**Table 1**

# Total nitrogen removal efficiency, chemical input, economic evaluation, main technical parameters of different nitrogen removal process compared to conventional process.

Operation technique Total nitrogen removal efficiency

Chemical input Economic evaluation Main technical parameters References

Partial nitrification via nitrite 1.5–2 fold increase of nitrite

reduction rates in the subsequent denitrification stage

40% reduction of COD 25% reduced oxygen demand, 300% biomass

reduction, 20% CO2 emission during denitrification

pH, temperature, DO, real-time aeration control, sludge retention time, substrate concentration, alternating anoxic and aerobic operation, inhibitor, ultrasonic treatment

[Ge et al. (2015)](#_bookmark5)

Partial nitritation /anammox ≥85% of nitrogen removal No need of external carbon

source

60% reduced oxygen demand, 80% reduced sludge production, 24 Wh/p/day, compared to a 44 Wh/p/ day consumption in conventional treatment

Carbon concentrating pretreatment, suppression of NOB especially under low temperatures (15–10 °C), intensification of anammox biofilm activity, reactor design, final polishing

[Cao et al. (2017)](#_bookmark0)

Simultaneous nitrification and denitrification (SND)

82% nitrogen removal Requirement of external carbon source

Saving cost for anoxic tank, applicable only for low C/N ratio (< 5) wastewaters

Reactor design, oxygen availability for nitrification, effective carbon source utilization for denitrification

[Guo et al. (2005)](#_bookmark1)

Shortcut nitrification and denitrification

Nitrite denitrification rate is 1.5 to 2 times higher than nitrate denitrification rate

40% lower demand of electron donors in anoxic phase

25% reduced oxygen demand in aerobic phase with 60% saving energy, applicable for high ammonium concentrations or low C/N ratios wastewaters

DO, SRT, pH, temperature, substrate concentration and load, operational and aeration pattern, inhibitor

[Peng and Zhu (2006)](#_bookmark5)

Nitritation/anammox 81% nitrogen removal No need of external carbon source

60% reduced oxygen demand, energy recovery by methane production, minimal surplus sludge production, consumption of inorganic carbon CO2, no nitrous oxide emission, decrease in energy consumption from 2.66 to 1.50 kWh per kg N removed for reject water treatment

Poor effluent water quality, need of post- denitrification process

[Du et al. (2015)](#_bookmark6); [Ma](#_bookmark2) [et al. (2016)](#_bookmark2); [Li et al.](#_bookmark3) [(2016a)](#_bookmark3)

Simultaneous partial nitrification, anammox, and denitrification (SNAD)

99% nitrogen removal Low concentrations of organic matter

Simultaneous removal of inorganic nitrogen and organic carbon, applicable for wastewater with complex composition and high ammonia concentration and low C/N ratio

Intermittent aeration, pH, DO [Zhang et al. (2017)](#_bookmark7)

Denitrifying ammonium oxidation (DEAMOX)

94% nitrogen removal,

simultaneous nitrate and ammonium removal

80% reduced demand of organic carbon

100% reduced aeration demand, 64.8% reduced

sludge production, low nitrogen contained wastewater, low/high-strength nitrate and ammonium containing wastewater, reduced greenhouse gas (CO2 and N2O) emission

Co-existence of partial-denitrification and anammox bacteria

[Du et al. (2017)](#_bookmark8)

Partial-denitrification/anammox More than 90% nitrogen

removal

79% reduced demand of organic carbon

45% reduced oxygen demand, reduced biomass production, applicable for high-strength wastewater

Avoiding high organic matter in the effluent of partial denitrification reactor

[Ma et al. (2016)](#_bookmark2), [Cao](#_bookmark4) [et al. (2016)](#_bookmark4)

Denitrification by bioelectrochemical systems

100% nitrate removal Required carbon source and buffering agent

100% reduced oxygen demand, producing power and current densities of 2.1 W/m3 and 26.6 A/m3

Generation of high concentrations of ammonium in anode and cathode

[Naga Samrat et al.](#_bookmark8) [(2018)](#_bookmark8)

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# COD- chemical oxygen demand; DO- dissolved oxygen concentration; SRT- sludge retention time; Wh/p/day- watt hours per person per day.