USE OF A NON-VENTURI AIR INJECTION SYSTEM FOR PRODUCTION OF *Litopenaeus vannamei* IN BIOFLOC-DOMINATED ZERO-EXCHANGE RACEWAYS

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Introduction

Use of greenhouse-enclosed super-intensive limited discharge biofloc systems can potentially:

- Reduce water usage
- Reduce effluent discharge
- Increase biosecurity
- Be constructed close to markets

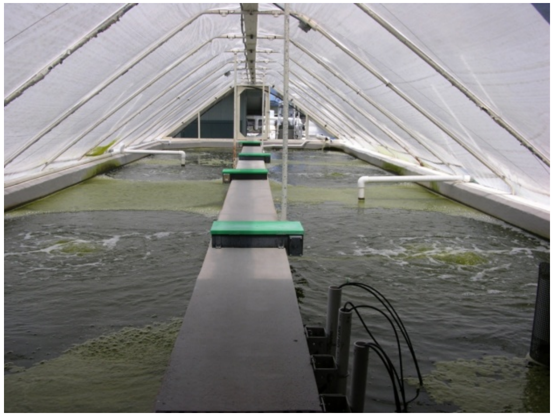
Introduction

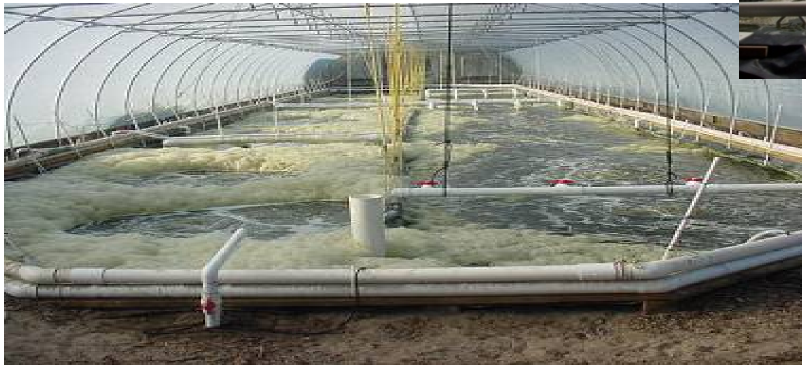
- Biosecure enclosed systems with advanced engineering

Introduction

Super-Intensive

- Capable of high output per unit area with multiple crops per year

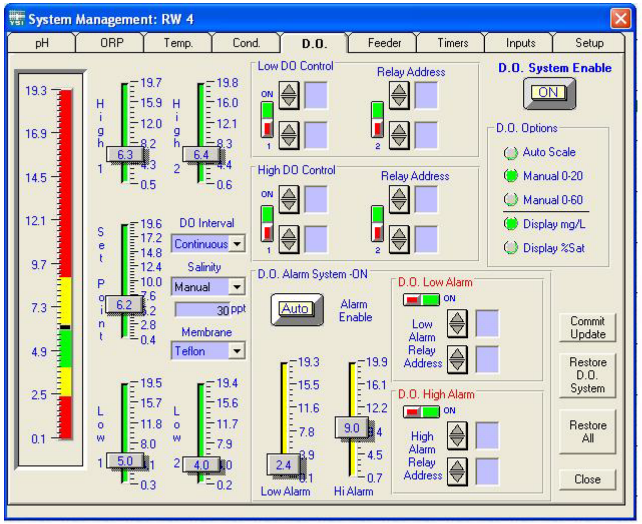


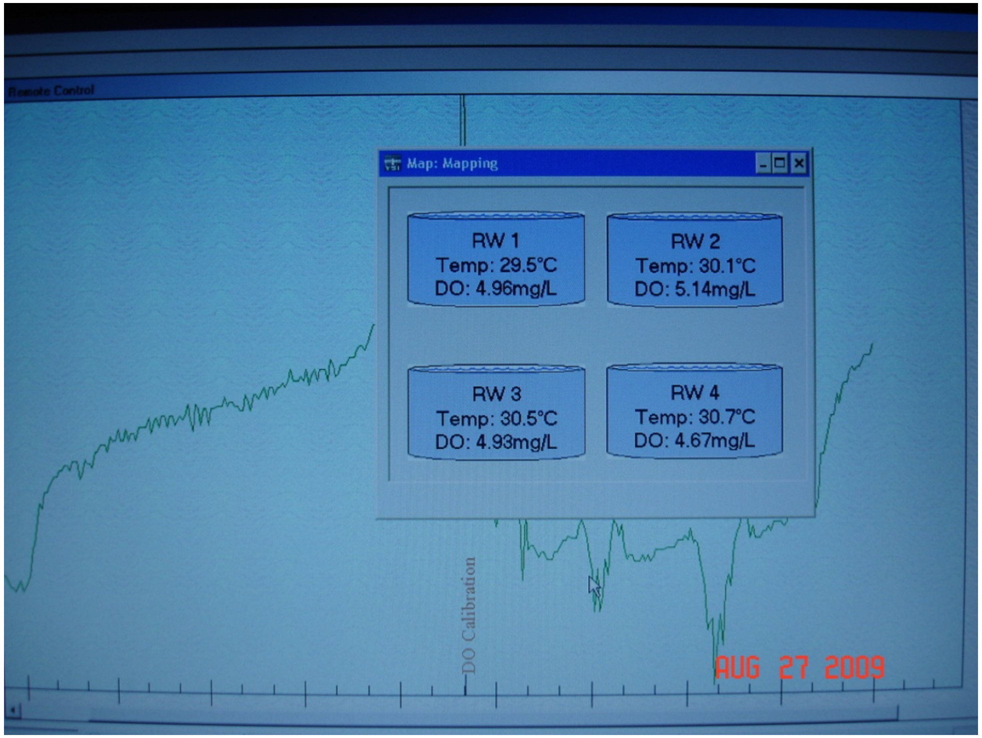


Introduction

Super-Intensive

- Automated systems for environmental and water quality control





Introduction

- These systems require substantial inputs to satisfy the high oxygen demand of the shrimp and the microbial communities

Introduction

- Previous studies at the Texas A&M AgriLife Research Mariculture Lab have utilized a combination of a pump driven Venturi injectors, airlifts & air diffusers to provide adequate DO and mixing
- Recently we began looking into a non-Venturi alternative currently used in several wastewater treatment facilities in Florida
- This technology may be successfully transferred to biofloc systems and other types of aquaculture

Introduction

- According to the manufacturer these pump-driven nozzles are capable of providing a 3:1 air to water ratio

- In contrast, our current Venturi system provides a ratio of < 1:1 and requires injection of supplemental oxygen to maintain adequate DO levels at high biomass loading (>7-8 kg/m^3)

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Introduction

2011

- In 2011 we conducted an 106-day trial in 100 m^3 raceways (RWs) stocked at 390 shrimp/ m^3
- 25 g shrimp at 8.4 kg/m^3 with weekly growth of 1.46 g/wk, survival of 83%, and FCR of 1.7
- Home-made foam fractionators and settling tanks were used to control solids
- The new nozzles provided adequate aeration and mixing throughout the water column; eliminating the need for an air blower, air diffusers, airlifts, and supplemental oxygen

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Objectives

2012

- Evaluate the ability of the nozzles to maintain adequate DO levels and mixing in an intensive RW system and reduce or eliminate the use of pure oxygen
- Evaluate the effect of the nozzles on shrimp performance
- Determine if the foam fractionators and settling tanks used in the 2011 study could control particulate matter and dissolved organics in the system despite the anticipated increase in loading (e.g., biomass, feed input)

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Materials & Methods

- 14 nozzles were positioned inside each RW
- Each RW had 1 additional nozzle powering a home-made foam fractionator
- Each RW had two 2 hp pumps which could be operated independently or simultaneously depending on loading factors (e.g., biomass, DO concentration)

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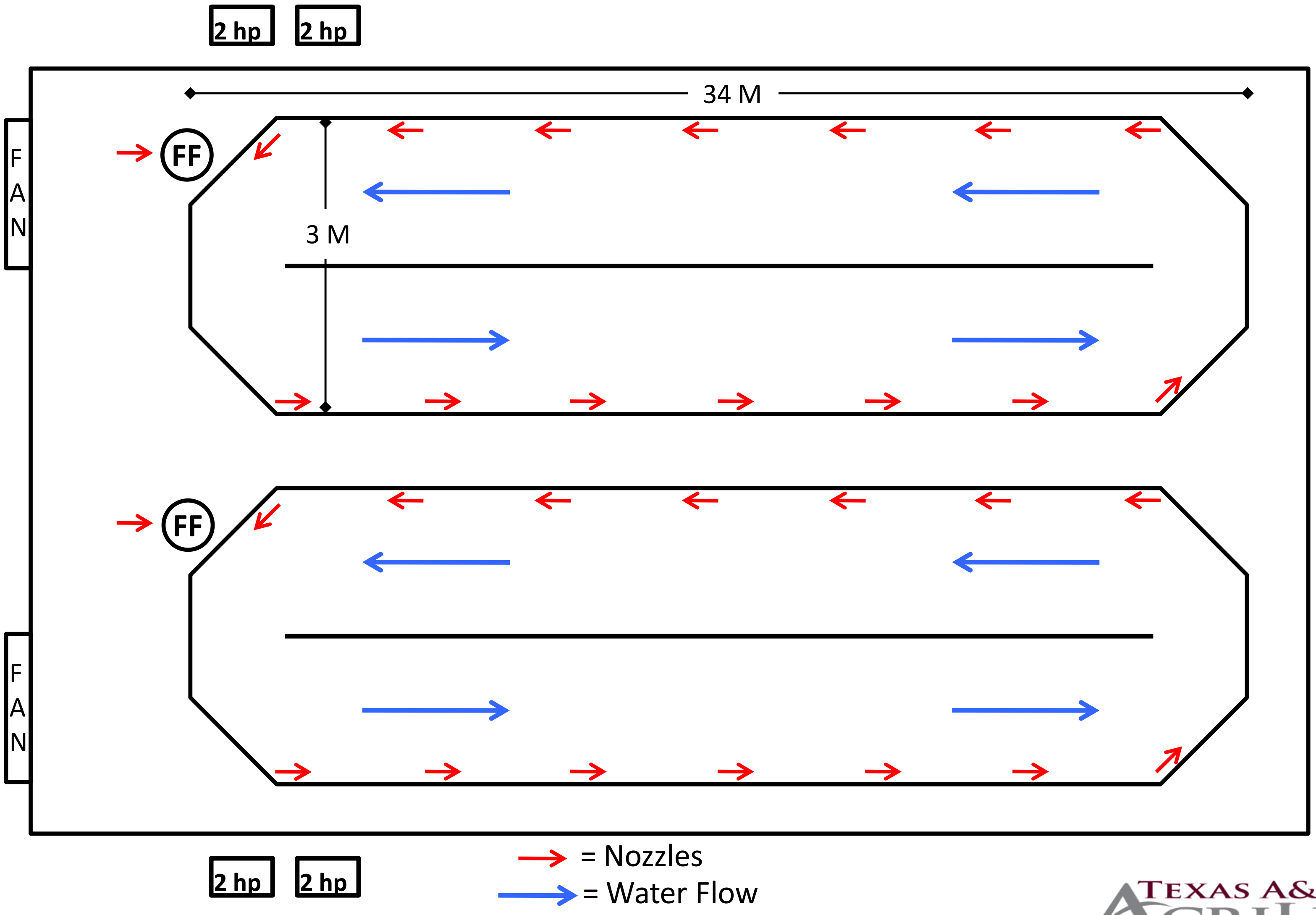
New 100 m^3 RWs at Texas AgriLife



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Materials and Methods

- Home-made foam fractionator
- One nozzle
- Flow rate ≈ 28 Lpm
- Size ≈ 30 cm diameter at base, ≈ 2 m tall

Materials and Methods

Settling Tanks

- Conical tank 2 m^3
- Flow rate 8.5 to 20 Lpm
- Flow from side-loop off aeration pump
- Land application of sludge

Materials and Methods

- Study was conducted over 63 days
- Two 100 m^3 RWs
- RWs were initially filled to 72 m^3 with a mixture of seawater (23 m^3), freshwater (24 m^3), and biofloc-rich water (25 m^3) from a previous study
- On Day-7 RWs were filled to capacity (100 m^3) with a mixture of seawater (14 m^3) and freshwater (14 m^3)
- Freshwater was added to offset losses due to evaporation and solids removal

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Materials and Methods

- Shrimp used in the current study were a cross produced from Taura Resistant and Fast-Growth genetic lines (Shrimp Improvement Systems, Islamorada, FL)
- Juvenile shrimp (3.60 g) were stocked at 500/m^3 (1.8 kg/m^3)
- Shrimp were fed a 35% CP commercial feed (Hyper-Intensive 35 Extra Short-cut, Zeigler Bros., Gardners, PA)
- Feed was delivered by belt feeders 24h/day

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Materials and Methods

WQ

- Temperature, salinity, dissolved oxygen, and pH were recorded twice daily
- Settleable (SS) were measured daily
- Total suspended solids (TSS) were measured twice/wk
- NH_4-N, NO_2-N, NO_3-N, VSS, turbidity, $cBOD_5$, and RP were monitored weekly
- Alkalinity was adjusted to 160 mg/L daily using sodium bicarbonate
- Each RW was equipped with a YSI 5200 monitoring system to provide continuous DO and temperature readings

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Summary of mean twice-daily water quality parameters during the 63-d grow-out study

		Temp (°C)	Salinity (ppt)	DO (% Sat)	DO (mg/L)	pH
AM	Mean	29.3	29.3	87.2	5.6	7.1
	Min	28.2	25.4	77.6	4.9	6.6
	Max	30.6	34.7	108.4	6.8	7.4
PM	Mean	29.8	29.2	84.2	5.4	7.1
	Min	28.4	25.9	68.4	4.4	6.2
	Max	31.1	34.8	96	6.3	7.5

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Results

Nitrogen

- Mean ammonia-N levels were low: 0.3 mg/L (min: 0.15 max: 0.59 mg/L)
- Mean nitrite-N levels were low: 0.36 mg/L (min: 0.10 max: 1.4 mg/L)
- Nitrate-N levels increased from 67.0 mg/L at stocking to about 308.8 mg/L at harvest

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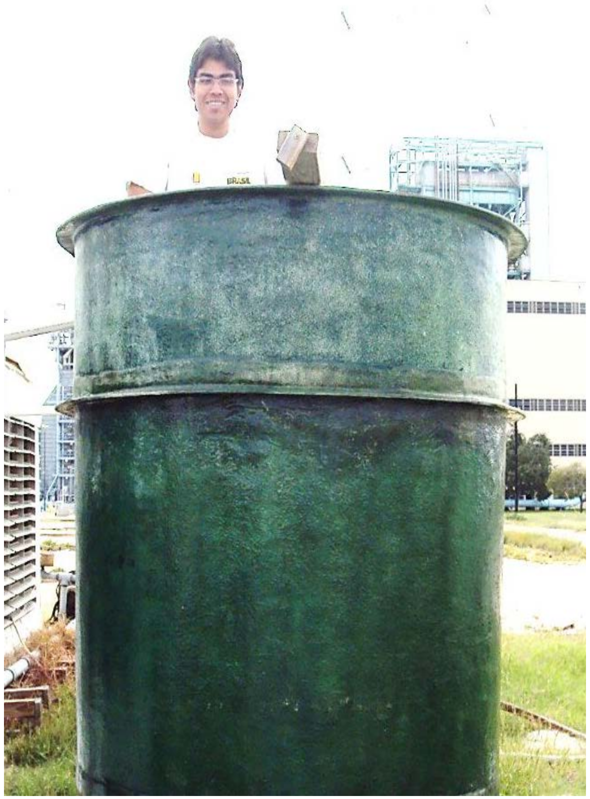
Results

- Foam fractionator use began on Day-7
- Settling tanks on Day-22
- Mean TSS levels were 292 mg/L
- Mean SS levels were 12 mL/L
- This combination of foam fractionators and settling tanks was adequate to control solids within the targeted ranges at feed loads of up to 22 kg feed/RW/d



Results

Oxygen Usage

- Despite relatively high mean DO levels (85.7 % saturation) supplemental oxygen was provided intermittently between Day-22 and Day-44 for various reasons
- The second 2 hp pump was engaged on Day-44, when biomass was estimated to be about 8.2 kg shrimp/m^3
- However, no oxygen supplementation was provided during the final 16 days until harvest (9.03 kg shrimp/m^3)

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Summary of 63-d grow-out study in two 100 m^3 raceways stocked with *L. vannamei* (3.60 g) at 500/m^3

RW	Yield (kg/m^3)	Av. Wt. (g)	Survival (%)	FCR	(g/wk)
1	9.20	22.76	80.8	1.43	2.13
2	8.86	22.67	78.2	1.53	2.12
Average	9.03	22.72	79.5	1.48	2.13

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Results and Discussion

Shrimp

- FCRs in 2012 improved over the 2011 trial (1.48 vs. 1.77, respectively)
- Survival was moderate (79.5%)
- The major improvement was sustained weekly growth of more than 2 g/wk
- Based on growth per week this reduced the grow-out period required to achieve 22.7 g shrimp from 94 days (2011) to only 63 days in the current study

Future Considerations

- Maintain pH at more optimal levels
- Reduce FCR
- Continue to use fast growth line
- Explore heating and cooling options
- Study the changes in ionic composition over time
- Denitrification, sludge digestion and disposal
- Integrate automatic feeders with our DO monitoring system

Acknowledgements

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