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Based on MBR Microbial Community Structure Analysis of Shortcut Nitrification Initiation in Different Kinds of Mud

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Abstract: For clear membrane bioreactor (MBR)Microbial Community structure changes before and after the short-cut Nitrification with different sludge inoculation.MBRNitrifying sludge (R1.),Anaerobic nitrification sludge (R2.)And1.:1.Mixed inoculation of anaerobic and Denitrifying sludge (R3.)Sludge source for achieving rapid short-cut nitrification.The results show that the combination of Intermittent Aeration and reduced hydraulic retention time (HRT),R1.R2.WithR3.Reactor time-consuming46 d,8 dAnd30 dThe shortcut nitrification was successfully launched,R2.Shortest startup cycle of Reactor.During the stable operation period,R1.R2.AndR3.The average nitrite accumulation rate was92%,93%And94%,R3.The reactor showed more stable short-cut Nitrification performance..Ace,Chao,ShannonAndSimpsonIndex results show that after stable operation,R1.AndR2.The microbial abundance and diversity of the reactor were significantly lower than that of the inoculated sludge,R3.The abundance of reactor species decreased slightly while the diversity level changed little..After the shortcut nitrification was successfully started,3.The main bacteria in the reactor were Proteus phyla (Proteobacteria)And bacteriocin (Bacteroidetes)And the abundance of the Main Nitrogen Removal Function bacteria is higher than that of the inoculated sludge..Beta-Proteus3.The dominant bacteria in the short-cut Nitrification system of each reactor accounted59. 6%,63. 6%And69. 3%.R1.R2.AndR3.Reactor in the advantage bacteria of are nitrosation single (Nitrosomonas)Of proportion respectively up12. 8%,Natural 20. 2%And19. 7%.ComparedR1Reactor,R2AndR3Reactor inoculation sludge in there is a certain proportion of nitrification bacteria more conducive to system short-range nitrification of implementation.

Keywords: short-range nitrification; Membrane Biological Reactor; inoculation sludge; start; microbial community structure

Many scholars for this of the difficult problems of a large number of research results show that the high temperature,HighFA,LowDO,Intermittent Aeration and real time control Mud source start short-range nitrification of study few reports.And most research are from Start Time,Nitrification rate and macro-angle analysis short-range nitrification start performance of quality for start before and after microbial community structure of Change Characteristics Research is less, so Will macro-and micro-combined with up the different mud source conditions under short-range nitrification start performance difference is very necessary.High Flux sequencing technology as an New Microbial Population Identification Technology Of has analysis results accurate,High-speed,High sensitivity and high automatic[910] Of and CharacteristicsIn environment microbial identification field application widely.At the same time, the technology also more and more be applied to short-range nitrification process[11]The microbial community structure detection in help short-range nitrification

process of further regulation and implementation.Membrane Biological Reactor (MBR)Compared with traditional biological reactor has covers an area of small,Volume load high and left[12]More than sludge of low advantage and membrane filtration water of operation style can achieve system sludge of efficient interception to enrichment growth slowAOBReduce Short-range nitrification of Start Time.This study SelectionMBRReactor respectively inoculation nitrification Sludge,Anaerobic nitrification Sludge
1:1Mixed inoculation anaerobic nitrification sludge and anti-nitrification sludge the different inoculation sludge of short-range nitrification start characteristics and start before and after flora structure change in order to for rapid start short-range nitrification reactor of sludge source select provide basis.

1. Material and Methods

1.1 Experimental Device

This experiment usingMBR(Figure1)Reactor by organic glass made long10 cmWide8 cmEffective Height24 LengthEffective Volume1. 9 L.MBRThe hollow fiber microfiltration membrane module membrane hole0. 1MuMMembrane area0. 2 m^2.Reactor by peristaltic pump continuous water by membrane module suction continuous water.Reactor at the bottom of the use of exposure
Gas sand head Oxygen Supply,DOControl0. 6~1. 0 mg in L^{-1}By timing socket control stop exposure time.The whole operation process in reactor place in water tub in keep run temperature in (30 ± 1).

1.2 Inoculation sludge

This experiment using3Of sludge Reactor1(R1):From Suzhou a wastewater treatment plantA^2/OProcess of good oxygen nitrification sludge;Reactor
2(R2):From laboratory long-term place1More than of anaerobic Nitrite
Of sludge;Reactor3(R3):1:1Mixed inoculation the above of anaerobic nitrification sludge and anti-nitrification sludge from Suzhou a wastewater treatment plantA^2/OProcess of hypoxia pool.Early inoculation sludge properties such as table1Shown in.

1.3 Experimental water and run conditions

Reactor experimental water same were the Artificial Water Distribution.To sodium acetate as an organic carbon source ammonium chloride as an nitrogen source potassium dihydrogen phosphate as an phosphorus sodium bicarbonate provide alkalinity regulation waterCOD,NH_4^+-N,TPConcentration andPHValue and add magnesium sulfate,Calcium chloride and biological required nutrition elements and other trace elements specific content see
2.The whole experimental operation process in,3A reactorPHValue were control in7/. 5~8. 0.Reactor of specific operation conditions are shown in Table3.

2. Results and discussions

2.1 MBRStart-up analysis of shortcut nitrification

Influent control by Reactor$NH_{4.}^+$-NAndCODLoad in 72~1. 20 kg ·$(M^{3.}\cdot D)^{-1.}$,PHFor7. 5~8. 0,DoNō
Du is0. 6~1. 0 mg · $L^{-1.}$Intermittent Aeration and gradual reductionHRTThe way56 dAll obtained stable short-cut nitrification..In this experiment, the nitrite accumulation rate is continuous.7 dStable in85%The above marks the success of shortcut nitrification,R1.R2.AndR3.Run separately46,8.And30 dAchieve short-cut nitrification.Inlet and outlet water quality of each reactor during startup,Ammonia Nitrogen Removal Rate and nitrite accumulation rate2.The whole running process is divided4.Stages.

Stage, using continuous aeration, gradually activated,AugmentationAOBThe activity,3.Ammonia Nitrogen Removal Rate in each reactor gradually increased95%Above.In this phase,R1.R2.AndR3.Reactor time consumption16,10And12 dThis is associated with the inoculation of sludge contained inAOBQuantity is closely related.Running until the end of this phase,R1.AndR3.Inside the reactor$No_{3.}^-$-NThe concentration showed an upward trend, because$NH_{4.}^+$-NReduction of free ammoniaNObThe inhibitory effect$No_{2.}^-$-NMore$No_{3.}^-$-N.It is worth mentioning that,R2.Effluent from Reactor$No_{3.}^-$-NConcentration stabilized13 mg · $L^{-1.}$About, Average nitrite accumulation rate90%And successfully started short-cut nitrification.The analysis shows that:On the one handMBRThe Interception Effect of the reactor was effectively avoided.AOBStable membrane environment is very conduciveAOBEnrichment and proliferation; on the other hand, the inoculation of anaerobicAOBAnd lower orders of magnitudeNObBacteria, coupled with the effective regulation of the outside environment, that is, high temperature,LowDoAnd fittingPHSuccessful suppression under conditionsNObShort-cut nitrification.

Stage In keepingHRTUnder the same conditions, using hypoxia/
Aerobic bi1.:3.(15 min:45 min)Operating mode of Intermittent Aeration. R1.AndR3.Inside the reactor$No_{3.}^-$-NThe overall concentration showed a downward trend, indicating that hypoxia/Aerobic alternate operating mode can effectively inhibit nitrate nitrogen.
Once aeration is restored, a long-term experience"Hunger"OfAOBAmmonia production capacity can be more used to make its own proliferation.AOBOf
Effluent from Reactor$No_{3.}^-$-NThe concentration showed a trend of first decline and then rise, reaching the highest21 mg · $L^{-1.}$, The corresponding nitrite accumulation rate fell85%.Pre-Analysis$No_{3.}^-$-NThe decreased and hypoxia/Good oxygen alternating run style about lateNO_3^--NOf rise because on the one hand with the reactor inAOBEnrichment degree more and more high waterNH_4^+-NMatrix can't meetAOBOf growth,AOBActivity by

suppression;On the other handHRTIs too long reactor in thereNOBLeads to an accumulationNO_2^--NFurther oxidationNO_3^--N.

Stage And stage Respectively in keep hypoxia/Good oxygen1:3 (15 min:45 min)The same of conditions under shortenHRTTo4 h And3 H.WithHRTOf shorten,R1, R2AndR3Reactor,Stage of ammonia nitrogen removal rate mean respectively87%,93%,91%And85%,91%,88%.Show that withHRTOf shorten the ammonia nitrogen removal rate gradually reduce.Stage stable runR1, R2AndR3Reactor ammonia nitrogen average removal load respectively1. 04, 10And1. 07 kg in ·$(M^3In\ D)^{-1}$R2Reactor show is high Of Ammonia Nitrogen Removal load (R2Reactor inAOBActivity is good.At the same time,R1, R2AndR3Reactor waterNO_3^--NMean respectively9,9And7/Mg IN L^{-1}Nitrite accumulation rate average92%,93%And94%Show that3A reactor were success start short-range nitrification andR3Reactor show more stability of short-range nitrification.

2.2 miseqHigh Flux sequencing results analysis

2.2.1 MBRReactor microbial abundance and diversity analysis

UseMiSeqHigh Flux sequencing platformR1, R2AndR3 Reactor of inoculation sludge and start success stable run the first56 dOf sludge sequencing by single sample of Diversity Analysis (αDiversity) reflecting microbial community of abundance and diversity specific situation such as table4Shown in.The sequencing6A sample of coverage were greater 99%Show that the sequencing results can representative sample in microbial of real situation.ACEAndChaoIndex can estimation community inOTUNumber of objective index characterization microbial population of rich of in ecology often used to estimate the species total number its value the greater the show that species total ACE,ChaoIndex performanceA0>C0>B0(R1Reactor in microbial population of abundance highest,R3Reactor secondly,R2Reactor at least.AnalysisR1Reactor inoculation of Wastewater Treatment PlantA^2/OGood oxygen nitrification sludge has certain of nitrogen removal carbon removal function microbial population of rich of relative is high;AndR2Reactor inoculation of laboratory place1More than of anaerobic nitrification sludge after long-term of endogenous respiratory and anaerobic digestion role microbial population of abundance decreased;R3Reactor1:1Mixed inoculation anaerobic nitrification sludge and anti-nitrification sludge microbial population of abundance than both moderate.In addition,R1, R2AndR3Reactor start success after,ACEAndChaoIndex were decreased show that species total number reduce its decline respectively45. 4%,30%,36%And45. 3%,28. 5%,38. 3%And the two index of Change Law andOTUThe number of change consistent.ShannonAndSimpsonIndex is used to estimate sample in microbial of diversity,ShannonValue the greater the (microbial population diversity the higher,SimpsonIndex the greater the (microbial population diversity the low,

At the same time also (advantage microbial accounted for total biomass of the greater the proportion .

4Display,R1, R2AndR3Reactor inShannonIndex of Change Trend andACE,ChaoIndex change trend consistent decreased trend.AndR1AndR2Reactor decline is big respectively 42. 3%And16. 1%R3Reactor decline is only5. 1%.Corresponding,R1AndR2ReactorSimpsonIndex increase is big,R3ReactorSimpsonIndex keep the same.Show thatR1AndR2Reactor in short-range nitrification start before and after microbial population diversity significantly reduce,

AndR3Reactor in microbial diversity change not.Short-range nitrification of START process essentially is Ammonia Oxidation Bacteria of enrichment disadvantages Strain Of out.In this process in with the system in advantage microbial accounted for than gradually increase usually will makes microbial population diversity reduce.

From this point of view,R1AndR2Reactor short-range nitrification start before and after of microbial community structure change in line with this a trend.Compared inR2Reactor,R3Reactor start time slightly longer but nitrification stability performance is strong this May and reactor in microbial community of diversity have Should be a stress of complementary unit to makes in through stress after community of Rapid Repair Ability stronger improve community of recovery force ensure that community of stability.

2.2.2 MBRReactor in door classification level of Distribution Law3For6A sample in door level under microbial community structure of distribution situation from can see main including deformation bacteria door(Proteobacteria),Quasi-of door (Bacteroidetes),Green bending bacteria door (Chloroflexi),Actinomycetes door (Actinobacteria),Thick-walled bacteria door (Firmicutes)And acid of door (Acidobacteria)And and Shaped bacteria door and quasi-of door main of proportion respectively up6%~58. 9%And3. 9%~35%.In addition,6A sample also detection to floating mold door(Planctomycetes)And nitrification bacterium door(Nitrospirae)Of proportion relative is small.

And nitrosation screw bacteria (Nitrosospira)System not detection to nitrosation screw bacteria of so inference the system inAOBBelongs to nitrosation single.This and most research results consistent the Sewage Processing 6IsMBRReactor inoculation different mud source in short-range nitrification start before and after nitrogen removal bacteria of the genus distribution characteristics from can see,3 A reactor start short-range nitrification after nitrosation single of were in excellent

Research indicate that the in organic short-range nitrification System in nitrogen removal bacteria of main for anti-nitrification bacteria and nitrification single of not found nitrification screw bacteria of this and this experimental results phase consistent.Analysis show that in a certain amount of carbon source conditions under,AOBAndNOBProduceDOCOMPETITION MECHANISM ANDAOBOkayDOOf affinity ability higher than thatNOBMakesAOBIn favorable status.Combined with this experiment the Intermittent Aeration and shortenHRT Of Style gradually Suppression,Washing reactor inNOB.At the same time only inR3Reactor start success of samples in detection to a small amount of anti-nitrifying bacteria(Denitratisoma)And anti-nitrifying bacteria(Pseudomonas)Of specific reason still need to be further study here not explain.In addition contrast inoculation sludge,R2AndR3Reactor in the Tao, the genus,In P. Of and thermal single (Thermomonas)Was reduce Trend.Analysis Three are of heterotrophic bacteria with the reactor in advantage strain nitrosation single cell bacteria of the genus enrichment disadvantages bacteria of abundance gradually reduction

The Study on Nitrogen found to sodium acetate for carbon source no matter good oxygen or anaerobic conditions all have nitrite of cumulative this is because anti-nitrifying bacteria to sodium acetate for carbon source to nitrate nitrogen for electronic receptor anti-nitrification, to lead to the nitrite of accumulation so the author think reactor in anti-nitrifying bacteria of the genus there promote the short-range nitrification of implementation.

3. Conclusion

DAll of them successfully started short-cut nitrification,R2.Minimum reactor start-up time.During the stable operation period,R1.R2.AndR3.The accumulation rate of nitrite in the reactor was stable.90%Above, andR3.The reactor showed more stable short-cut Nitrification performance..

(2.)Ace,Chao,ShannonAndSimpsonThe index results show that compared with the inoculated sludge,,R1.AndR2.The microbial abundance and diversity of the reactor were significantly lower than that of the initial inoculation.

Level,R3.The abundance of reactor species decreased slightly while the diversity level changed little..

(3.)After stable operation,3.The main bacteria in the reactor were

Change, bacteria, door (Proteobacteria) Kazuo, bar, fungus, door

Bacteroidetes)And the abundance of the Main Nitrogen Removal Function bacteria is higher than that of the inoculated sludge..Second,3.Short-range Reactor

After the success of nitrificationBeta-Proteus is the dominant bacteria in the system.

(4.)After the success of shortcut nitrification,R1.R2.AndR3.Reactor, internal, superior, potential, bacteria, genus, all sub, nitrate, chemical, Mono, cell, bacteria, genus

Nitrosomonas)Respectively, the proportion12. 8%,20. 2%

19. 7%.CompareR1.Reactor,R2.AndR3.There is a certain proportion of denitrifying bacteria in the reactor inoculated sludge, which is more conducive to the realization of short-cut Nitrification in the system..

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