Limited Water Exchange Shrimp Culture

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Shrimp farm !

&

Shrimp harm ?

Introduction

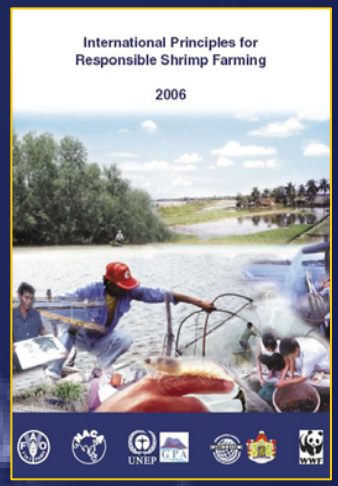
- Shrimp mariculture is one of the most important aquaculture industries in the west coast of Korea adjacent to the Yellow Sea.
- The most shrimp farms are under semi-intensive culture that requires high water exchange.
- Mass mortality could be happen anytime and the shrimp production can not be predictable.
- Sustainable production is now becoming limited by epizootic disease outbreaks.

Introduction

- Semi-intensive shrimp culture system requires high water exchange to maintain water quality.
- The possible introduction of harmful pathogen with incoming water and release of nutrient-rich effluent into the receiving sea are issue of concern.

Introduction

- In the near future, the shrimp farming industry will be required to meet tougher global standards for effluent water releases.
- These issues will force the shrimp farming industry to seek out more sustainable management practices.
- Limited water exchange shrimp culture system is an option that can reduce both disease introduction and the negative environmental impact created by semi-intensive shrimp farms.



Objective

- To develop the super-intensive shrimp culture methods under limited water exchange to reduce environmental impact in the Yellow Sea coast of Korea.

Introduction to Trials

- Nursery Trials
  - Under limited water exchange
  - Greenhouse-enclosed raceway (Indoor)
- Grow-out Trials (1)
  - Under limited water exchange
  - HDPE-lined pond (Outdoor)
- Grow-out Trials (2)
  - Under limited water exchange
  - Greenhouse-enclosed raceway (Indoor)

Nursery Trials

- Four 13-18 m^2 raceways at WSMRC in Korea
- Pacific white shrimp, *Litopenaeus vannamei* (0.08 g) were stocked at a density of 3,000-5,625 / m^3
- Operated with limited water exchange for 42 days.

Summary of nursery rearing

Table. 1. Summary of water quality parameters during the super-intensive nursery culture with *Litopenaeus vannamei*

	Water Temp.(C)	DO (ppm)	Salinity (ppm)	pH	TAN (ppm)	NO_2-N (ppm)	Alkalinity (ppm)	Turbidity (NTU)	Water exchange (%/day)	Molasses (L/day)
Tank 1	30.0 27.8-30.9	11.8 5.6-18.9	32.1 30.6-33.3	7.28 6.7-8.0	1.32 0.4-6.0	19.51 4.0-40.0	114.3 75-130	27.2 8.6-63.7	3.2	0.083
Tank 2	30.3 28.7-31.0	9.5 5.0-18.1	32.1 31.2-33.7	7.19 6.5-7.9	1.40 0.5-2.8	22.07 3.0-45.0	106.9 55-140	31.6 5.5-58.5	3.4	0.083
Tank 3	30.2 28.9-30.8	9.4 5.6-17.0	32.6 31.4-34.4	7.32 6.6-8.2	1.11 0.2-2.8	18.51 3.6-40.0	110.0 65-130	33.4 11.7-98.9	3.1	0.102
Tank 4	30.0 28.9-30.8	10.1 5.7-19.6	32.4 31.3-33.3	7.39 6.8-8.9	1.42 0.2-6.0	18.45 3.5-40.0	110.0 70-130	26.6 9.0-41.5	2.7	0.113

Table. 2. Summary of nursery production with *Litopenaeus vannamei* in four raceways under limited-water exchange

	Area (m^2)	Initial B.W.(g)	Stocking density		Final B.W.(g)	Yield		Survival rate(%)	FCR
			(/m^2)	(/m^3)		(kg/m^2)	(kg/m^3)		
Tank 1	13	0.09	1,846	3,000	1.73	1.53	2.49	48.0	1.02
Tank 2	13	0.09	3,462	5,625	1.45	1.89	3.31	40.6	0.79
Tank 3	18	0.08	2,333	3,818	2.03	2.58	4.22	54.4	1.03
Tank 4	18	0.08	3,333	5,455	1.97	2.51	4.1	38.2	1.29

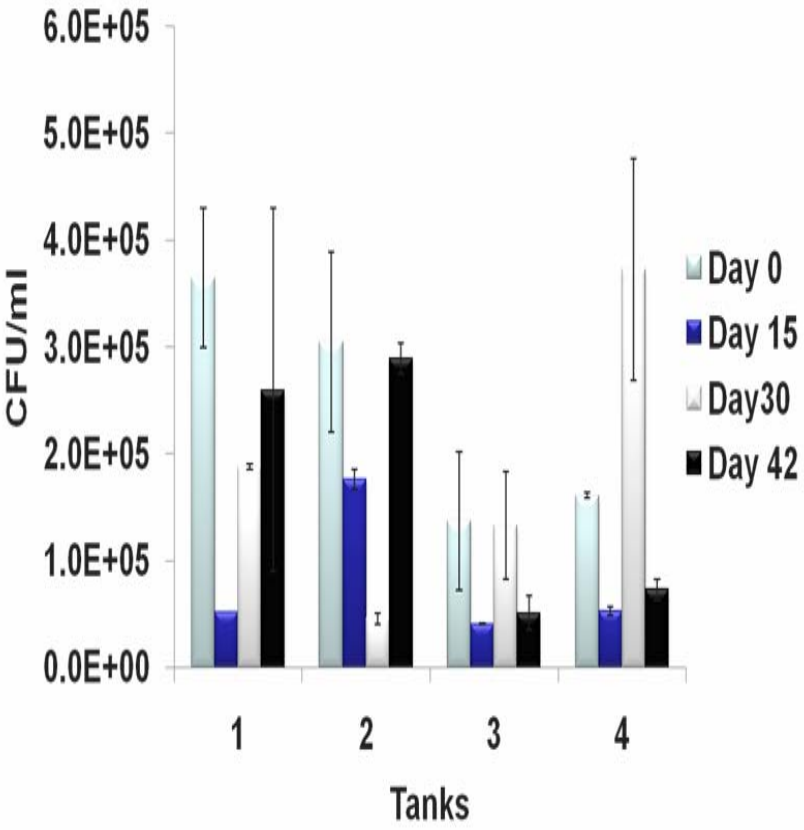


Table 8. Ratio (%) of heterotrophic bacterial community distribution in nursery raceways.

Heterotrophic bacteria	DAYS			
	0	15	30	42
Microbacterium esteraromaticum	33.33	0	0	0
Microbacterium kitamiense	33.33	0	0	0
Microbacterium spp.	0	0	0	10.52
Tenacibaculum aestuarii	11.11	14.28	92.3	42.11
Cyclobacterium linum	5.55	0	0	0
Staphylococcus epidermidis	5.55	0	0	0
Pseudomonas spp.	0	56.14	0	47.37
Pseudoalteromonas sp.	0	28.57	3.85	0
Vibrio spp.	11.11	<1	3.85	<1
other groups	<1	<1	<1	<1

Total heterotrophic bacterial count and community distribution in nursery raceways.

Grow-out Trials (1)

- Two 500 m^2 HDPE-lined ponds at WSMRC in Korea
- Pacific white shrimp, *Litopenaeus vannamei* (PL_{15}) were stocked at the density of 300 /m^3
- Operated with limited water exchange for 91 days

Summary of grow-out trials(1)

Table 3. Summary of water quality parameters in grow-out trial *with Litopenaeus vannamei* in HDPE-lined ponds.

	Water Temp.(℃)	DO (ppm)	Salinity (ppm)	pH	TAN (ppm)	NO_2-N (ppm)	Alkalinity (ppm)	Water exchange (%/day)
Pond 1	25.3 19.0-30.9	5.81 3.84-7.49	25.3 21.8-28.1	7.44 7.15-8.23	2.7 0-10.0	6.0 0-21.0	126 95-170	<0.1
Pond 2	25.3 19.8-30.7	5.75 3.36-7.17	25.6 22.2-28.5	7.43 7.01-8.19	2.43 0-10.0	5.3 0-24.0	125 95-170	<0.1

Table 4. Summary of stocking, harvest and survival information from grow-out trial with *Litopenaeus vannamei* in HDPE-lined ponds

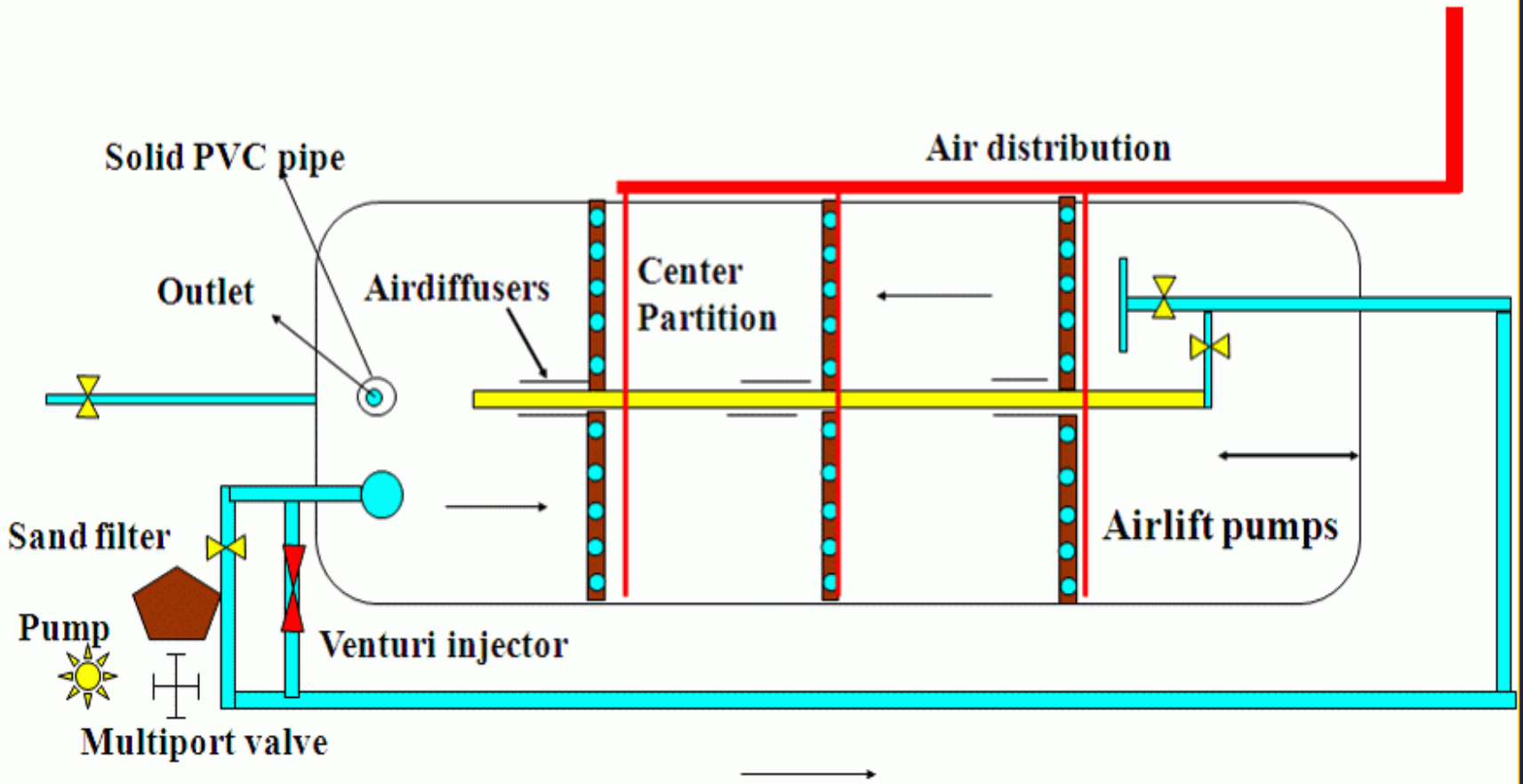
	Stocking			culture period (days)	Harvest			survival (%)	FCR
	B.W.(g)	Total No	density (/m^2)		B.W.(g)	total yield (kg)	production (kg/m^2)		
Pond 1	0.0015	150,000	300	91	12.5	1,362	2.72	72.6	1.39
Pond 2	0.0015	150,000	300	91	12.2	1,282	2.56	70.1	1.38

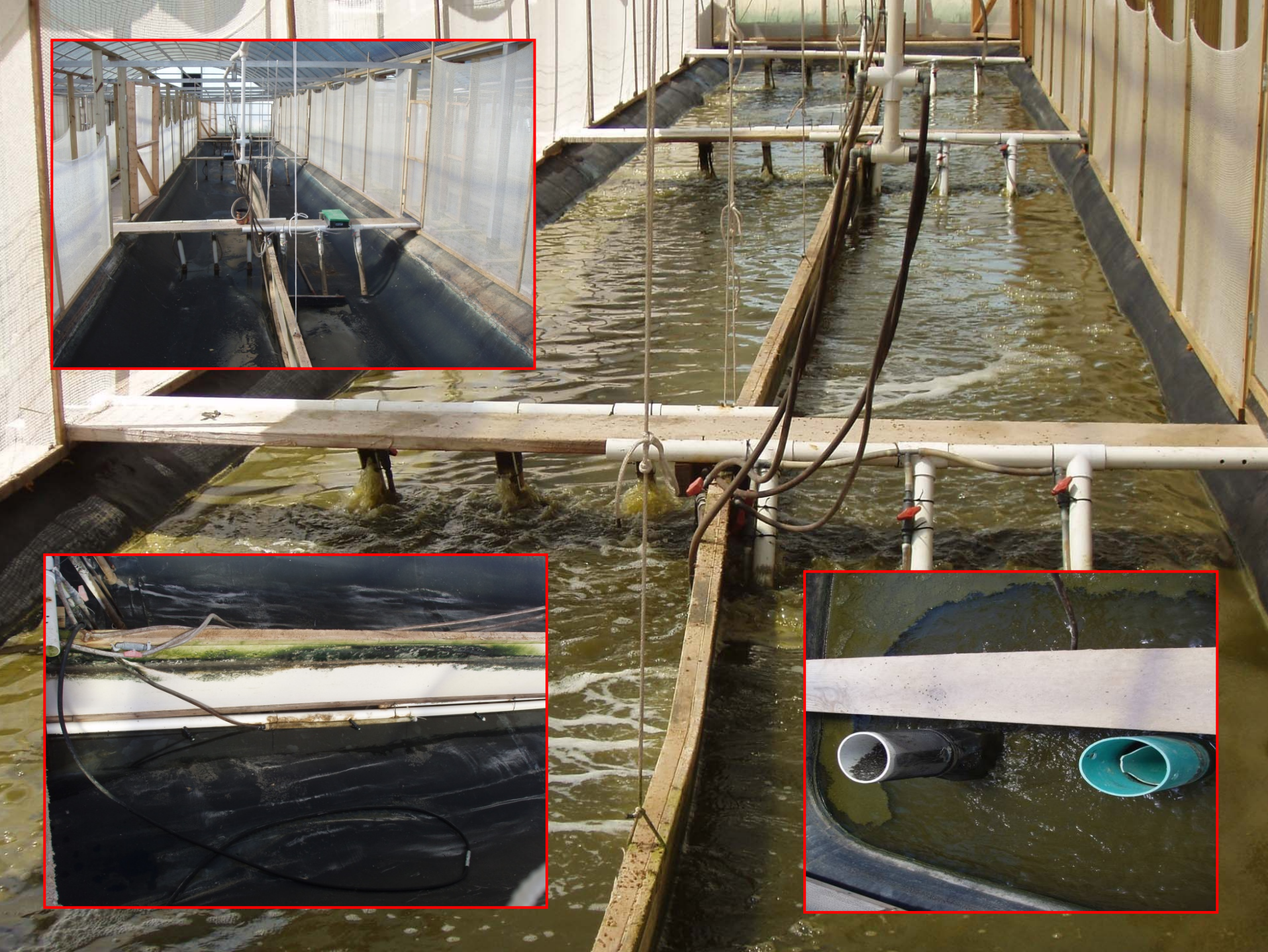
Grow-out Trials (2)

- Four 68.5 m^2 EPDM–lined raceway at TAES, Texas A&M Univ. in USA
- Pacific white shrimp, *Litopenaeus vannamei* (1.25 g) were stocked at a density of 530 shrimp/m^3
- Operated with limited water exchange for 94 days

- To study the effect of particulate removal by foam fractionation and settling processes on selected water quality indicators in a super-intensive culture system operated with no water exchange

Raceway Setup - Top View



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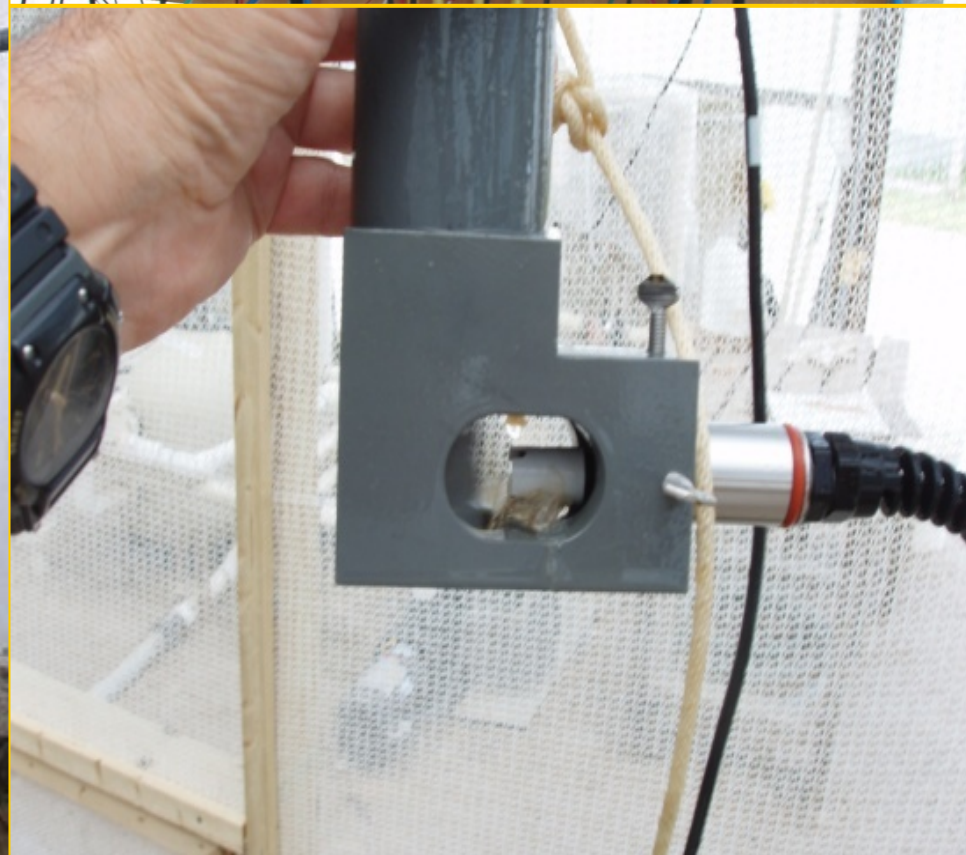


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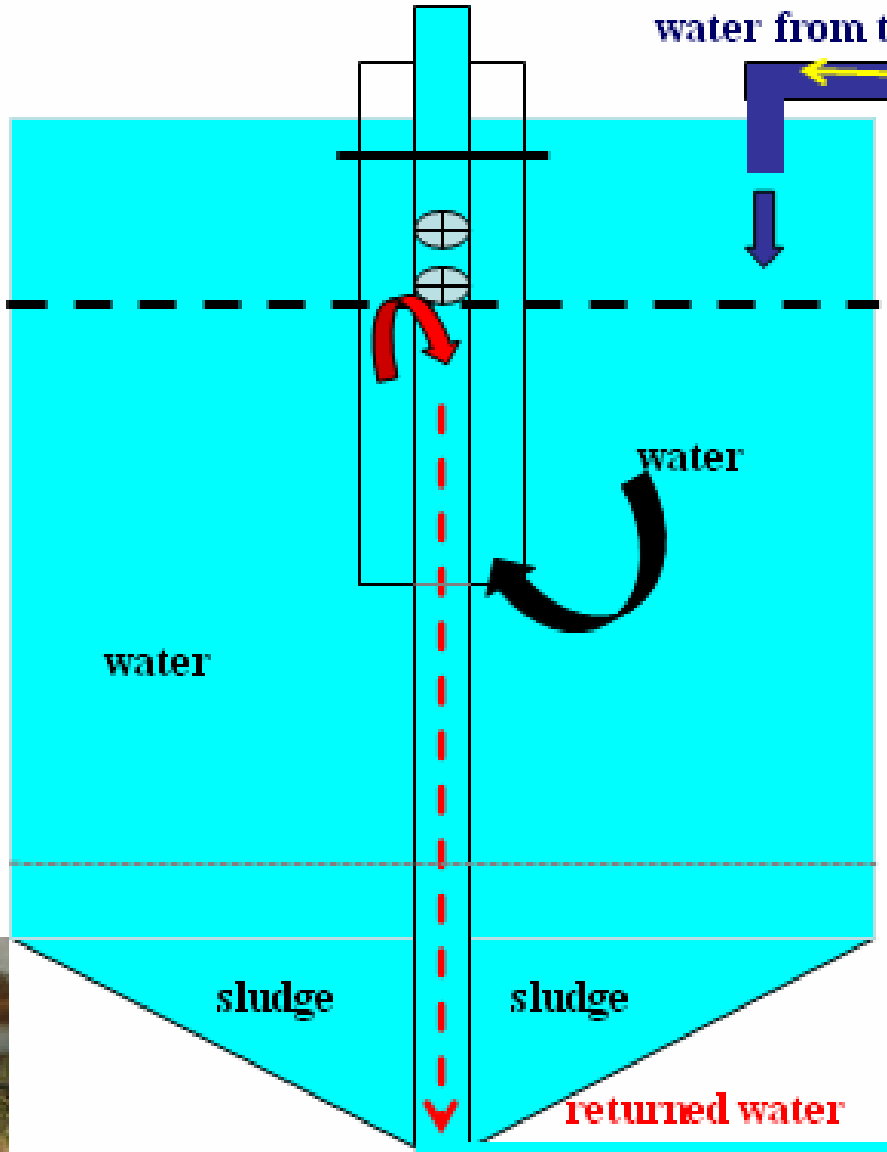
Foam Fractionator

Settling Tank Setup




CARDINAL

Summary of daily WQ for the raceways grow-out study

RW	Temp. (C)		DO (mg/L)		pH		Salinity
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	(ppt)
FF [1]	29.0	29.9	5.1	4.5	7.3	7.3	33
ST [2]	28.7	29.7	5.1	4.6	7.3	7.3	33

[1] RW's operated solely with FF
[2] RW's operated solely with settling tanks

Summary of weekly WQ for the raceways grow-out study

RW	$cBOD_5$	TAN	NO_2-N	NO_3-N	RP	TSS	VSS	SS	Turb.	Algae
	(mg/L)							(mL/L)	(NTU)	($x10^4$)
FF [1]	35	0.10	0.02	74	17	588	414	49	307	75
ST [2]	33	0.11	0.01	120	17	458	349	33	276	53

[1] RW's operated solely with FF

[2] RW's operated solely with settling tanks

Table 7. *Litopenaeus vannamei* performance in a 94 d grow-out trial in greenhouse-enclosed RW's stocked with juveniles (1.25 g) at a density of 530/m³ & operated with no water exchange

Treatment	Wt_f (g)	Growth (g/wk)	Yield (kg/m³)	Yield** (kg/m²)	Sur. (%)	FCR	Water Use (L/kg Shrimp)
Settling-1	18.4[a]	1.32	9.29*	5.02	88.3	1.21	155
Settling-4	18.5[a]	1.23	8.63*	4.50	80.5	1.36	142
FF-2	17.4[b]	1.22	8.57*	4.38	80.5	1.40	152
FF-3	17.3[b]	1.30	7.92	4.66	80.0	1.30	147

* Based on RW water volume at harvest (37 m³)

** Based on RW bottom area of 68.5 m²

Discussion

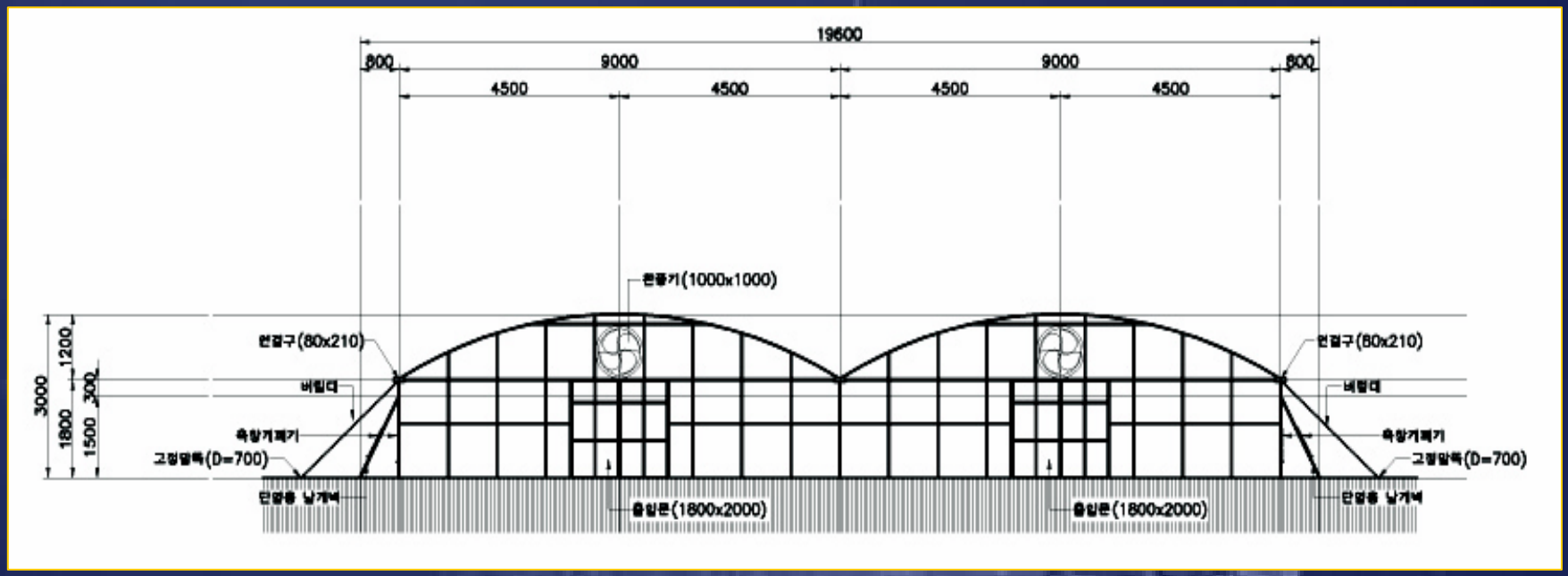
- All shrimp from 3 different trials for disease diagnosis showed no signs of viral or bacterial infections.
- Higher survival and yields with lower FCR and limited water use were found in the raceways for nursery rearing and grow-out in the lined ponds .
- As the levels of ammonium and nitrite were controlled to lower in raceway with NO_3 settling tanks than foam fractionators.

Conclusion

- Pacific white shrimp, *Litopenaeus vannamei* can be successfully cultured at high density in raceways and HDPD-lined ponds with limited water exchange in Korea.
- These trials will go far toward reducing the environmental impact to the Yellow Sea.
- Future studies will evaluate the feasibility of increasing shrimp biomass load at harvest to about 10 kg/m^3 in Korea.

YSLME Project

- Title : Strategic Action Program Demonstration Activity for Limited Water-exchange Shrimp Culture
- Period : August 2008 through September 2009
- Activities : The 1st year (2008)
  - Grow-out trials with HDPE-lined ponds
  - Construction of greenhouse-enclosed raceway
  - Study on dynamics of heterotrophic bacterial communities
- Activities : The 2nd year (2009)
  - Grow-out trials with greenhouse-enclosed raceways
  - Conducting the best management practice (BMP) of systems
  - Implementation of technology to private sector
  - Designing the prototype (Model farm) of the system in commercial scale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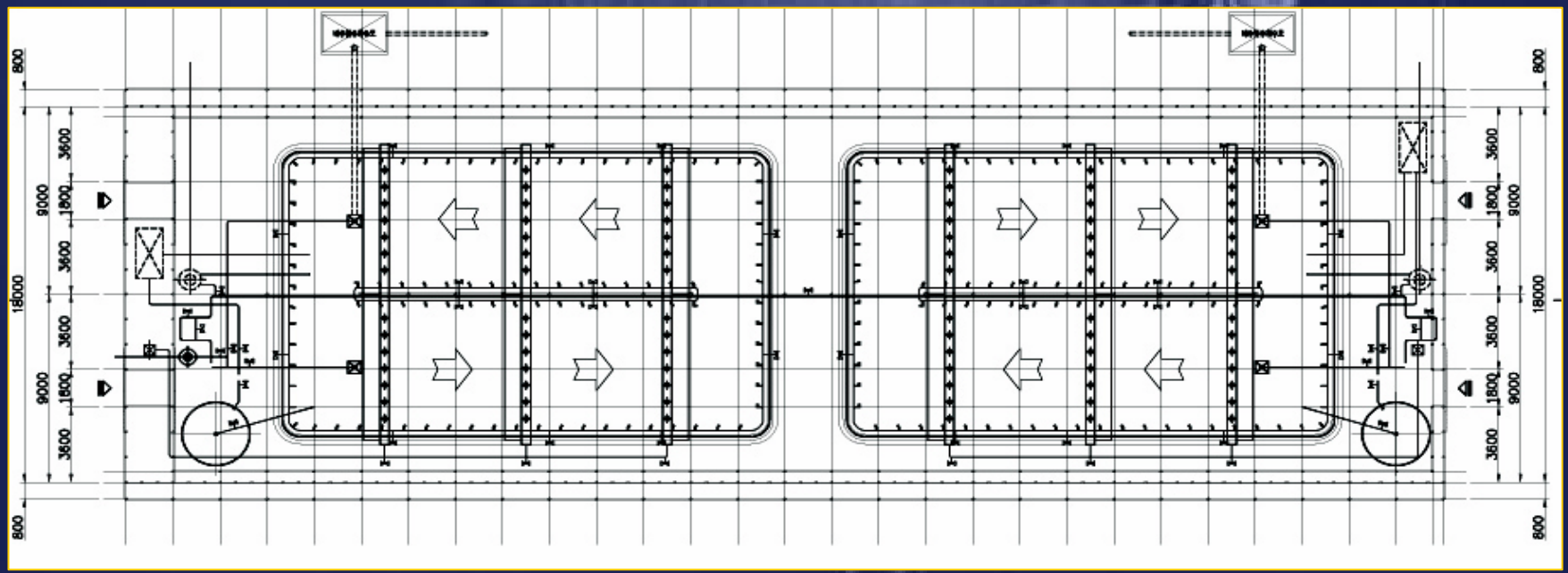
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