Technological Advances in the Manufacture of Feeds for Marine Farmed Shrimp: Pelleted versus Extruded Rations

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WENGER

Processing of Shrimp Feed: Extrusion versus Pelleting?

Reported advantages of extrusion process:

1) Higher starch gelatinization
2) Less fines in feed
3) Increased water stability
4) Flexibility in formulation of recipes
5) Product sizes down to 0.8 mm

Advances in Extrusion Process

1) Product densities similar to pelleted feeds
2) Protein levels in diets can be varied from 25-45% to match culture system
3) Fat levels can exceed pelleted products
4) Capacities have increased significantly

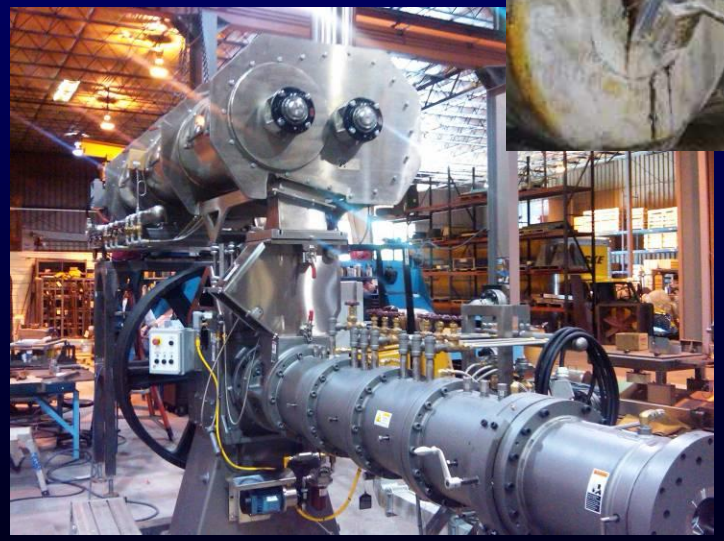
Dr. Tacon Reported in Brasil, WAS 2011

Extrusion Cooking of Shrimp Feeds Can:

- Reduced feed ingredient costs
- Improved feed water stability
- Reduced nutrient leaching
- Improved nutrient digestibility
- Increased oil & energy addition
- Higher starch gelatinization
- Increased feed efficiency
- Increased potential shrimp growth & profit per unit of feed intake

Comparison of Extrusion and Pelleting

1) Operating costs
2) Potential savings in recipe costs
3) Effects on feed performance



Comparison of Operating Costs

1) Operating costs for extrusion typically reported to be $20-25/ton higher than for pelleting
2) Increasing extrusion rates with smaller extruder size can greatly reduce operating costs

Process	Processing Costs ($/t)
Pellet Mill	45.00
C²TX Extrusion	69.00

C²TX and Dryer/Cooler versus Pelletmill, post conditioner and cooler.

Assume 2mm diameter at 5 tons per hour. 5000 hours per year or 25,000mt per year

Cost of equipment

Extrusion		Pelleting
1280200.00 USD (cooler at 150,000.00) Extruder Dryer/cooler		500,000.00 USD 2 each at 250,000.00 USD Pelletmill post conditioner Cooler
	Capital Cost and amortization 5 years 4% interest 0% salvage	
282,922.00/yr **11.31/mt**		110498.40/yr **4.41/mt**
	Electricity used@.0.20/kw	
271kw/hr **10.84/mt**		420kw/hr (600 x .70) **16.80/mt**
	Steam At 20.00/mt	
3.212 mt/hr 64.24/hr/5 **12.84/mt**		0.5mt/hr 10.00/hr/5 **2.00/mt**
	Water	
1216l/hr .50/m3 .60/hr/5 **0.12/mt**		**0**
	Wear	
3.00/mt		**2.40/mt**
=======		=======
38.11/mt		**25.61/mt**

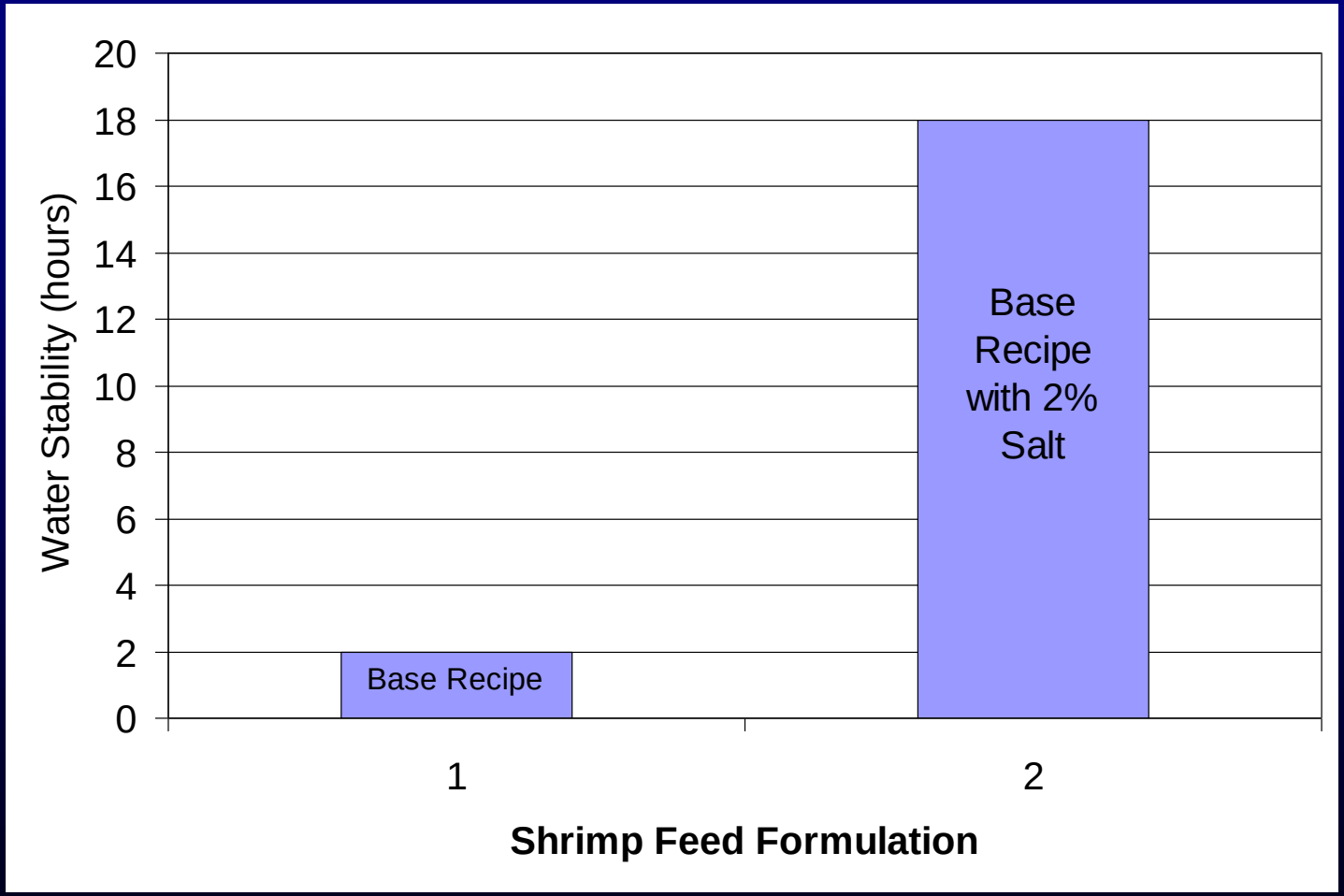
White Shrimp Formulations

- Soybean Meal or vegetable proteins accepted thus less fishmeal, lower protein costs
- Extruders need lower starch levels, 10% compared to 25 to 30%, more room for protein sources at lower protein levels.
- Lower feed costs with similar results.
- Total cost is less but extruder system is more expensive initially.

Potential Savings in Recipe Costs

1) Extruded recipes reported to have $20-$100/ton potential savings over pelleted recipes
2) Extrusion process allows reduction or elimination of special binders
3) Extrusion process can use less expensive starch sources (Example is to use lower cost wheat flour at $0.10/kg versus more expensive higher gluten flour at $0.20/kg)

Use of Inexpensive Binders in Extrusion Process



Pellets in Water approx 4 hours

Example study*

- Litopenaeus Vannamei stocking density of 50/m²

Process	Pelleted 2.4 mm	Extruded 1.6mm	Extruded 2.4 mm
Survival	75.0%	88.9%	88.9%
Final wt. (g)	7.11	8.17	8.35
Daily intake (g)	0.21	0.19	0.19
FCR	2.96	2.25	2.23
Cost of shrimp produced ($/kg)	3.08	2.34	2.32

*Aqua Feeds: Formulation and Beyond, pages 18-20, Vol. 1 Issue 2, 2004

Comparison of Pelleting versus Extrusion processing of Shrimpfood

- Assuming:

1) Operating costs of pelleting = $10.00/ton and costs of extrusion = $21.30/ton
2) Same FCR ratio for both processes

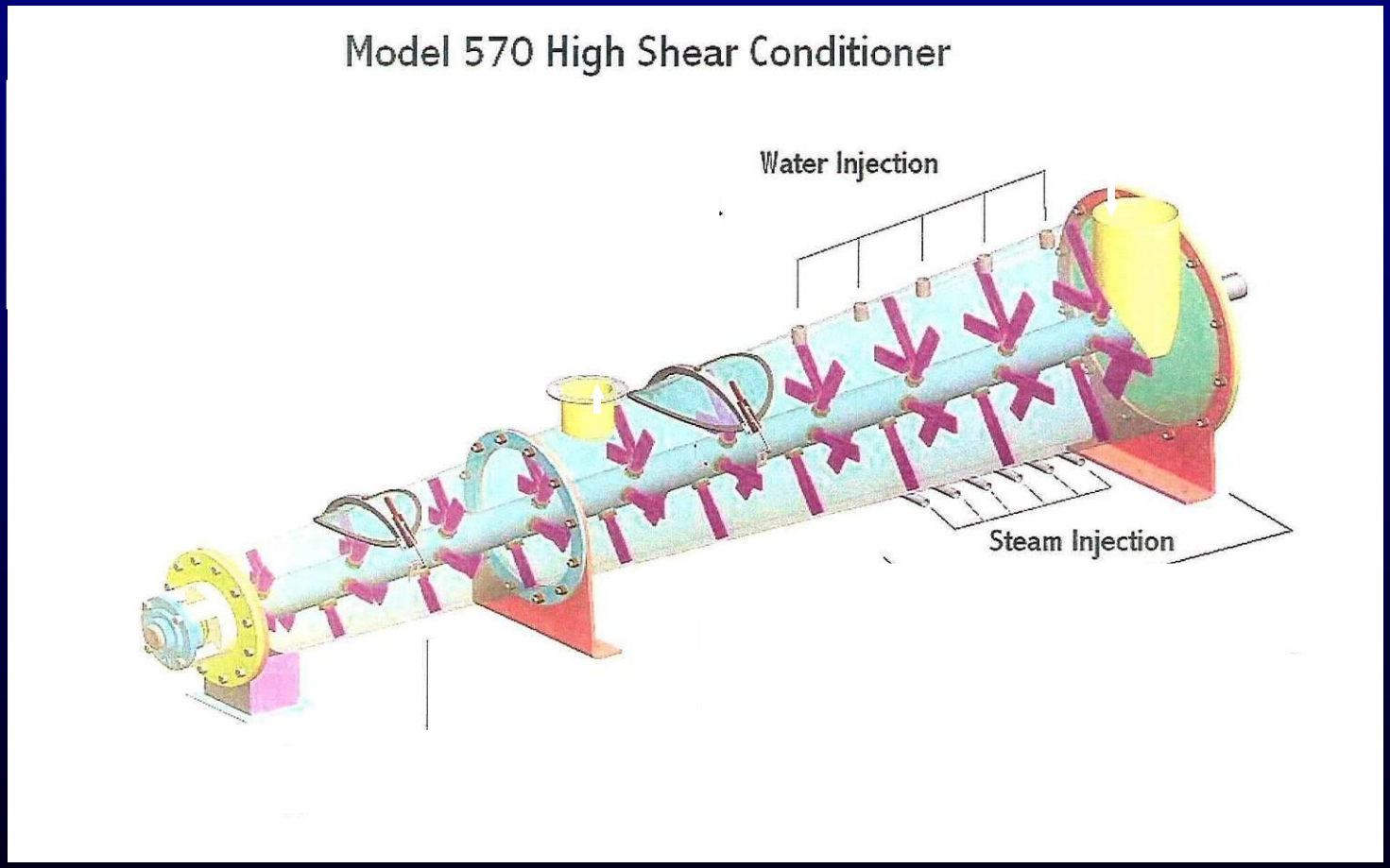
- The recipe costs for extrusion would only have to decrease $21.00/ton to have same processes costs as pelleting process

Patented High Capacity Extrusion Process for Small Diameter Feeds: Shrimp, Micro-Aquatic Feed, Chickens


Wenger C2 8.1 Conical
Twin Screw Extrusion Cooker
WENGER®

C²TX for Shrimp Feeds

High Shear Conditioner
Model 570 HSC



HSC (High Shear Conditioner)

1) High shaft speeds create dispersive and distributive mixing

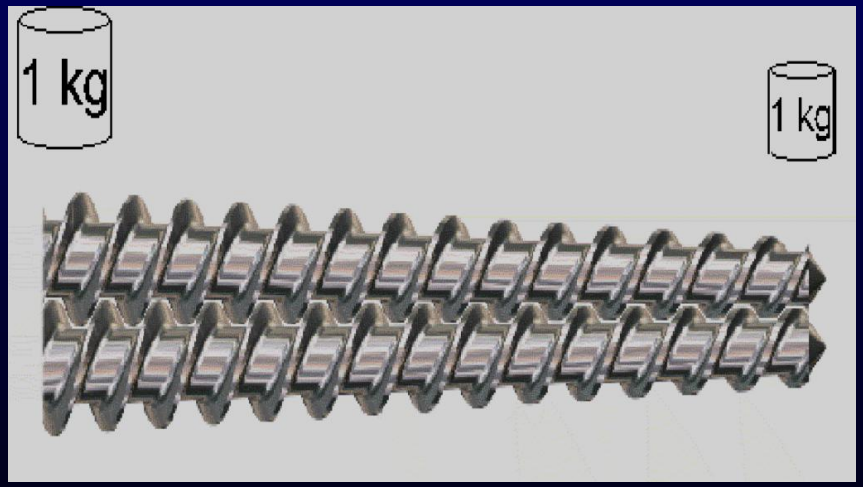
2) Tapered design increases fill at discharge to seal in steam and create additional shear forces

C²TX Conical Twin Screw System

1) Co-rotating / tapered shaft
2) Positive conveyance
3) Profile kneading
4) Wide ingredient flexibility
5) No configuration changes required
6) Unique die assembly for wide range of product sizes

Cook and Mixing (SME) Achieved on the C²TX System by:

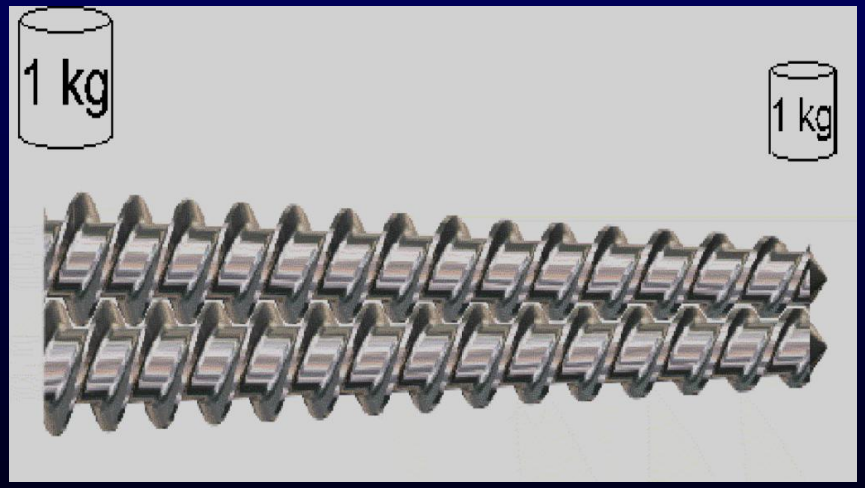
1) ***Compression*** (6:1 compression built into screw design via decreasing diameters)
2) ***Restriction*** (use of die and decreasing screw volume)
3) ***Friction*** (large surface area of screw and high speed shafts)



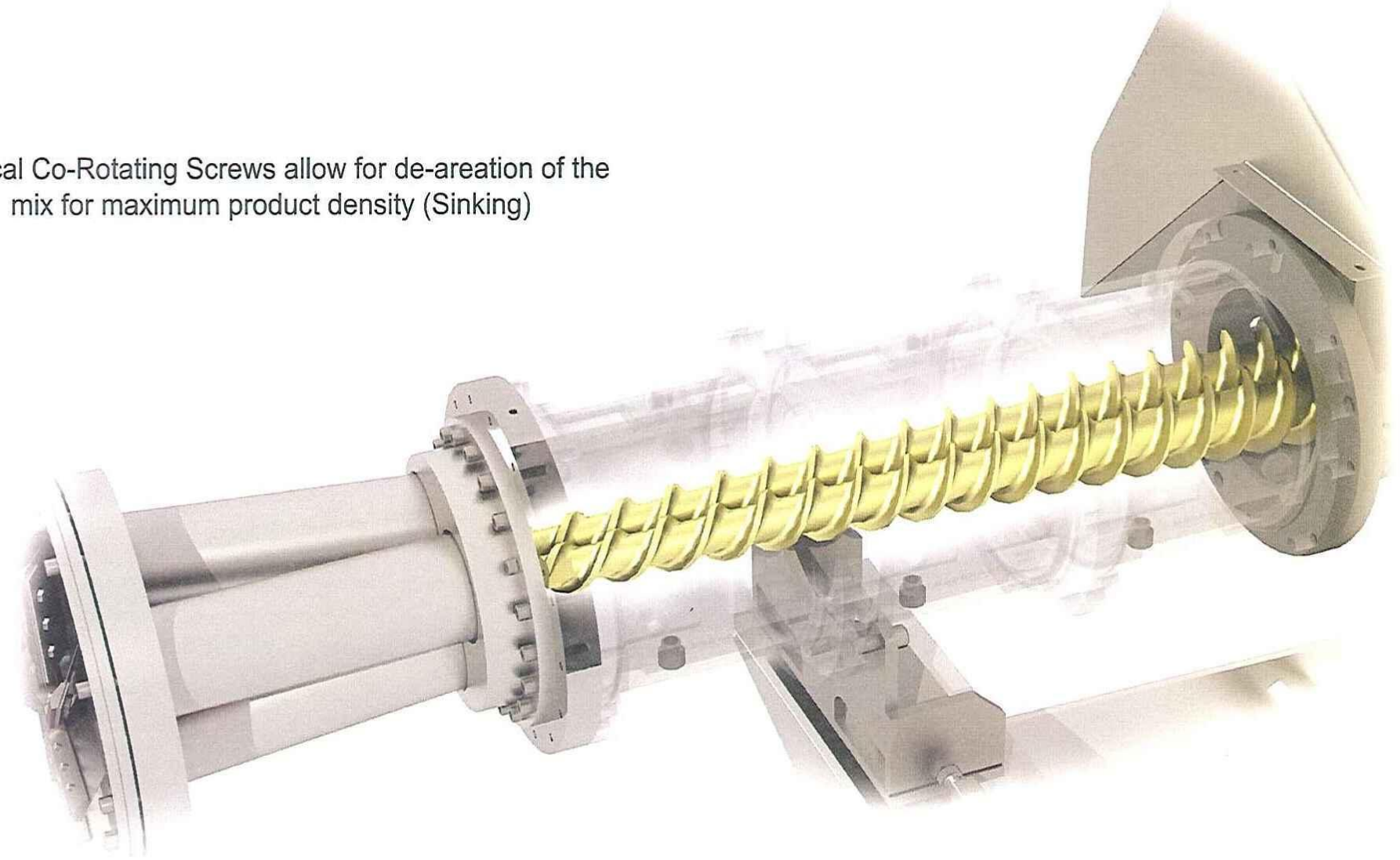
Effect of Compression Screw Profile of C²TX System

1) Compression of screws de-aerates product to increase extrudate density

2) Compression adds energy into product which pasteurizes recipe, gelatinizes the starch for better water stability, and inactivates any growth inhibitors present.

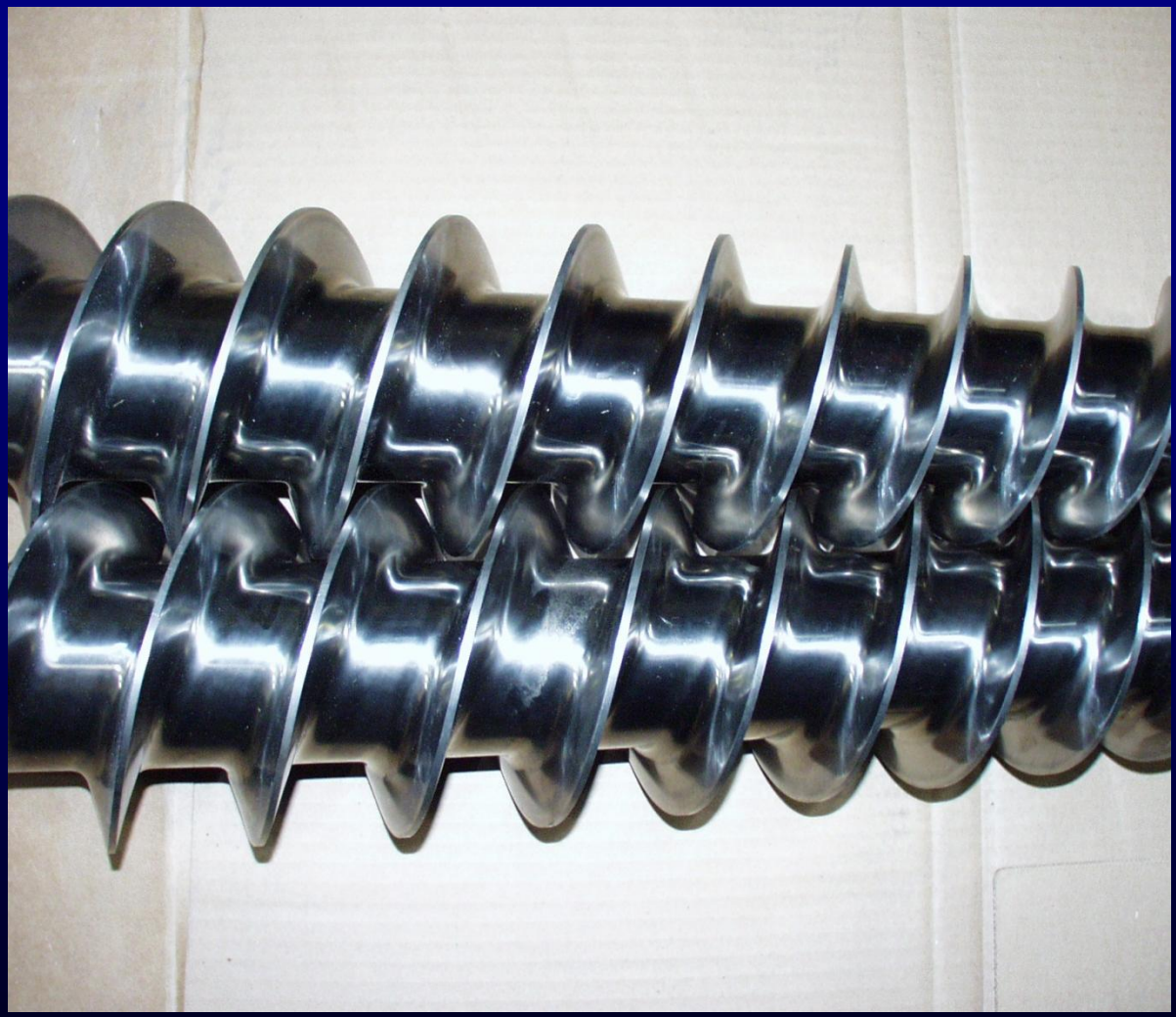


Conical Co-Rotating Screws allow for de-areation of the mix for maximum product density (Sinking)



Special High Capacity Oblique Tube Die Assembly for Sinking Aquatic

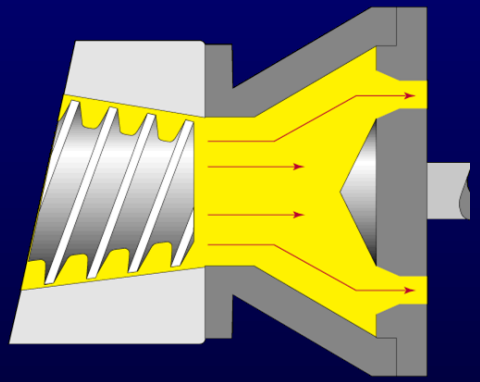
WENGER®



Limitations of Old Technology for Products Smaller than 3mm Diameter

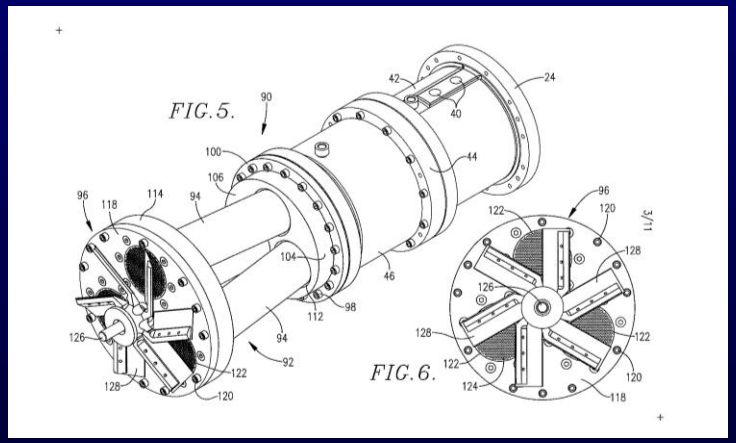
1) Final die open area was the limiting factor in production capacity earlier designs on smaller than 3mm diameters

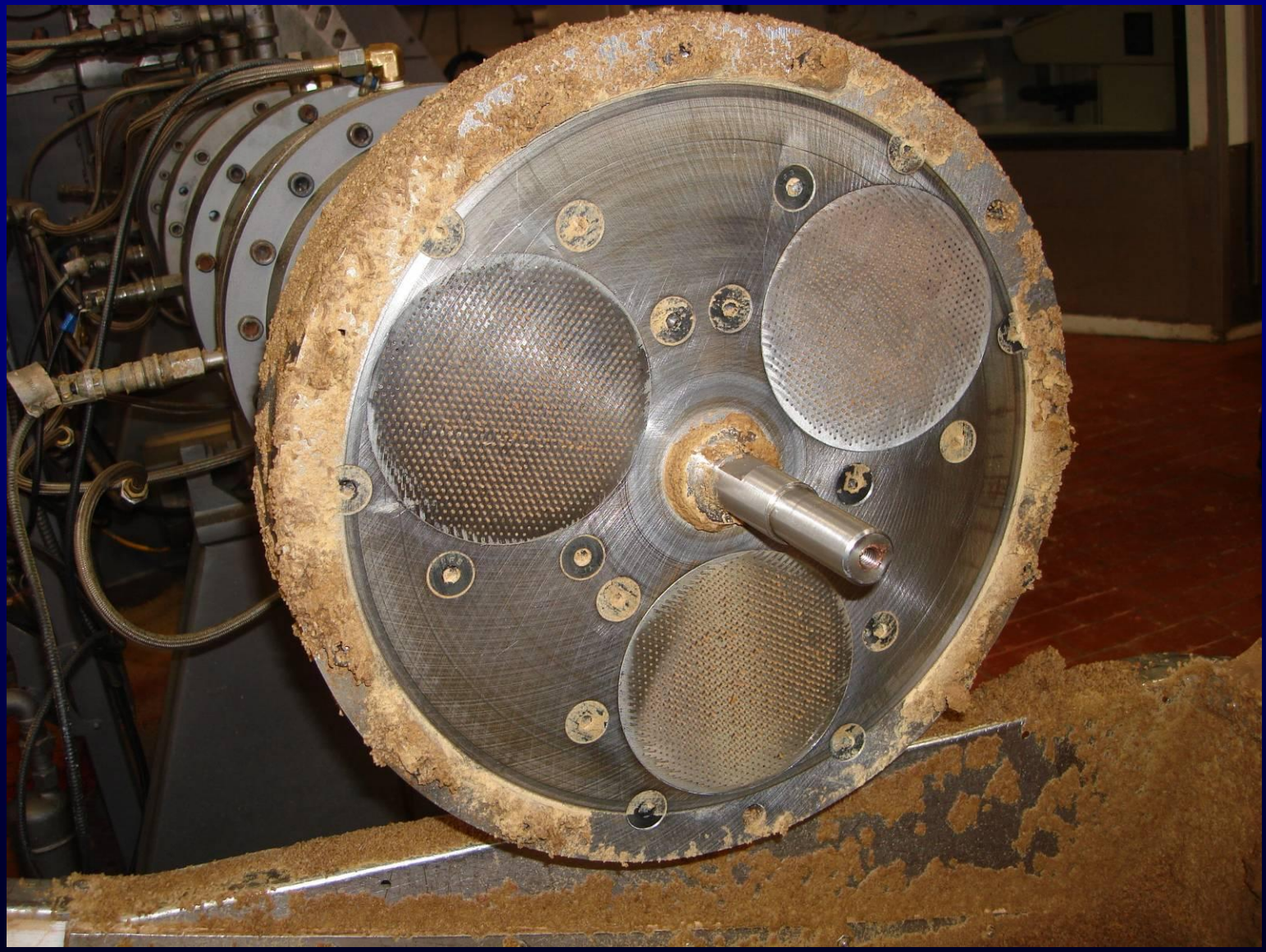
- 2) Flare-out adapters disrupted product flow on sinking products resulting in non-uniform product size.



Technology for Shrimp Feed and Sinking Products Smaller than 3mm

(3 oblique diverging tubes)



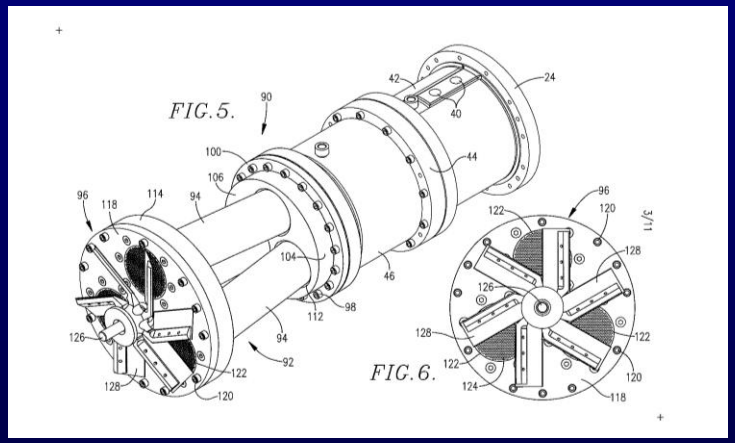


Die Blockage

Benefits of this Technology for Sinking Products

(oblique diverging tubes)

1) Die hole population almost 3 times normal
2) Long tubes increase cook and decrease expansion through pressure drop and retention time
3) Small tube diameter gives uniform cross-sectional flow



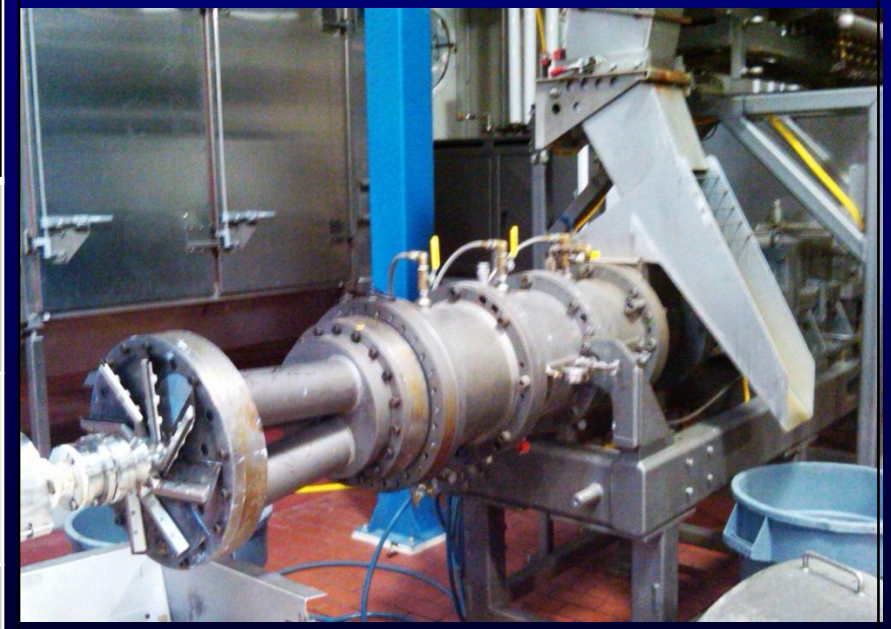
Value of this Technology for Sinking Products

(oblique diverging tubes)

1) Higher rates
2) More size uniformity
3) Greater product density and thus higher percentage of sinking
4) Increased water stability

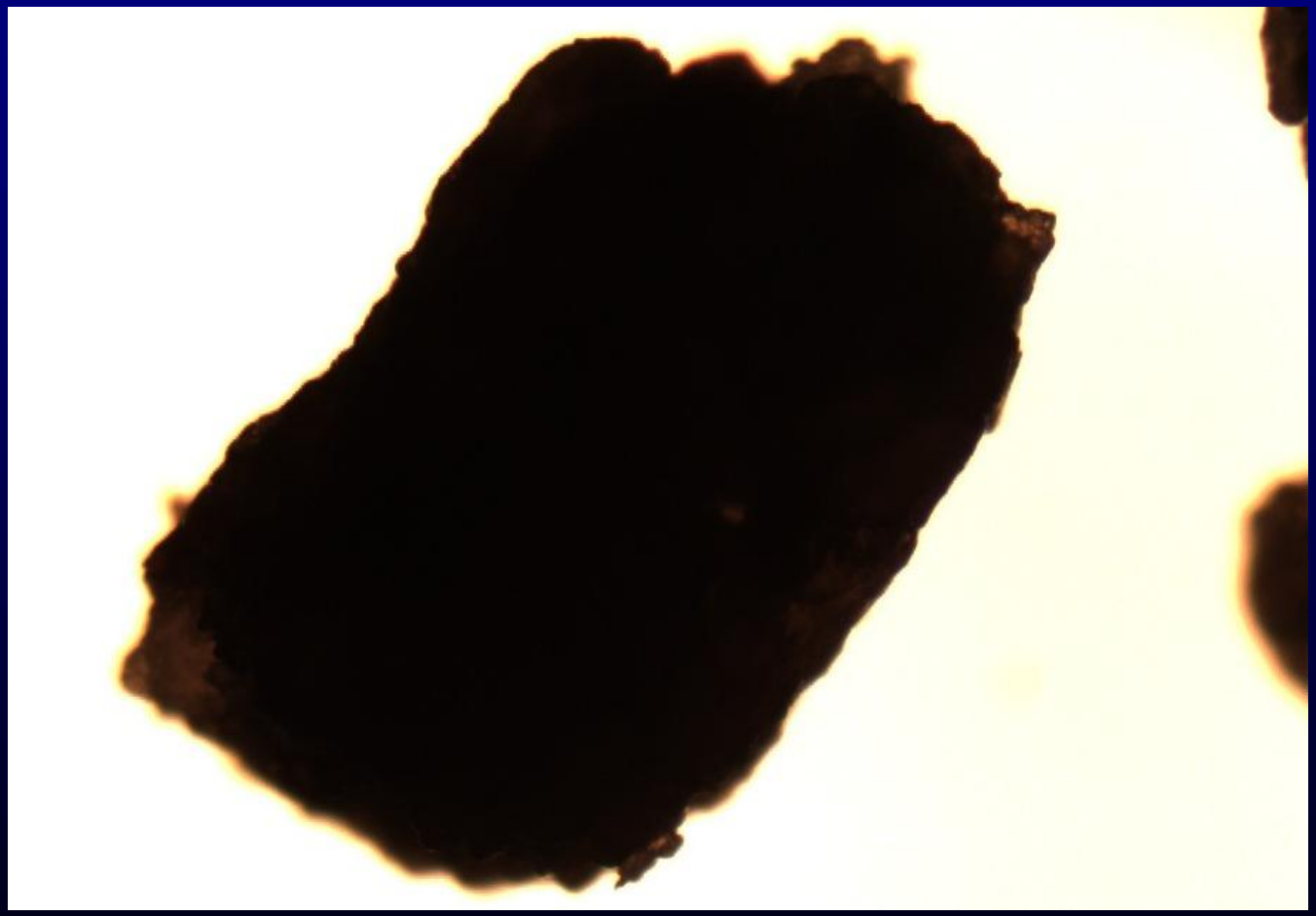
C²TX Twin Screw Extruder Shrimp Food System Throughputs

Aquatic Product	Capacity with New Technology (kg/hr)
0.8-1.2 mm die hole diameter	1,875-2,500
1.2-1.5 mm die hole diameter	2,250-4,000
1.5-3.0 mm die hole diameter	4,000-5,000

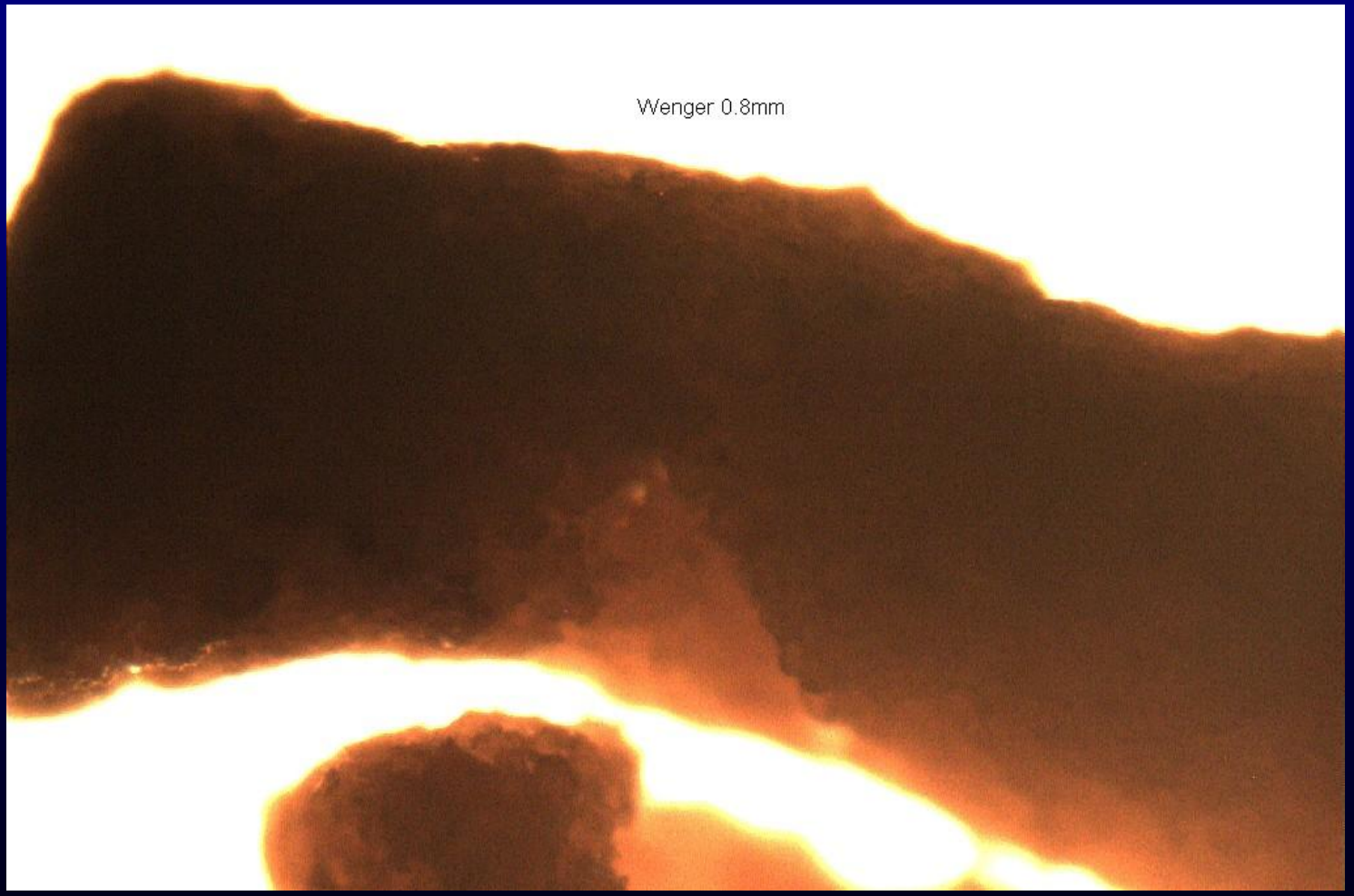


0.6 mm Sinking via Extrusion

0.6mm Pellet Extruded



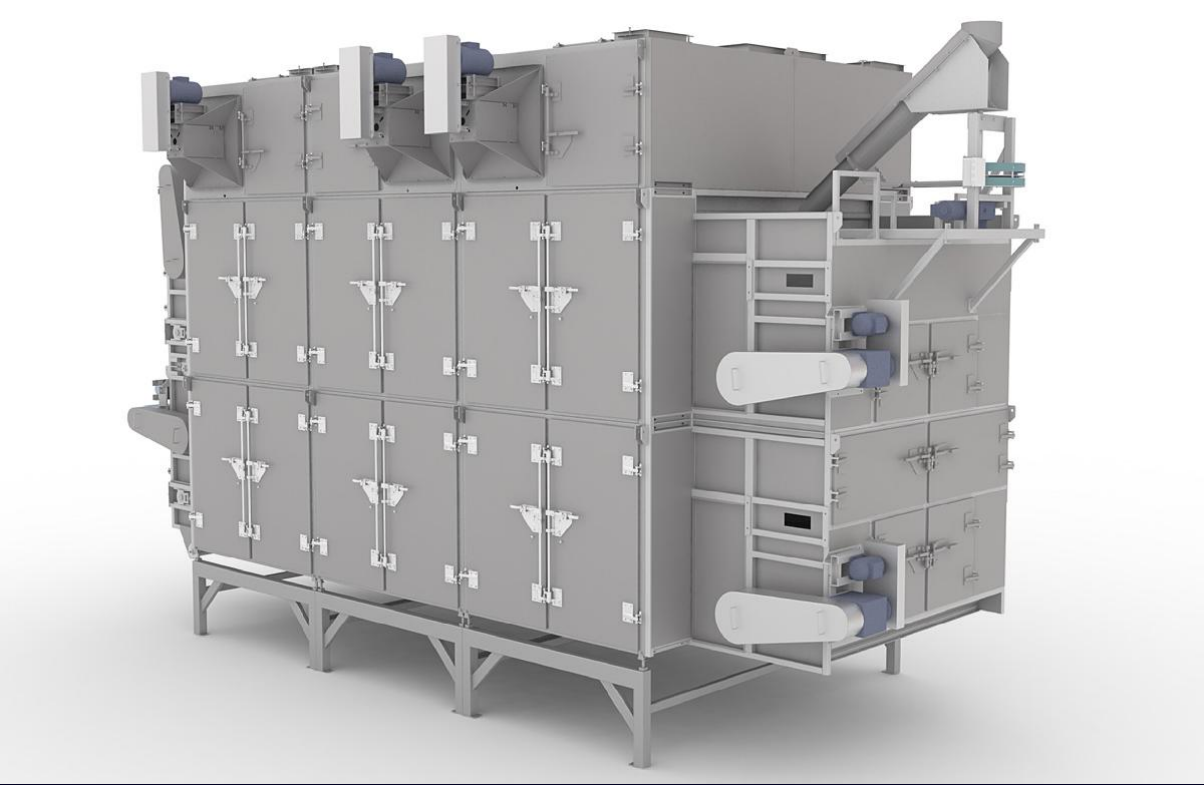
0.8mm Extruded Pellet



Wenger Shrimp Feed Dryer

5000 kg/hr dry shrimp feed

1.5 – 3.0 mm pellets



WENGER®
DRYING TECHNOLOGY

Wenger Shrimp Feed Dryer

Reduced Plant Footprint

- Easier fit into existing plant space
- Space for other processing equipment

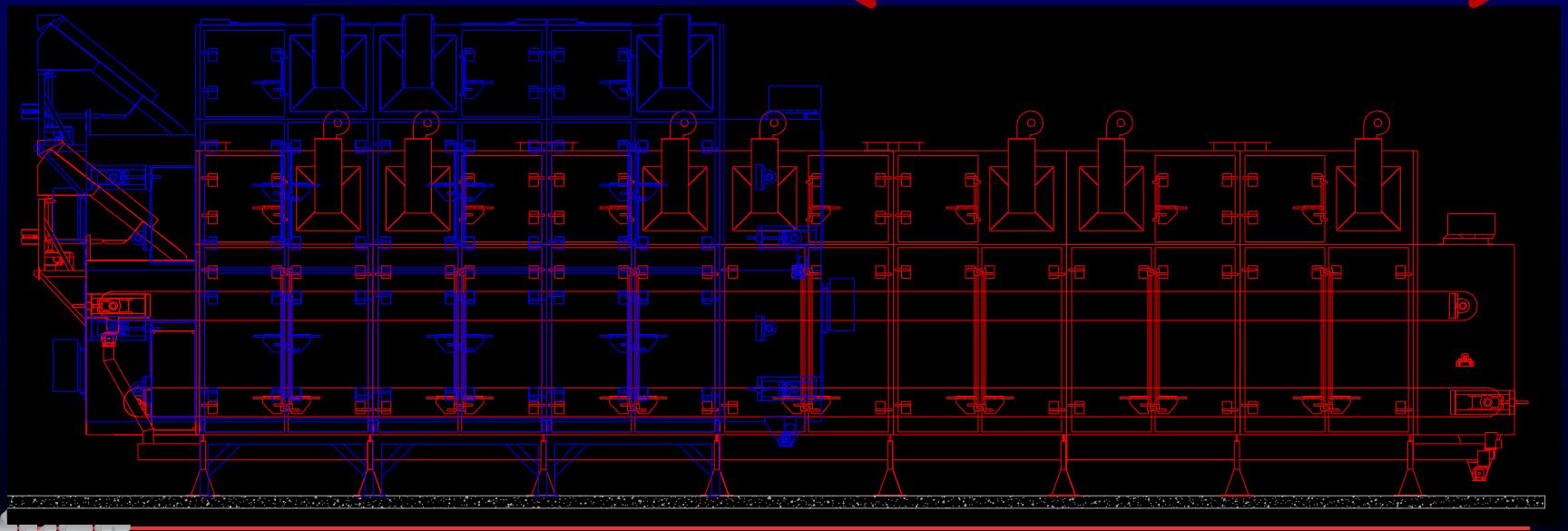
WENGER 4 pass Shrimp Feed Dryer

Standard 2 pass Fish Feed Design

9.6 M

(8.5 M. less plant floor space)

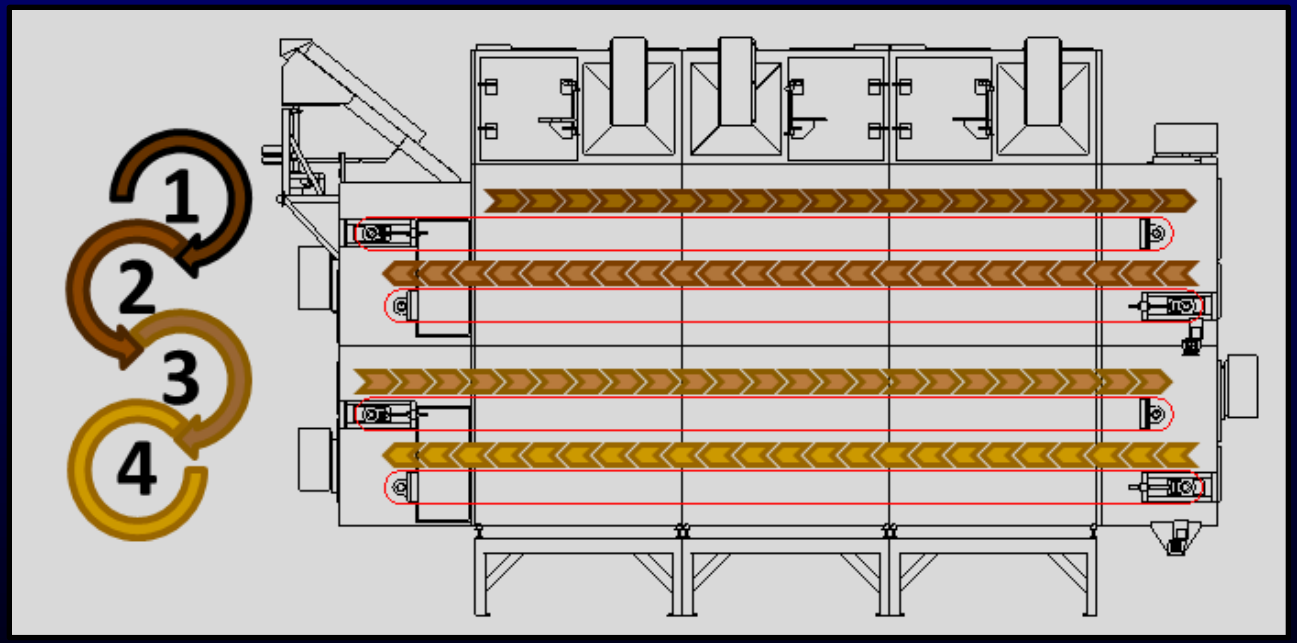
5.9 M



Wenger Shrimp Feed Dryer

Multi-Pass Conveyor Dryer

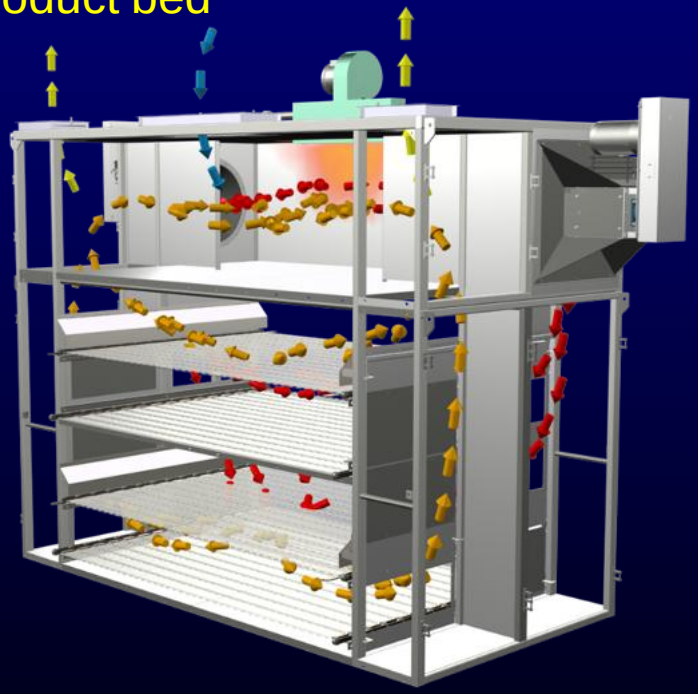
- Continuous process flow for moisture uniformity
- Added control of product bed depths and retention times on each of four conveyors
- Improved final product uniformity from gently blending during drying process



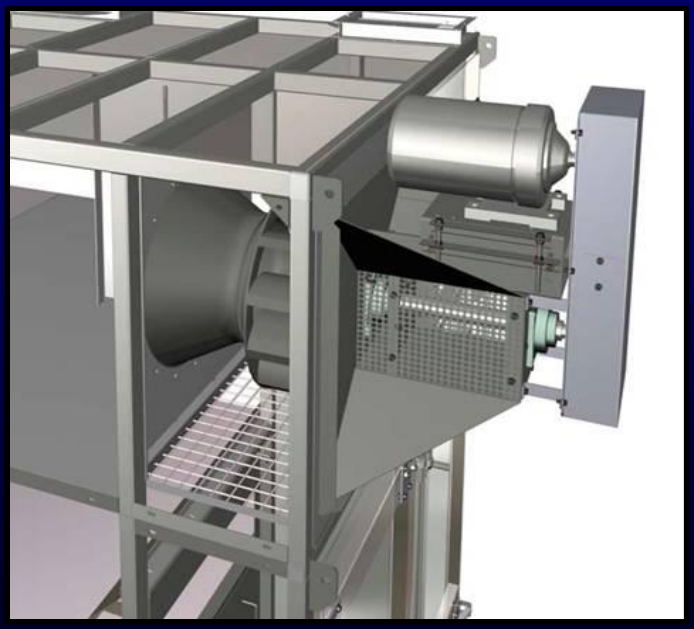
Wenger Shrimp Feed Dryer

Process Airflow Control

Airflow from both sides of the dryer provide even drying across the product bed



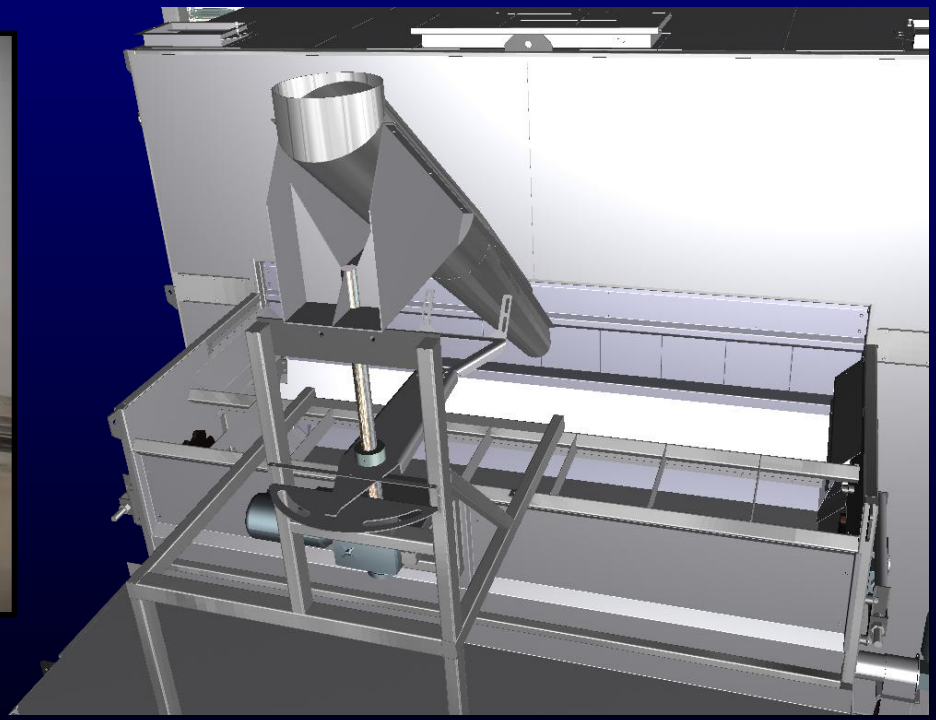
Airflow speed control optimizes the drying capacity for each product



Wenger Shrimp Feed Dryer

New Direct Drive Spout Spreader

- Easy in-line adjustment for level product bed
- Highest product quality and consistency



Wenger Shrimp Feed Dryer

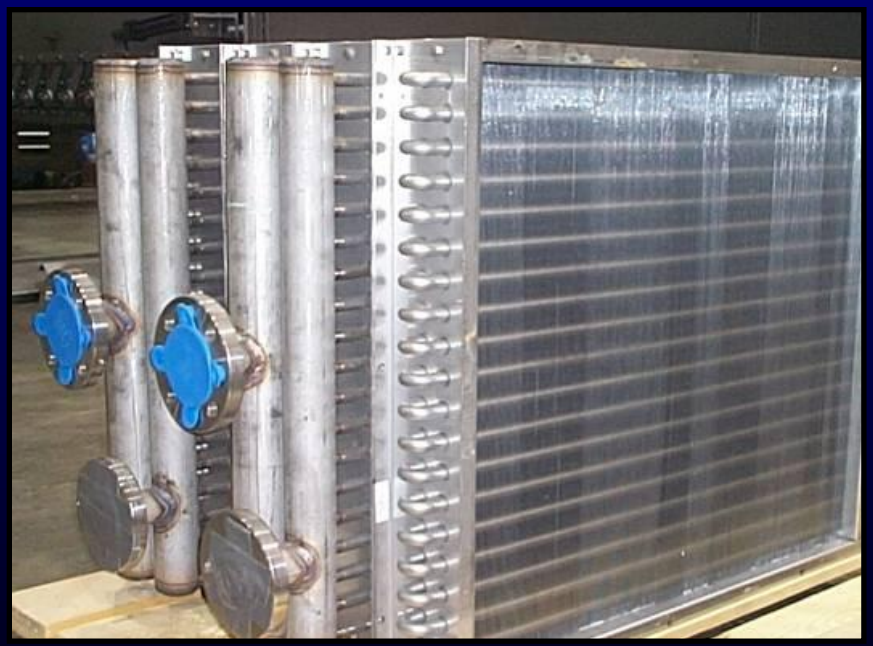
Mesh Screen Conveyor

- Retains feed down to 0.8 mm diameter
- Maximizes airflow through the product for high moisture removal rate

Wenger Shrimp Feed Dryer

Heavy Duty Steam Coils

- Ensures reliability of heat source
- Provides an abundance of consistent heat to product (ideal for high humidity climates)
- 304 Stainless Steel tubes for extended service life



Fishmeal Replacement Blend Via Extrusion Cooking (NDA)

- Work has advanced by Stuart Romes of Agronomics Trading of Cyprus, Wenger Mfg. and Dr. Addison Lawrence of TA&M. An engineered liquid solution containing limiting Amino Acids when compared to fish meal is used in conjunction with a Wenger extruder to improve the AA profile of vegetable proteins.

Plant Proteins – Fish Protein Replacement

- Problem: Essential Amino Acids (EAA) not optimal in Plant Proteins
- Problem: Optimization of EAA using crystalline amino acids limited
- Solution: Chemically bind EAA to plant protein
- Problem: Process to bind EAA to plant protein is expensive and not cost effective

- Dr. Addison Lawrence, Texas A&M University

Plant Proteins – Fish Protein Replacement

- Solution: Exciting new technology utilizing proprietary chemical mixture with desire mixture of EAA and extruding with any plant protein in a feed grade ingredient
- Result:
- Increase digestibility of plant protein
- 3 to 10 fold fortification of one or more EAAs of choice
- >99% of EAA bound

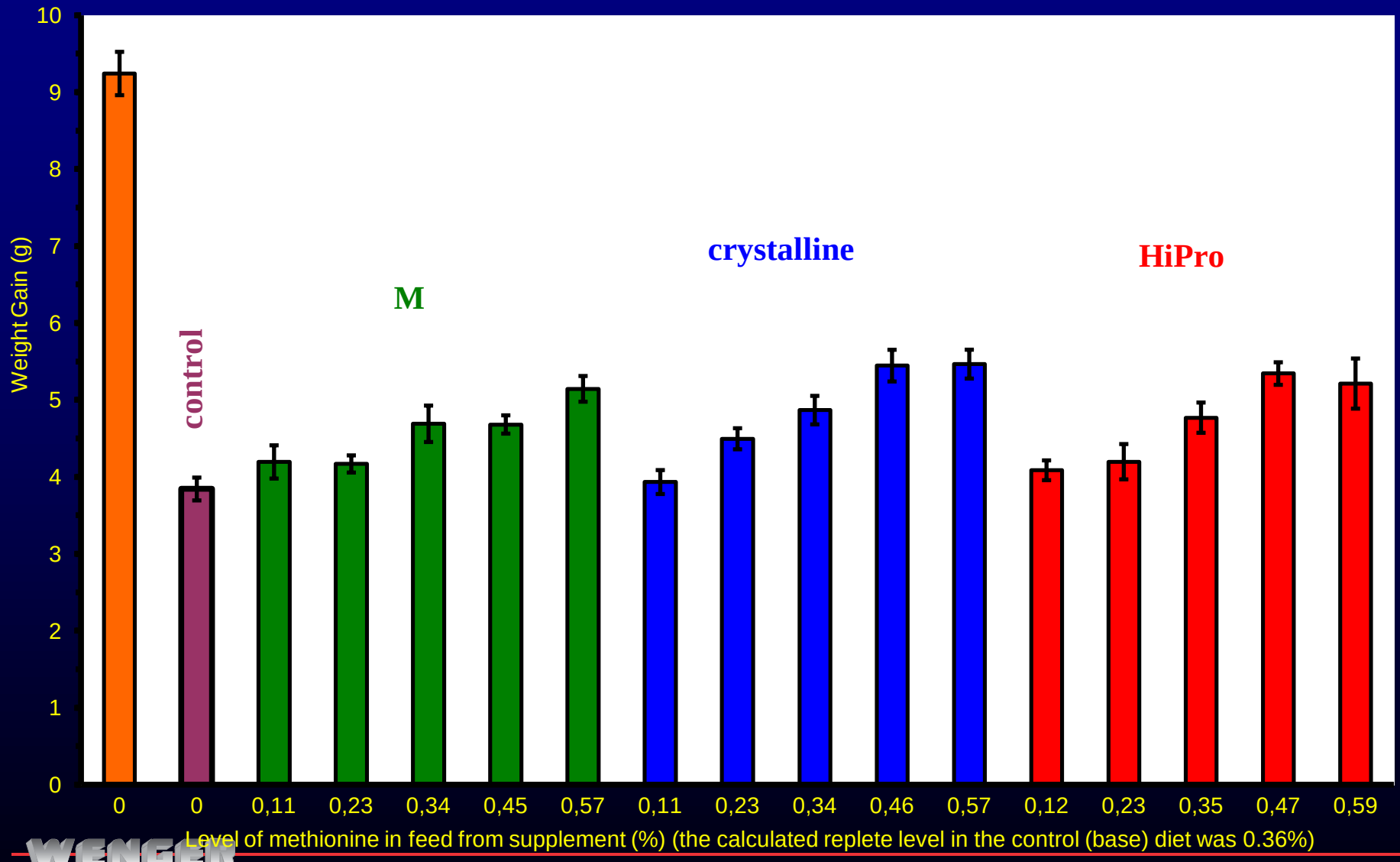
- Dr. Addison Lawrence, Texas A&M University

Plant Proteins – Fish Protein Replacement

- Test results:
- 1. Crystalline methionine bound to soybean protein in 44% soybean meal
- Methionine level in 44% soybean meal increase a minimum of three-fold (times)
- Greater than 99% of methionine bound
- Growth rate of bound methionine equal to that of crystalline methionine with L. vannamei

- Dr. Addison Lawrence, Texas A&M University

Figure 1. Effect of supplemental methionine on weight gain of Litopenaeus vannamei . The M and HiPro are proprietary sources of methionine. The crystalline represents the level of pure DL-methionine supplemented to the diet.



The following slides courtesy of Dr. Addison Lawrence Texas A&M University AgriLife Research

Stacked Raceway Shrimp Production System
1ha indoors = 100 ha outdoors

Future Trends for Shrimp Farm Production

- Production predictability requiring
- Complete biosecurity requiring
- Raceways inside buildings requiring
- Higher production levels
- Intensification requiring
- More optimum production systems and conditions and feeds

Production Conditions

- Optimum brown (biofloc), green (algae) or clear H_2O
- Constant and optimum:
  - -Alkalinity
  - -Temperature
  - -Oxygen
  - -TAN, NO_2, NO_3
  - -Salinity
  - -pH
  - -Light

AgriLIFE RESEARCH
Texas A&M System

Production Methods and Raceway Optimization

- More partial harvests
- Shallow water
- Stacked raceways
- Raceways sloped for center to side

A Glimpse of the Future

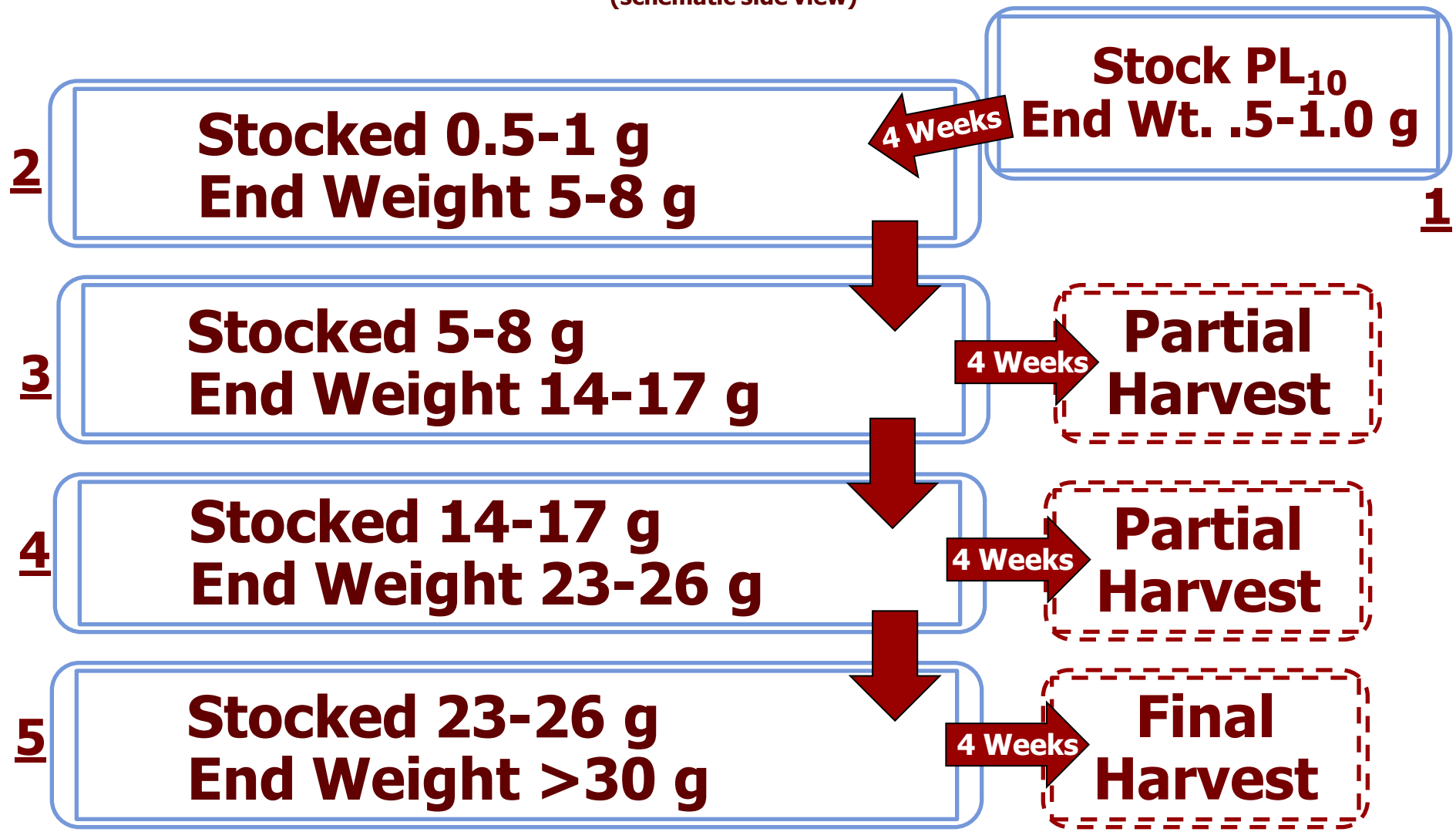
Stacked Shallow Water Raceway Technology (*SST*)

Shallow Water Advantages

- Decrease water usage
- Small weight from sea water allows stacking requiring less footprint area
- Greater management quality
- Less production cost (e.g. probiotic, chemical levels)

The SST System for Raceways

(schematic side view)



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Summary

- A prediction of future trends in shrimp farming and feeds were given
- A glimpse of future shrimp production and feeds were given

AgriLIFE RESEARCH
Texas A&M System

Dr. Lawrence's New Growout System


Family
Center
IGA
418 S. Alister
Port Aransas, TX 78373
MEAT DEPARTMENT
SAFE HANDLING INSTRUCTIONS
THIS PRODUCT WAS PROCESSED IN A FACILITY THAT PROCESSES MEAT AND/OR POULTRY. SOME FOOD PRODUCTS MAY CONTAIN BACTERIA THAT COULD CAUSE ILLNESS IF THE PRODUCT IS MISHANDLED OR COOKED IMPROPERLY. FOR YOUR PROTECTION, FOLLOW THESE SAFE HANDLING INSTRUCTIONS.
KEEP REFRIGERATED OR FROZEN. THAW IN REFRIGERATOR OR MICROWAVE.
KEEP RAW MEAT AND POULTRY SEPARATE FROM OTHER FOODS.
WASH WORKING SURFACES (INCLUDING CUTTING BOARDS), UTENSILS, AND HANDS AFTER TOUCHING RAW MEAT AND POULTRY.
COOK THOROUGHLY.
KEEP HOT FOODS HOT. REFRIGERATE LEFTOVERS IMMEDIATELY OR DISCARD.
Packed On
Net Wt/Ct
0.95 lb
Unit Price
$5.99/lb
Sell By
Aug 01, 11
Total Price
$5.69

Thanks