Denitrification and energy conservation study at Hutchinson Wastewater Treatment Facility

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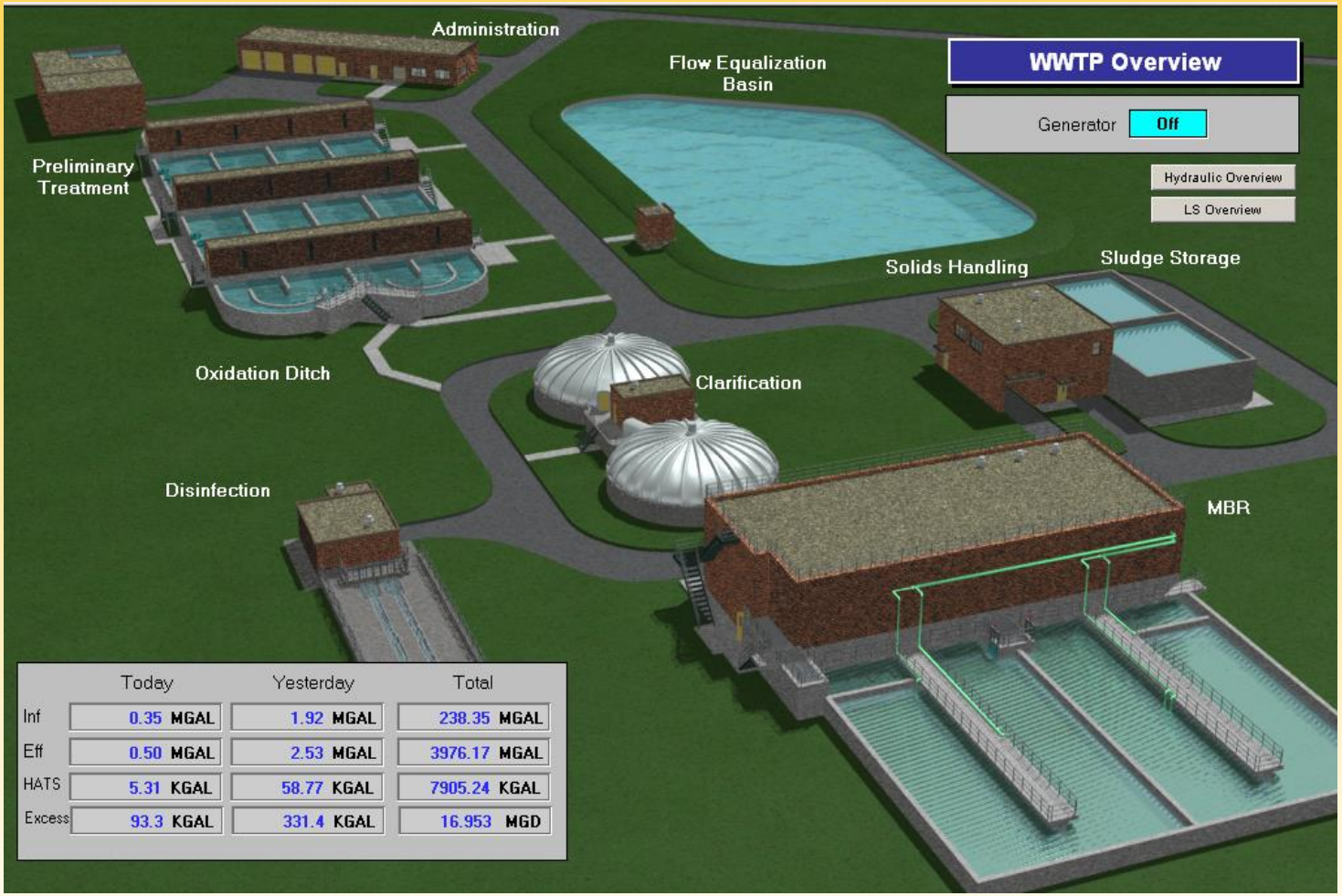
Facility Overview

Hutchinson Wastewater Treatment Facility

- Year in service: 1988
- Designed flow rate: 3.67 million gallon per day
- Treatment capacity: 7,000 lbs Biological Oxygen Demand (BOD) per day
- Energy consumption: ~100,000 kWh per month

Facility Overview (cont.)



Motivations for Change

- Process modification for nitrate removal
- Opportunity in energy conservation through aeration control

Approach

- Literature review
- Bench study of Denitrification rate
- Monitoring the power of aeration device
- Plant trials and data collection

Background of denitrification

Denitrification: the biological process that convert nitrate to harmless nitrogen gas

$$2\,NO_3^- + 10\,e^- + 12\,H^+ \rightarrow N_2 \uparrow + 6\,H_2O$$

Process requirement:

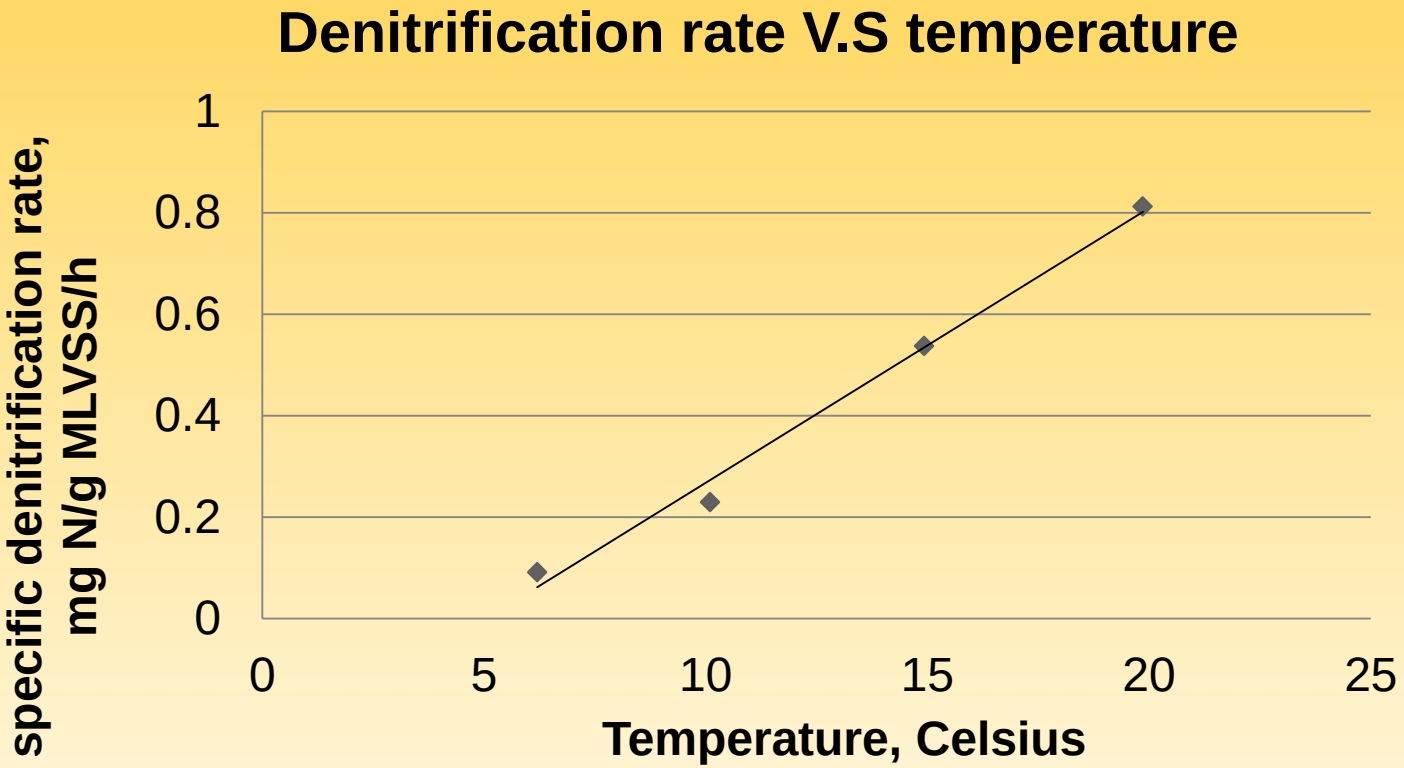
- Absent of oxygen (anoxic condition)
- Present of Microorganism (facultative aerobes) and readily biodegradable organics

Denitrification rate study

$$r_D = -\frac{dS}{dt} = xK_s$$

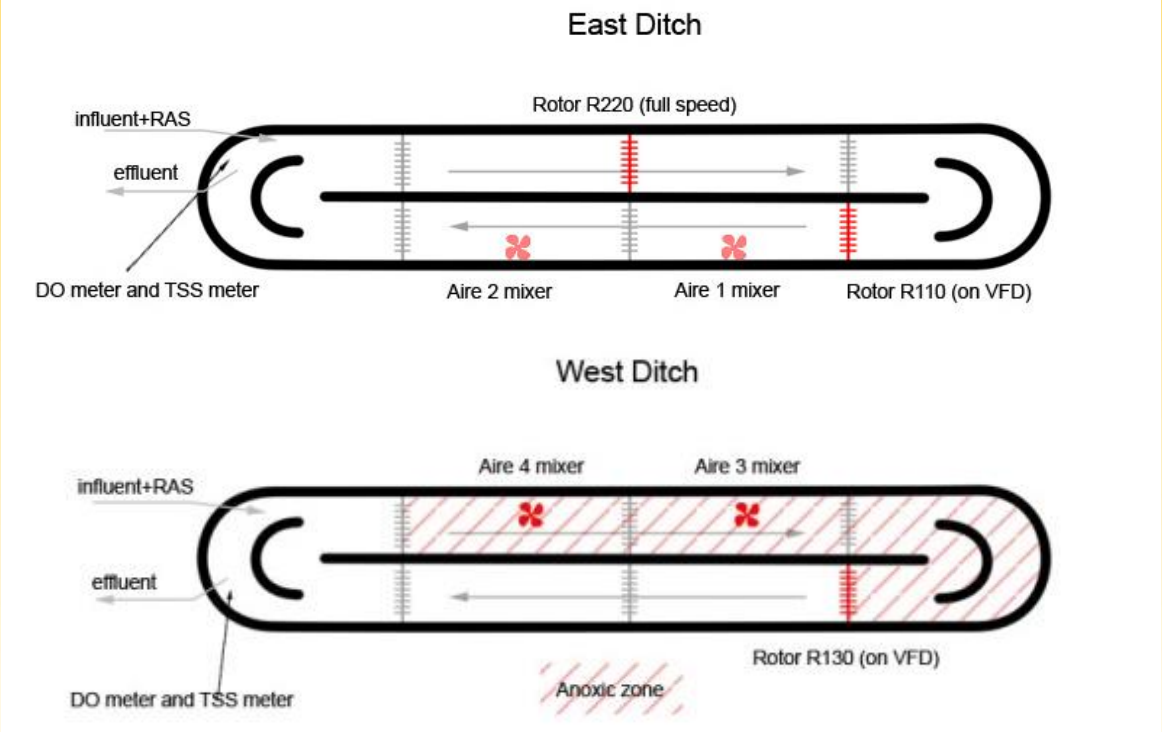
r_D: denitrification rate, mg NO_3^-N/L·h
S: nitrate concentration, mg NO_3^-N/L
x: denitrification bacteria concentration expressed as mixed liquor volatile suspended solid (MLVSS), mg MLVSS/L
K_s: specific denitrification rate, mg NO_3^-N/mg MLVSS·h

Denitrification rate study



Modification I

	West ditch	East ditch
Number of aeration rotors	1	2
D.O maintaining point	0.5 mg/L	2.0 mg/L



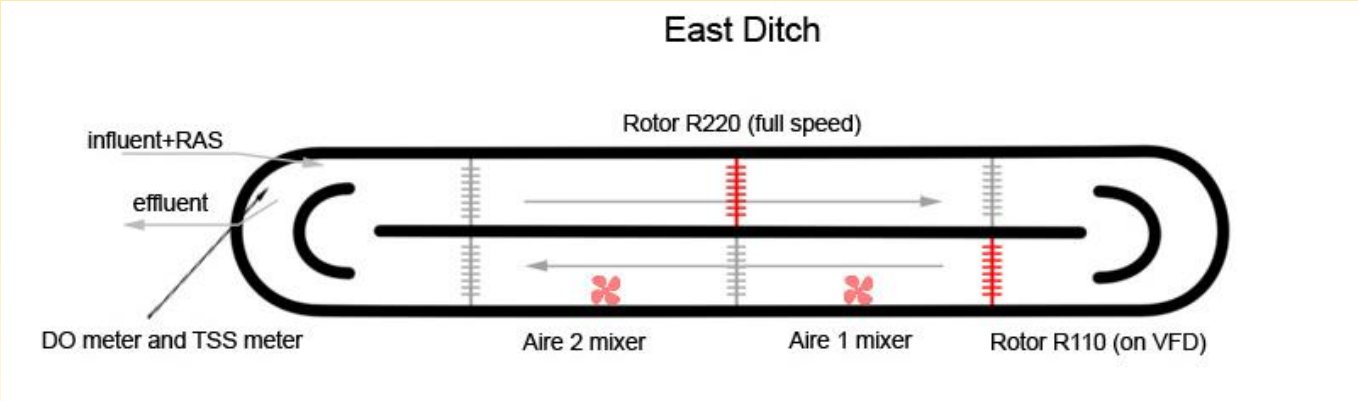
Modification I (cont.)

- An anoxic zone which is approx. 50% of total activated sludge reactor volume was developed
- The modification removed 15-20mg/L more nitrate than the experiment control
- System instability caused by inadequate mixing was observed by the end of the test
- No significant energy saving

Modification II

Single-ditch operation

- West ditch was shut down
- DO maintaining point was lowered from 2mg/L to 1mg/L



Modification II (cont.)

- No degradation in treatment quality
- Energy consumption was reduced by nearly a half, resulting in $3,500 in monthly electricity bill
- Small anoxic zone was developed but improvement on denitrification was not significant

Successful Process Changes

	Nitrate concentration, mg/L	Energy saved per month, kWh	Savings in monthly electricity bill
Baseline	26 ±7	-	-
Modification I	12 ±4	3,263	$424.88
Modification II	-	40,089	$3,480.08

- Modification I enhances nitrate removal of the activated sludge system and slightly reduces energy usage
- Modification II cut energy usage by a half while have limited improvement on nitrate removal

Recommended Future Projects

- To find a optimized mixing strategy for Modification I
- To test methanol as external carbon source for complete nitrate removal

Personal Benefits

- Understanding in process control
- Industrial environment exposure
- Project management
- Communication skill

Thank you!