

CLAIMS:

We claim:

- 5 1. A process comprising steps of,
 immersing an apparatus comprising a membrane aerated biofilm media (an "MABR
 unit") in water comprising ammonia;
 providing a gas comprising oxygen ("process air") to the inside of the MABR unit; and,
 growing a population of bacteria on the outside of the MABR unit wherein the bacteria
10 include ammonia oxidizing bacteria (AOB),
 wherein the process comprises one or more of: batch feed of process air in short
 cycles; process air modulation; process air direction reversal; process air nitrogen
 enrichment, for example by process air recycle; process air cascade flow; and, maintaining
 an exhaust air oxygen concentration below 4%.
- 15 2. The process of claim 1 comprising batch feed of process air in short cycle wherein air
 is provided to the MABR unit for a first period of time and then valves are closed upstream
 and downstream of the MABR unit for a second period of time.
- 20 3. The process of claim 2 wherein the total cycle time is between 0.1 and 2 hours.
4. The process of claim 1 comprising process air modulation wherein process air is
 provided to a MABR unit at a first rate for a first period of time and at a second rate for a
 second period of time.
- 25 5. The process of claim 4 wherein the total cycle time is between 0.5 and 10 days.
6. The process of claim 1 comprising process air direction reversal wherein process air
 flows in one direction through an MABR unit for a first period of time, and then flows in the
30 opposite direction through the MABR unit for a second period of time.
7. The process of claim 6 wherein the total cycle time is between 0.5 and 10 days.

8. The process of claim 1 comprising process air nitrogen enrichment wherein nitrogen enriched air is provided to the MABR unit.
9. The process of claim 8 wherein a first process air, for example ambient air, is provided to the MABR unit for a first period of time and a second, relatively nitrogen enriched, process air is provided to the MABR for a second period of time, for example with a total cycle time between 0.5 and 10 days long.
10. The process of claim 8 or 9 wherein the nitrogen enriched air is provided by process air recycle, comprising flowing at least some exhaust gas from an outlet of the MABR unit into an inlet of the MABR unit.
11. The process of any of claims 8 to 10 wherein the second process air flow rate is higher than the first process air flow rate.
12. The process of claim 1 comprising process air cascade flow between a plurality of MABR units, wherein process air is provided to the plurality of MABR units in series, for example by connecting a port of one MABR unit to a port of another MABR unit.
13. The process of claim 12 wherein each MABR unit is less than 0.5 m long, or wherein the MABR units in series are more than 1 m long.
14. The process of claim 1 comprising process air cascade flow combined with at least one of the other methods.
15. The process of claim 1 comprising process air direction reversal combined with at least one of the other methods.
16. The process of claim 15 wherein MABR exhaust has an oxygen concentration of 4% or less or 2% or less.

17. The process of claim 1 comprising a combination of a) one or more of: process air cascade flow; process air batch feed; process air modulation; and, process air nitrogen enrichment with b) process air direction reversal or exhaust gas recycle.
- 5 18. A process for starting an MABR comprising one or more of: pre-seeding a MABR unit to be used in the MABR with anammox; selecting a seed sludge containing a relatively fast growing anammox species to seed the MABR or MABR unit; breaking up a granular seed sludge containing anammox into smaller particles; and, seeding the MABR with a nitrifying sludge before seeding the MABR with a sludge containing anammox.
- 10 19. An MABR comprising an MABR unit and one or more of: conduit networks; gages; valves; sensors; and, flow control devices, configured for providing process air to the MABR unit according to a process of any of claims 1 to 18.
- 15 20. An MABR comprising one or more MABR units and network of pipes and valves configured to one or more of: connect two or more of the MABR units in series; alternately connect a source of process air to a first port and a second port of an MABR unit; and, periodically connect a second port of an MABR unit to a first port of the MABR unit, wherein the first port and the second port are on opposite ends of gas transfer membranes in the
- 20 MABR unit.