Sludge Treatment Method And Apparatus Thereof And Application To Wastewater Bio-Treatment

~~**Method and apparatus for sludge treatment and use thereof in sewage biotreatment**~~

The present application claims the priorities of the following patent applications: (1) Chinese patent application 200910249722.X, filed on December 1, 2009; and (2) Chinese patent application 201010000737.5, filed on January 15, 2010. The contents of these patent applications are incorporated into the present application by reference.

Technical Field

The present invention relates to a method and an apparatus for sludge treatment and their use in sewage biotreatment, in particular to a method and an apparatus for sludge reduction treatment as well as a method and an apparatus for sewage biotreatment by employing the method for sludge reduction treatment.

Background Art

Water pollution is gradually serious, so it is necessary to treat various sewages economically and effectively. Currently, thousands sewage treatment plants are running in the world, and more sewage treatment plants will be built with the development of environmental senses and requirements.

Sewage biotreatment is widely applied to sewage treatment due to its outstanding advantages of high performance and low energy consumption, and sewage biotreatment technologies represented with activated sludge technologies and biomembrane technologies are successfully used in sewage treatment and pollution abatement. However, the sewage biotreatment technologies in the prior art still have some drawbacks.

In practical processes, many sewage plants have to face the following challenges: (1) insufficient amount of sewage feed, mainly resulted from advanced design and failures in sanitary sewer system, which may influence the operation of sewage treatment apparatus; (2) unstable quality of sewage feed, mainly resulted from draining industrial wastewater into sanitary sewer system and living habit changes caused by holidays and seasonal variation, which may form shock load to influence sewage treatment effects; (3) carbon-source deficiency, as a common problem of sewage treatment plants, mainly attributed to modern living habits,

What is claimed is:

1. A method for sludge treatment, comprising the following steps:

(1) Mixing a sludge feed from a sewage biotreatment process with a first mixed liquor to obtain a second mixed liquor;

(2) Subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor;

(3) Subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor;

(4) Separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor; and

(5) Discharging the supernatant liquid, and returning at least a part of the first concentrated mixed liquor as the first mixed liquor to the step (1), wherein the amount of sludge of the first concentrated mixed liquor that does not return to the step (1) is less than the amount of sludge of the sludge feed.

2. The method for sludge treatment according to claim 1, wherein in the step (5), at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the first concentrated mixed liquor returns to the step (1) and is used as the first mixed liquor, and optionally the first concentrated mixed liquor that does not return to the step (1) is discharged.

3. The method for sludge treatment according any one of preceding claims, wherein in the step (1), an organic nutrient is mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor, wherein the organic nutrient is preferably a sewage feed.

4. The method for sludge treatment according to claim 3, wherein in the step (1), the flow ratio of the sludge feed to the sewage feed is 1:0.01 to 1:100, preferably 1:0.1 to 1:10, more preferably 1:0.5 to 1:5.

5. The method for sludge treatment according to any one of previous claims, wherein in the step (2), the oxygen-supplying process has an

oxygen-supplying treatment time of 0.1 to 4 hours, preferably 0.5 to 2 hours, more preferably 0.5 to 1.5 hours.

6. The method for sludge treatment according to any one of previous claims, wherein in the step (3), the anoxic process has an anoxic treatment time of 0.8 to 6 hours, preferably 1 to 4 hours, more preferably 1 to 3 hours.

7. The method for sludge treatment according to claim 6, wherein the ratio of the oxygen-supplying treatment time to the anoxic treatment time is 1:0.5 to 1:6, preferably 1:1 to 1:3, more preferably 1:1.5 to 1:2, most preferably 1:2。

8. The method for sludge treatment according to any one of previous claims, wherein in the step (2), the oxygen-supplying process is performed in a manner of intermittent aeration or continuous aeration.

9. The method for sludge treatment according to any one of the previous claims, wherein in the step (2), the third mixed liquor has a dissolved oxygen content of 0.1 to 4mg/L, preferably 1.5 to 3mg/L, more preferably 2 to 3mg/L.

10. The method for sludge treatment according to any one of the previous claims, wherein the step (3) and the step (4) are performed in a manner of sedimentation.

11. The method for sludge treatment according to any one of the previous claims, wherein in the step (1), the second mixed liquor has a sludge concentration of 3,000 to 30,000mg/L, preferably 3,000 to 20,000mg/L, more preferably 4,000 to 15,000mg/L.

12. The method for sludge treatment according to any one of previous claims, wherein the method further comprises a step for recovering gaseous phosphorus-containing compounds generated in the step (2) and/or (3).

13. A method for sewage biotreatment, comprising:

(1) Mixing a sludge feed from a sewage biotreatment process with a first mixed liquor to obtain a second mixed liquor;

(2) Subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor;

(3) Subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor;

(4) Separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor;

(5) Discharging the supernatant liquid, and returning at least a part of the first concentrated mixed liquor as the first mixed liquor to the step (1), wherein the amount of sludge of the first concentrated mixed liquor that does not return to the step (1) is less than the amount of sludge of the sludge feed;

(6) Subjecting at least a part of the supernatant liquid from the step (5) and optionally a part of sewage feed to the sewage biotreatment process to obtain a second concentrated mixed liquor and a purified water effluent; and

(7) Discharging the purified water effluent, and optionally returning at least a part of the second concentrated mixed liquor from the step (6) as the sludge feed to the step (1);

wherein a sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor and/or introduced to the step (6) and subjected to the sewage biotreatment process together with the at least part of supernatant from the step (5), preferably, at least part of the sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor, and more preferably, all of the sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor.

14. The method for sewage biotreatment according to claim 13, wherein in the step (5), at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the first concentrated mixed liquor returns to the step (1) and is used as the first mixed liquor, and optionally the first concentrated mixed liquor that does not return to the step (1) is discharged.

15. The method for sewage biotreatment according to claims 13 or 14, wherein in the step (2), the oxygen-supplying process has an oxygen-supplying treatment time of 0.1 to 4 hours, preferably 0.5 to 2 hours, more preferably 0.5 to 1.5 hours.

16. The method for sewage biotreatment according to any one of claims 13 to 15, wherein in the step (3), the anoxic process has an anoxic treatment time of 0.8 to 6 hours, preferably 1 to 4 hours, more preferably 1 to 3 hours.

17. The method for sewage biotreatment according to any one of claims 13 to 16, wherein the ratio of the oxygen-supplying treatment time to the anoxic treatment time is 1:0.5 to 1:6, preferably 1:1 to 1:3, more preferably 1:1.5 to 1:2, most preferably 1:2.

18. The method for sewage biotreatment according to any one of claims 13 to 17, wherein in the step (2), the oxygen-supplying process is performed in a manner of intermittent aeration or continuous aeration.

19. The method for sewage biotreatment according to any one of claims 13 to 18, wherein the third mixed liquor has a dissolved oxygen content of 0.1 to 4 mg/L, preferably 1.5 to 3 mg/L, more preferably 2 to 3 mg/L.

20. The method for sewage biotreatment according to any one of claims 13 to 19, wherein the step (3) and the step (4) are performed in a manner of sedimentation.

21. The method for sewage biotreatment according to any one of claims 13 to 20, wherein in the step (1), the second mixed liquor has a sludge concentration of 3,000 to 30,000 mg/L, preferably 3,000 to 20,000 mg/L, more preferably 4,000 to 15,000 mg/L.

22. The method for sewage biotreatment according to any one of claims 13 to 21, wherein the method further comprises a step for recovering gaseous phosphorus-containing compounds generated in the step (2) and/or the step (3).

23. The method for sewage biotreatment according to any one of claims 13 to 22, wherein the second concentrated mixed liquor that returns from the step (7) to the step (1) and is used as the sludge feed is 1 to 100%, preferably about 80 to 100%, more preferably about 100%, relative to the second concentrated mixed liquor.

24. The method for sewage biotreatment according to any one of claims 13 to 23, wherein the second concentrated mixed liquor that returns from the step (7) to the step (1) is of a proportion of 1 to 100%, preferably about 80 to 100%, more preferably about 100%, relative to the sludge feed of the step (1).

25. The method for sewage biotreatment according to any one of claims 13 to 24, wherein in the step (6), the sewage biotreatment process is Wuhrmann process, A/O process, Bardenpho process, Phoredox process, A^2/O process, reversed A^2/O process, UCT process, MUCT process, VIP process, OWASA process, JHB process, TNCU process, Dephanox process, BCFS process, MSBR process, SBR process, AB process, oxidation ditch process, biomembrane process, moving bed process or a combination thereof.

26. An apparatus for sludge treatment useful in the method for sludge treatment according to any one of claims 1 to 12, comprising: a first device disposed for mixing a sewage feed, a sludge feed and a first mixed liquor to obtain a second mixed liquor; a second device disposed for subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor; a third device disposed for subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor; a fourth device disposed for separating the fourth mixed liquor to obtain a supernatant and a first concentrated mixed liquor; a fifth device disposed for discharging the supernatant liquid; and a sixth device disposed for returning at least part of the first concentrated mixed liquor as the first mixed liquor to the first device so that the amount of sludge of the first concentrated mixed liquor that does not return to the first device is less than the amount of sludge of the sludge feed.

27. The apparatus for sludge treatment according to claim 26, wherein the second device is disposed to have an oxygen-supplying treatment time of 0.1 to

4 hours, preferably 0.5 to 2 hours, more preferably 0.5 to 1.5 hours.

28. The apparatus for sludge treatment according to claims 26 or 27, wherein the third device is disposed to have an anoxic treatment time of 0.8 to 6 hours, preferably 1 to 4 hours, more preferably 1 to 3 hours.

29. The apparatus for sludge treatment according to any one of claims 26 to 28, wherein the second device and third device are disposed so that the ratio of the oxygen-supplying treatment time to the anoxic treatment time is 1:0.5 to 1:6, preferably 1:1 to 1:3, more preferably 1:1.5 to 1:2, most preferably 1:2.

30. The apparatus for sludge treatment according to any one of claims 26 to 29, wherein the second device is an aeration basin.

31. The apparatus for sludge treatment according to any one of claims 26 to 30, wherein the third device and the fourth device are a sedimentation basin.

32. The apparatus for sludge treatment according to any one of claims 26 to 31, wherein the apparatus for sludge treatment further comprises a recovery device for collecting and recovering gaseous phosphorus-containing compounds.

33. An apparatus for sewage biotreatment useful in the method for sewage biotreatment according to any one of claims 13 to 15, comprising: a first device disposed for mixing a sludge feed with a first mixed liquor to obtain a second mixed liquor; a second device disposed for subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor; a third device disposed for subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor; a fourth device disposed for separating the fourth mixed liquor to obtain a supernatant and a first concentrated mixed liquor; a fifth device disposed for discharging the supernatant liquid; a sixth device disposed for returning at least part of the first concentrated mixed liquor as the first mixed liquor to the first device so that the amount of sludge of the first concentrated mixed liquor that does not return to the first device is less than the amount of sludge of the sludge feed; a seventh device disposed for subjecting at

least part of the supernatant from the fifth device to a sewage biotreatment process to obtain a second concentrated mixed liquor and a purified water effluent; an eighth device disposed for discharging the purified water effluent; a ninth device disposed for introducing a sewage feed into the first device so as to mix with the sludge feed and the first mixed liquor to obtain the second mixed liquor and/or into the seventh device so as to subject to the sewage biotreatment process together with the supernatant; and optionally a tenth device disposed for returning at least part of the second concentrated mixed liquor to the first device.

34. The apparatus for sewage biotreatment according to claim 33, wherein the second device is disposed to have an oxygen-supplying treatment time of 0.1 to 4 hours, preferably 0.5 to 2 hours, more preferably 0.5 to 1.5 hours.

35. The apparatus for sewage biotreatment according to claims 33 or 34, wherein the third device is disposed to have an anoxic treatment time of 0.8 to 6 hours, preferably 1 to 4 hours, more preferably 1 to 3 hours.

36. The apparatus for sewage biotreatment according to any one of claims 33 to 35, the second device and third device are disposed so that the ratio of the oxygen-supplying treatment time to the anoxic treatment time is 1:0.5 to 1:6, preferably 1:1 to 1:3, more preferably 1:1.5 to 1:2, most preferably 1:2.

37. The apparatus for sewage biotreatment according to any one of claims 33 to 36, wherein the second device is an aeration basin.

38. The apparatus for sewage biotreatment according to any one of claims 33 to 37, wherein the third device and the fourth device are a sedimentation basin.

39. The apparatus for sewage biotreatment according to any one of claims 33 to 38, wherein the apparatus for sludge treatment further comprises a recovery device for collecting and recovering gaseous phosphorus-containing compounds.

40. The apparatus for sewage biotreatment according to any one of claims 33 to 39, wherein the seventh device is a device that is disposed to perform sewage biotreatment by Wuhrmann process, A/O process, Bardenpho process, Phoredox process, A^2/O process, reversed A^2/O process, UCT process, MUCT process, VIP process, OWASA process, JHB process, TNCU process, Dephanox process, BCFS process, MSBR process, SBR process, AB process, oxidation ditch process, biomembrane process, moving bed process or a combination thereof.

41. A method for reducing carbon content, nitrogen content and phosphorus content in a sludge from a sewage biotreatment, comprising using the sludge as a sludge feed and subjecting to the method for sludge treatment according to any one of claims 1 to 12 to reduce the carbon content, nitrogen content and phosphorus content in the sludge.

42. A method for reducing carbon content, nitrogen content and phosphorus content in a sewage, comprising using the sewage as a sewage feed and subjecting to the method for sewage biotreatment according to any one of claims 13 to 25 to reduce the carbon content, nitrogen content and phosphorus content in the sludge.

43. A method for recovering phosphorus from a sludge generated in a sewage treatment process, comprising: (1) using the sludge as a sludge feed and subjecting to the method for sludge treatment according to any one of claims 1 to 12 so as to convert phosphorus-containing compounds, especially phosphorus-containing compounds in form of solution of the sludge into gaseous phosphorus-containing compounds and allow the gaseous phosphorus-containing compounds escape, and (ii) recovering the gaseous phosphorus-containing compounds that escape in the step (i).

44. A method for recovering phosphorus from a sewage, comprising: (1) using the sewage as a sewage feed and subjecting to the method for sewage biotreatment according to any one of claims 13 to 25 so as to convert phosphorus-containing compounds, especially phosphorus-containing compounds in form of solution of the sewage into gaseous

phosphorus-containing compounds and allow the gaseous phosphorus-containing compounds escape, and (ii) recovering the gaseous phosphorus-containing compounds that escape in the step (i).

45. A method for sludge reduction treatment, comprising the following steps:

(a) Introducing a first sludge from a sewage biotreatment process and an optional sewage feed into an aerobic treatment zone, preferably an aeration basin;

(b) Subjecting the mixture solution in the aerobic treatment zone to aerobic treatment;

(c) Introducing the mixture solution from the aerobic treatment zone to an anoxic treatment zone, preferably a sedimentation basin, for anoxic treatment to obtain a second sludge and a supernatant; and

(d) Circulating at least part of the second sludge back to the aerobic treatment zone, and optionally discharging the residual part of the second sludge;

wherein the discharged residual part of the second sludge has a total MLSS less than the total MLSS of the first sludge; and the aerobic treatment can be carried out in a manner of intermittent aeration or continuous aeration.

46. The method for sludge reduction treatment according to claim 45, wherein in the step (d), at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the second sludge is circulated back to the aerobic treatment zone.

47. The method for sludge reduction treatment according to any one of claims 45-46, wherein in the step (b), the aerobic treatment time is 0.1-4h, preferably 0.5-2h, more preferably 0.5-1.5h.

48. The method for sludge reduction treatment according to any one of claims 45-47, wherein the mixture solution in the aerobic treatment zone has an

outlet dissolved oxygen content of 0.1 to 4mg/L, preferably 1.5 to 3mg/L, more preferably 2 to 3mg/L after the aerobic treatment.

49. The method for sludge reduction treatment according to any one of claims 45-48, wherein the aerobic treatment zone has a sluge concentration of 3,000 to 30,000mg/L, preferably 3,000 to 20,000mg/L, more preferably 4,000 to 15,000mg/L.

50. The method for sludge reduction treatment according to any one of claims 45-49, further comprising a step for recovering gaseous phosphorus-containing compounds generated in the step (b) and/or (c).

51. An apparatus for sludge reduction treatment, comprising:

An aerobic treatment zone, which comprises a first inlet for receiving a first sludge, a second inlet for receiving at least part of a second sludge and optionally a third inlet for receiving a sewage feed; wherein the first sludge is from a sewage biotreatment process; the aerobic treatment zone is used for receiving the first sludge, the second sludge and the sewage feed and performing aerobic treatment; the aerobic treatment can be performed in a manner of intermittent aeration or continuous aeration;

An anoxic treatment zone, which is used for processing the mixture solution from the aerobic treatment zone to form a supernatant and a second sludge; and

A circulating device, which is used for circulating at least part of the second sludge back to the aerobic treatment zone.

52. The apparatus for sludge reduction treatment according to claim 51, wherein the circulating device is disposed to circulate at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the second sludge back to the aerobic treatment zone.

53. The apparatus for sludge reduction treatment any one of claims 51-52,

wherein the aerobic treatment zone is disposed to have an aerobic treatment time of 0.1-4h, preferably 0.5-2h, more preferably 0.5-1.5h.

54. The apparatus for sludge reduction treatment according to any one of claims 51-53, further comprising a device for recovering phosphorus for recovering gaseous phosphorus-containing compounds generated in the aerobic treatment zone and the anoxic treatment zone.

55. A method for sewage treatment by sludge reduction, comprising: subjecting a sewage feed to an aerobic treatment, an anoxic treatment and/or a sedimentation treatment and a sewage biotreatment in order in a sewage biotreatment apparatus comprising an aerobic treatment zone such as an aerobic basin, an anoxic treatment zone such as a sedimentation basin and a biotreatment zone, characterized by:

Circulating at least part of a first sludge that is present and/or formed in the biotreatment zone and at least part of a second sludge that is present and/or formed in the anoxic treatment zone back to the aerobic treatment zone so that the sludge is reduced simultaneously when the sewage feed is subjected to biotreatment.

56. A method for sewage treatment by sludge reduction, comprising the following steps:

(a) Introducing a sewage feed and at least part of a second sludge from the step (d) and at least part of a first sludge from the step (g) into an aerobic treatment zone, preferably an aeration basin;

(b) Subjecting the mixture solution in the aerobic treatment zone to aerobic treatment;

(c) Introducing the mixture solution from the aerobic treatment zone to an anoxic treatment zone, preferably a sedimentation basin, for anoxic treatment to obtain a second sludge and a supernatant;

(d) Circulating at least part of the second sludge back to the aerobic treatment zone, and optionally discharging the residual part of the second sludge, wherein the discharged residual part of the second sludge has a total MLSS less than the total MLSS of the at least part of the first sludge that is introduced into the aerobic treatment zone of the step (a);

(e) Introducing the supernatant separated out from the anoxic treatment zone and optional other sewage feeds into the sewage biotreatment zone;

(f) Subjecting the supernatant and the optional other sewage feeds to a biotreatment process to obtain the first sludge and a water effluent;

(g) Circulating at least part of the first sludge back to the aerobic treatment zone, optionally circulating another part of the first sludge back to the sewage biotreatment zone, and optionally discharging the residual part of the first sludge;

wherein the aerobic treatment can be carried out in a manner of intermittent aeration or continuous aeration.

57. The method for sewage treatment by sludge reduction according to any one of claims 55-56, wherein in the step (d), at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the second sludge is circulated back to the aerobic treatment zone.

58. The method for sewage treatment by sludge reduction according to any one of claims 55-57, wherein in the step (g), at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the first sludge is circulated back to the aerobic treatment zone.

59. The method for sewage treatment by sludge reduction according to any one of claims 55-58, wherein in the step (b), the aerobic treatment time is 0.1-4h, preferably 0.5-2h, more preferably 0.5-1.5h.

60. The method for sewage treatment by sludge reduction according to any one of claims 55-59, wherein the mixture solution in the aerobic treatment zone has an outlet dissolved oxygen content of 0.1 to 4mg/L, preferably 1.5 to 3mg/L, more preferably 2 to 3mg/L after the aerobic treatment.

61. The method for sewage treatment by sludge reduction according to any one of claims 55-60, wherein the aerobic treatment zone has a sluge concentration of 3,000 to 30,000mg/L, preferably 3,000 to 20,000mg/L, more preferably 4,000 to 15,000mg/L.

62. The method for sewage treatment by sludge reduction according to any one of claims 55-61, further comprising a step for recovering gaseous phosphorus-containing compounds.

63. The method for sewage treatment by sludge reduction according to any one of claims 55-62, wherein the biotreatment process of the step (f) is a sewage biotreatment process selected from Wuhrmann process, A/O process, Bardenpho process, Phoredox process, A^2/O process, reversed A^2/O process, UCT process, MUCT process, VIP process, OWASA process, JHB process, TNCU process, Dephanox process, BCFS process, MSBR process, SBR process, AB process, oxidation ditch process, biomembrane process, moving bed process and a combination thereof.

64. An apparatus for sewage treatment by sludge reduction, the apparatus comprising: an aerobic treatment zone such as an aeration basin, an anoxic treatment zone such as a sedimentation basin and a sewage biotreatment zone, which are communicated in order, characterized in that: the aerobic treatment zone has a sewage feed inlet, a second sluge runback conduit communicating with the anoxic treatment zone, and a first sluge runback conduit communicating with the sewage biotreatment zone, and the apparatus for sewage biotreatment is disposed so that the total MLSS of the second sludge discharged from the anoxic treatment zone is less than the total MLSS of the first sludge circulated from the sewage biotreatment zone to the aerobic treatment zone.

65. An apparatus for sewage treatment by sludge reduction, comprising:

An aerobic treatment zone, preferably an aeration basin, which comprises a first inlet for receiving a first sludge, a second inlet for receiving at least part of a second sludge and a third inlet for receiving a sewage feed; wherein the

aerobic treatment zone is used for performing aerobic treatment of the first sludge, the second sludge and the sewage feed; the aerobic treatment can be performed in a manner of intermittent aeration or continuous aeration;

An anoxic treatment zone, preferably a sedimentation basin, which is used for anoxic treatment of the mixture solution from the aerobic treatment zone to form a supernatant and a second sludge;

A sewage biotreatment zone, optionally having an inlet for other sewage feeds, which is used for performing biotreatment of the supernatant and optional other sewage feeds to form the first sludge and a water effluent;

A first circulating device, which is used for circulating at least part of the first sludge back to the aerobic treatment zone;

A second circulating device, which is used for circulating at least part of the second sludge back to the aerobic treatment zone;

An optional first sludge discharging device for discharging the residual part of the first sludge;

An optional second sludge discharging device for discharging the residual part of the second sludge.

66. The apparatus for sewage treatment by sludge reduction according to any one of claims 64-65, wherein the second circulating device is disposed to circulate at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the second sludge back to the aerobic treatment zone.

67. The apparatus for sewage treatment by sludge reduction according to any one of claims 64-66, wherein the first circulating device is disposed to circulate at least 60%, preferably at least 65%, more preferably at least 70%, more preferably at least 75%, more preferably at least 80%, more preferably at least 85%, more preferably at least 90%, more preferably at least 93%, more preferably at least 95%, more preferably at least 98%, most preferably essentially 100% of the first sludge back to the aerobic treatment zone.

68. The apparatus for sewage treatment by sludge reduction according to

any one of claims 64-67, wherein the aerobic treatment zone is disposed to have an aerobic treatment time of 0.1-4h, preferably 0.5-2h, more preferably 0.5-1.5h.

69. The apparatus for sewage treatment by sludge reduction according to any one of claims 64-68, further comprising a device for recovering phosphorus for recovering gaseous phosphorus-containing compounds generated in the sewage treatment apparatus.

70. The apparatus for sewage treatment by sludge reduction according to any one of claims 64-69, wherein the biotreatment zone is a device capable of performing sewage biotreatment according to Wuhrmann process, A/O process, Bardenpho process, Phoredox process, A^2/O process, reversed A^2/O process, UCT process, MUCT process, VIP process, OWASA process, JHB process, TNCU process, Dephanox process, BCFS process, MSBR process, SBR process, AB process, oxidation ditch process, biomembrane process, moving bed process and a combination thereof.

What is claimed is:

1. A method for sludge treatment, comprising the following steps:

(1) mixing a sludge feed from a sewage biotreatment process with a first mixed liquor to obtain a second mixed liquor;

(2) subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor;

(3) subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor;

(4) separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor; and

(5) discharging the supernatant liquid, and returning at least a part of the first concentrated mixed liquor as the first mixed liquor to the step (1), wherein the amount of sludge of the first concentrated mixed liquor that does not return to the step (1) is less than the amount of sludge of the sludge feed.

2. The method for sludge treatment according to claim 1, wherein in the step (5), at least 60%, or at least 65%, or at least 70%, or at least 75%, or at least 80%, or at least 85%, or at least 90%, or at least 93%, or at least 95%, or at least 98%, or essentially 100% of the first concentrated mixed liquor returns to the step (1) and is used as the first mixed liquor, and optionally the first concentrated mixed liquor that does not return to the step (1) is discharged.

3. The method for sludge treatment according any one of preceding claims, wherein in the step (1), an organic nutrient is mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor, wherein the organic nutrient is optionally a sewage feed.

4. The method for sludge treatment according to claim 3, wherein in the step (1), the flow ratio of the sludge feed to the sewage feed is 1:0.01 to 1:100, or 1:0.1 to 1:10, or 1:0.5 to 1:5.

5. The method for sludge treatment according to any one of previous claims, wherein in the step (2), the oxygen-supplying process has an oxygen-supplying treatment time of 0.1 to 4 hours, or 0.5 to 2 hours, or 0.5 to 1.5 hours; and/or wherein in the step (3), the anoxic process has an

anoxic treatment time of 0.8 to 6 hours, or 1 to 4 hours, or 1 to 3 hours.

6. The method for sludge treatment according to claim 5, wherein the ratio of the oxygen-supplying treatment time to the anoxic treatment time is 1:0.5 to 1:6, or 1:1 to 1:3, or 1:1.5 to 1:2, or 1:2.

7. The method for sludge treatment according to any one of previous claims, wherein in the step (2), the oxygen-supplying process is performed in a manner of intermittent aeration or continuous aeration.

8. The method for sludge treatment according to any one of the previous claims, wherein in the step (2), the third mixed liquor has a dissolved oxygen content of 0.1 to 4mg/L, or 1.5 to 3mg/L, or 2 to 3mg/L.

9. The method for sludge treatment according to any one of the previous claims, wherein the step (3) and the step (4) are performed in a manner of sedimentation.

10. The method for sludge treatment according to any one of the previous claims, wherein in the step (1), the second mixed liquor has a sludge concentration of 3,000 to 30,000mg/L, or 3,000 to 20,000mg/L, or 4,000 to 15,000mg/L.

11. The method for sludge treatment according to any one of previous claims, wherein the method further comprises a step for recovering gaseous phosphorus-containing compounds generated in the step (2) and/or (3).

12. A method for sewage biotreatment, comprising a method for sludge treatment according to any one of claims 1-11, wherein the method for sludge treatment comprises the following steps:

(1) mixing a sludge feed from a sewage biotreatment process with a first mixed liquor to obtain a second mixed liquor;

(2) subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor;

(3) subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor;

(4) separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor;

(5) discharging the supernatant liquid, and returning at least a part of the first concentrated mixed liquor as the first mixed liquor to the step (1), wherein the amount of sludge of the first concentrated mixed liquor that does not return to the step (1) is less than the amount of sludge of the sludge feed; and

wherein the method for sewage biotreatment further comprises:

(6) subjecting at least a part of the supernatant liquid from the step (5) and optionally a part of sewage feed to the sewage biotreatment process to obtain a second concentrated mixed liquor and a purified water effluent; and

(7) discharging the purified water effluent, and optionally returning at least a part of the second concentrated mixed liquor from the step (6) as the sludge feed to the step (1);

wherein a sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor and/or introduced to the step (6) and subjected to the sewage biotreatment process together with at least part of the supernatant liquid from the step (5), orat least part of the sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor, orall of the sewage feed is introduced to the step (1) and mixed with the sludge feed and the first mixed liquor to obtain the second mixed liquor.

13. The method for sewage biotreatment according to claim 12, wherein:

the second concentrated mixed liquor that returns from the step (7) to the step (1) and is used as the sludge feed is 1% to 100%, or about 80 to 100%, or about 100%, relative to the second concentrated mixed liquor; and/or

the second concentrated mixed liquor that returns from the step (7) to the step (1) is of a proportion of 1 to 100%, or about 80 to 100%, or about 100%, relative to the sludge feed of the step (1).

14. The method for sewage biotreatment according to any one of claims 12 to 13, wherein in the step (6), the sewage biotreatment process is Wuhrmann process, A/O process, Bardenpho process, Phoredox process, A^2/O process, reversed A^2/O process, UCT process, MUCT process, VIP process, OWASA process, JHB process, TNCU process, Dephanox process, BCFS process, MSBR process, SBR process, AB process, oxidation ditch process, biomembrane process, moving bed process or a combination thereof.

15. An apparatus for sludge treatment useful in the method for sludge treatment according to any one of claims 1 to 11, comprising: a first device disposed for mixing a sewage feed, a sludge feed and a first mixed liquor to obtain a second mixed liquor; a second device disposed for subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor; a third device disposed for subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor; a fourth device disposed for separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor; a fifth device disposed for discharging the supernatant liquid; and a sixth device disposed for returning at least part of the first concentrated mixed liquor as the first mixed liquor to the first device so that the amount of sludge of the first concentrated mixed liquor that does not return to the first device is less than the amount of sludge of the sludge feed.

16. An apparatus for sewage biotreatment useful in the method for sewage biotreatment according to any one of claims 12 to 14, comprising: a first device disposed for mixing a sludge feed with a first mixed liquor to obtain a second mixed liquor; a second device disposed for subjecting the second mixed liquor to an oxygen-supplying process to obtain a third mixed liquor; a third device disposed for subjecting the third mixed liquor to an anoxic process to obtain a fourth mixed liquor; a fourth device disposed for separating the fourth mixed liquor to obtain a supernatant liquid and a first concentrated mixed liquor; a fifth device disposed for discharging the supernatant liquid; a sixth device disposed for returning at least part of the first concentrated mixed liquor as the first mixed liquor to the first device so that the amount of sludge of the first concentrated mixed liquor that does not return to the first device is less than the amount of sludge of the sludge feed; a seventh device disposed for subjecting at least part of the supernatant liquid from the fifth device to a

sewage biotreatment process to obtain a second concentrated mixed liquor and a purified water effluent; an eighth device disposed for discharging the purified water effluent; a ninth device disposed for introducing a sewage feed into the first device so as to mix with the sludge feed and the first mixed liquor to obtain the second mixed liquor and/or into the seventh device so as to subject to the sewage biotreatment process together with the supernatant liquid; and optionally a tenth device disposed for returning at least part of the second concentrated mixed liquor to the first device.

17. A method for reducing carbon content, nitrogen content and phosphorus content in a sludge from a sewage biotreatment, comprising using the sludge as a sludge feed and subjecting to the method for sludge treatment according to any one of claims 1 to 11 to reduce the carbon content, nitrogen content and phosphorus content in the sludge.

18. A method for reducing carbon content, nitrogen content and phosphorus content in a sewage, comprising using the sewage as a sewage feed and subjecting to the method for sewage biotreatment according to any one of claims 12 to 14 to reduce the carbon content, nitrogen content and phosphorus content in the sludge.

19. A method for recovering phosphorus from a sludge generated in a sewage treatment process, comprising: (i) using the sludge as a sludge feed and subjecting to the method for sludge treatment according to any one of claims 1 to 11 so as to convert phosphorus-containing compounds, especially phosphorus-containing compounds in form of solution of the sludge into gaseous phosphorus-containing compounds and allow the gaseous phosphorus-containing compounds to escape, and (ii) recovering the gaseous phosphorus-containing compounds that escape in the step (i).

20. A method for recovering phosphorus from a sewage, comprising: (1) using the sewage as a sewage feed and subjecting to the method for sewage biotreatment according to any one of claims 12 to 14 so as to convert phosphorus-containing compounds, especially phosphorus-containing compounds in form of solution of the sewage into gaseous phosphorus-containing compounds and allow the gaseous phosphorus-containing compounds to escape, and (ii) recovering the gaseous phosphorus-containing compounds that escape in the step (i).