to [sum of the

concentrations of nitrite and nitrate] which is about 1" in claim 1 of the third to fifth auxiliary requests has no influence on the reasoning for the main request.

Therefore, the admissibility of the third to fifth auxiliary requests under Article 12(6) RPBA 2020 notwithstanding, the objection under Article 56 EPC against the main request also applies to these auxiliary requests.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chair:

L. Stridde E. Bendl

Decision electronically authenticated