FENACAM'14

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Shrimp Feed Usage: Why Extruded over Pelleted Feeds?

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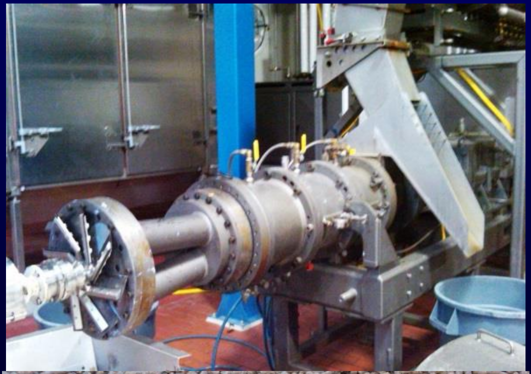

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TX3000 Shrimp Feed Production, 8 to 10 tons /hr

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

The key word on the previous slide was “can”

Rules of Extrusion Cooking

1. Raw Material Specifications and Formula
2. Hardware or Equipment Arrangement
3. Method of Equipment Operation, Software
4. Final Product Characteristics

Floating or Sinking Feeds

- 10% starch for sinking feeds
- 20% starch for floating feeds

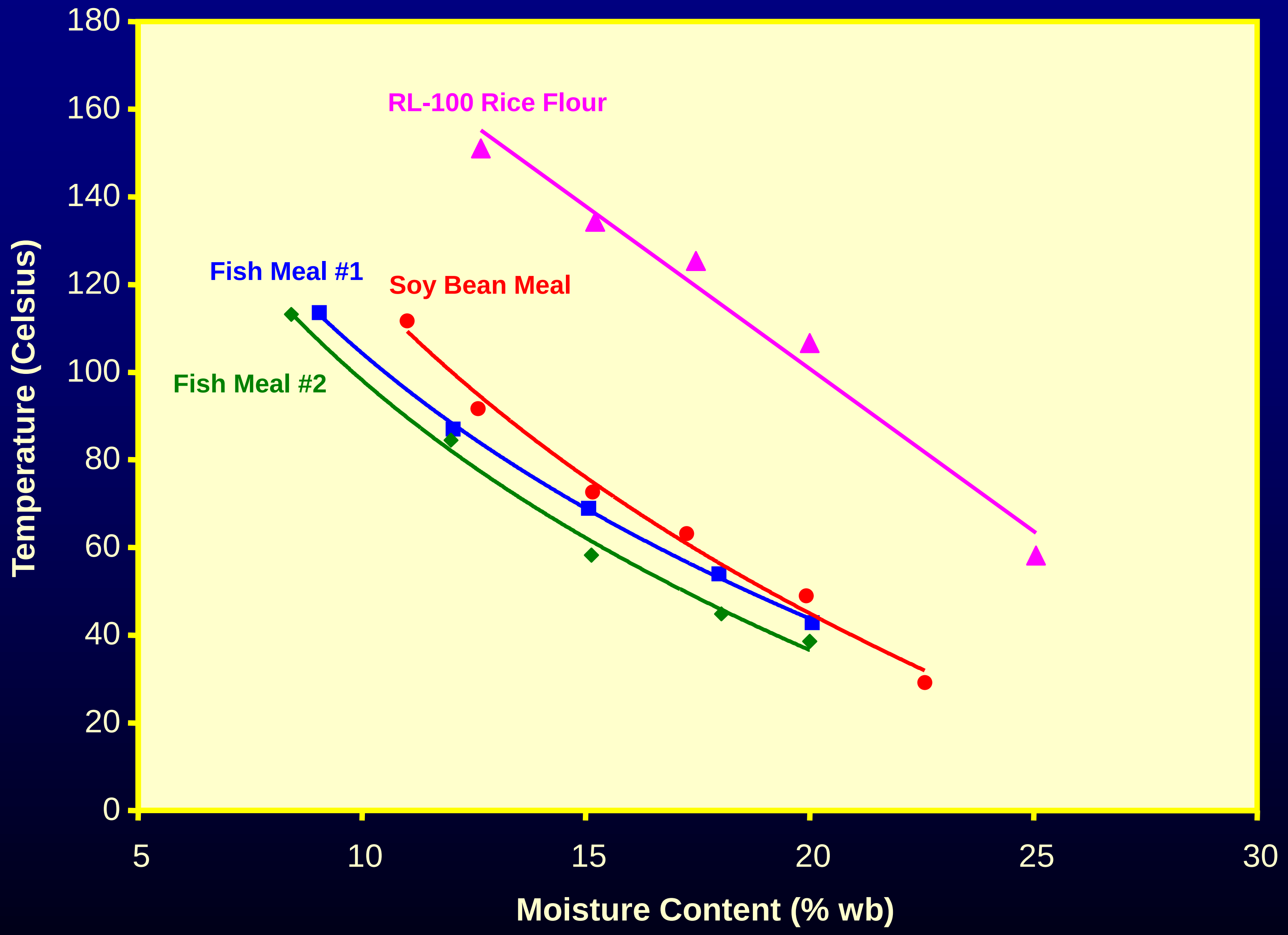
✓Can you verify the amount of starch in by products?

wheat mids, rice bran,

✓No, changes daily and from whom you get it all mills are set up differently.

Comparison of Protein and Starch Flow Curves

Phase Transition Analyzer, Lab device to test ingredients under time temperature and pressure



Samples at a plant of their SBM

How functional is your SBM?

Sample of DDGS at a plant visit.

How functional is your raw materials in general?

Protein Source Samples in Meeting

What is meant by functionality of ingredients?

Quick test, placed in water and let's see what they do, predicted they would sink and not soften quickly and act like sand. Client called my bluff, brought in samples and water.

By no means is this test conclusive. Lab test suggested.

Functionality is defined by a Protein Dispersibility Test, PDI.

Laboratory Tests to Indicate Protein Functionality

1) PDI (Protein Dispersibility Index)
2) NSI (Nitrogen Solubility Index)

These are a measure of the protein's solubility in water and are indicative of the level of heat treatment. The PDI test is a more rapid test and will usually give slightly higher results.

Effect of Raw Material Protein Quality

7 PDI 12 PDI 30 PDI 54 PDI

Harder to cook

Easier to cook

PRODUCT COLOR

Very Dark

Very Light

Soy Proteins used for FEED
(Soybean Meal)

Soy Proteins used for FOOD
(Flour, Concentrate, Isolate)

Crown Iron Works
Down Draft Desolventiser for High PDI Soya

- Flakes are handled gently throughout the process, producing a final product with a maximum amount of whole flakes and a minimum amount of fines.
- Higher attainable PDI than with conventional systems (potentially 80-85).
- Flexibility in operation to fine tune the system for the ideal combination of PDI, residual hexane, and steam consumption.

Flow Index Test for Fish Meals, Shows Functionality

- Indicates difficulty in processing fish meal recipes
- Quality control of incoming raw materials

Flow # > 5 cm
Poor flowing properties (high internal friction)
Harder to cook.

Flow # < 2 cm
Good flowing properties (low internal friction)
Easier to cook.

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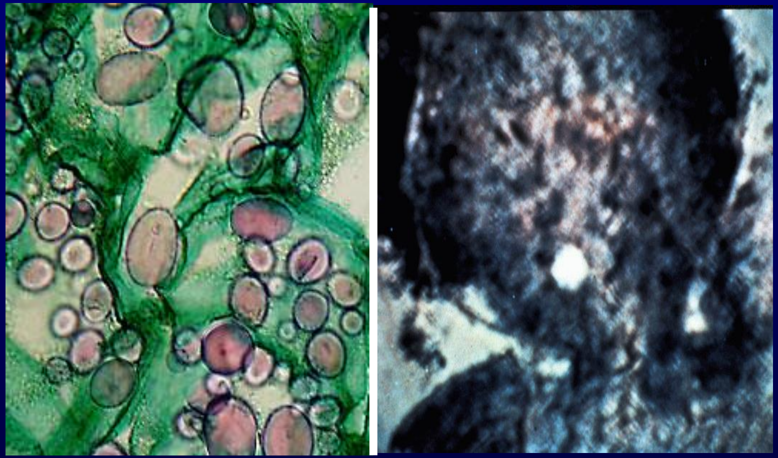
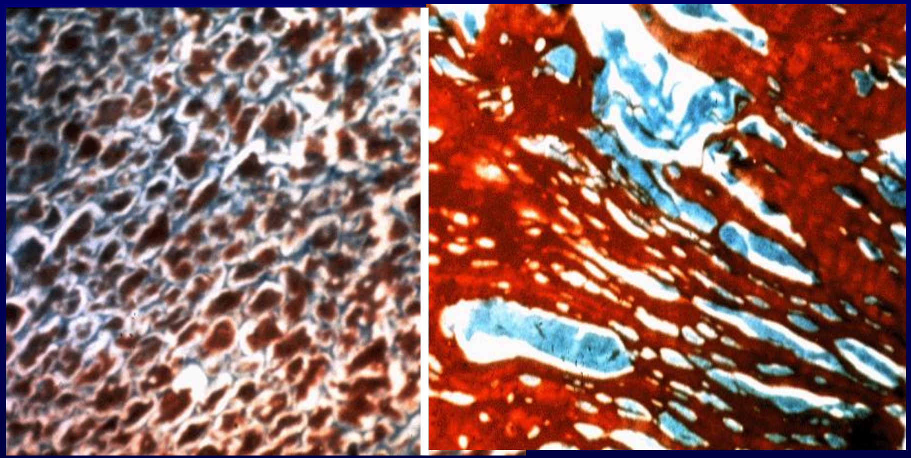
- Protein denatures at 60 - $70^{0}C$
  - As protein denatures, it becomes insoluble (non-functional)
- Starch gelatinizes at 55 - $75^{0}C$
  - As starch gelatinizes, it becomes soluble



Raw After Extrusion

Starch



Raw After Extrusion

Protein

So specify Soybean Meal that has not been overheated after the extractor, low temperature drying

2. Hardware or Equipment Arrangement

Effective good grinding and sifting are extremely important, 0.8mm needs 250 micron fineness

Or the fun starts real quick

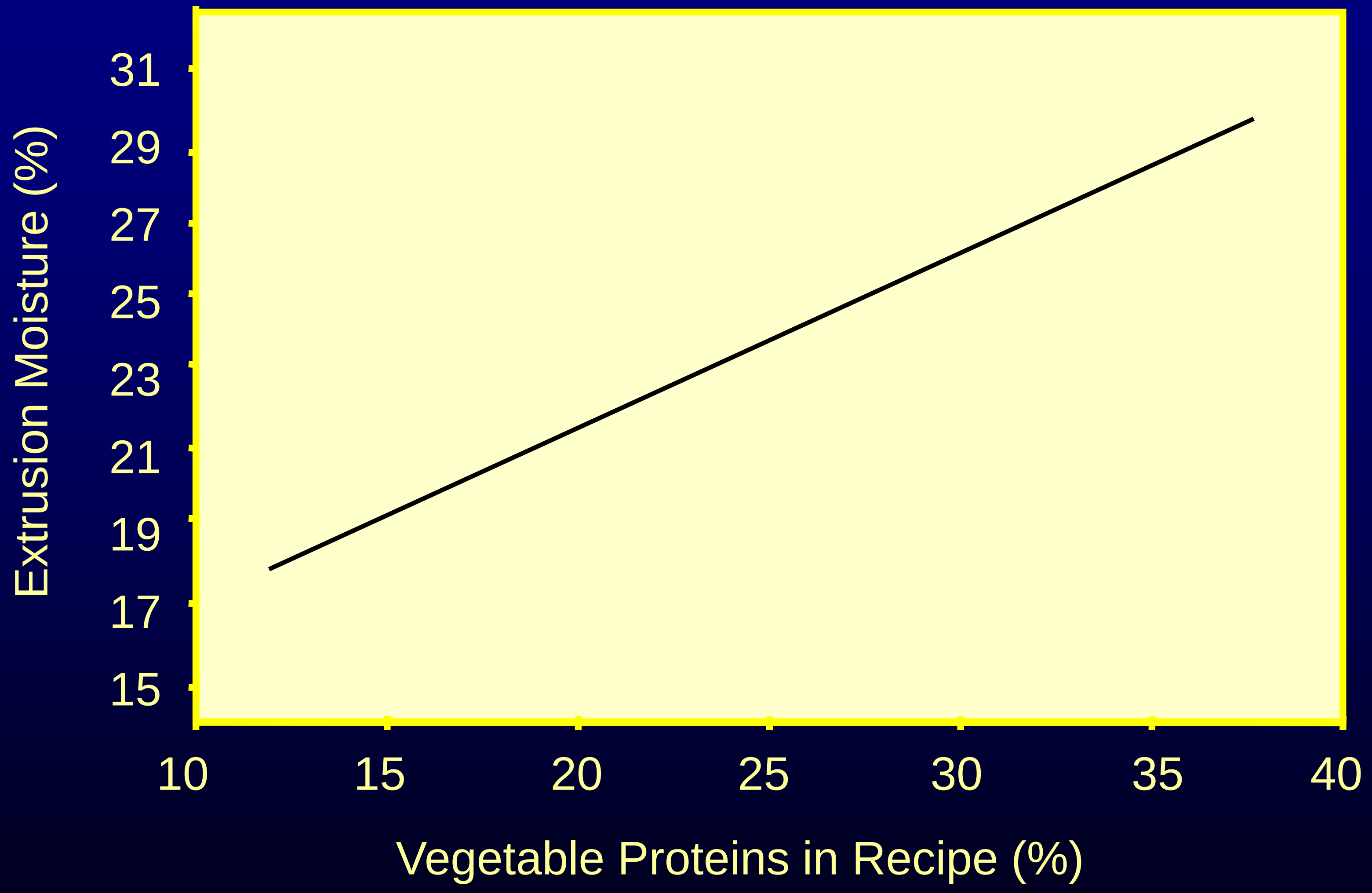
Shut down from die blockage

Grinding Considerations

Sample #1B4	
Pulverized	
Micron Size	% Through
450	99.8%
350	99.2%
250	98.6%
149	97.8%
75	77.7%

Sample #1B4	
Pulverized & Sifted	
Micron Size	% Through
450	100.0%
350	100.0%
250	100.0%
149	99.8%
75	80.8%

Effect of Vegetable Protein Levels On Extrusion Moisture



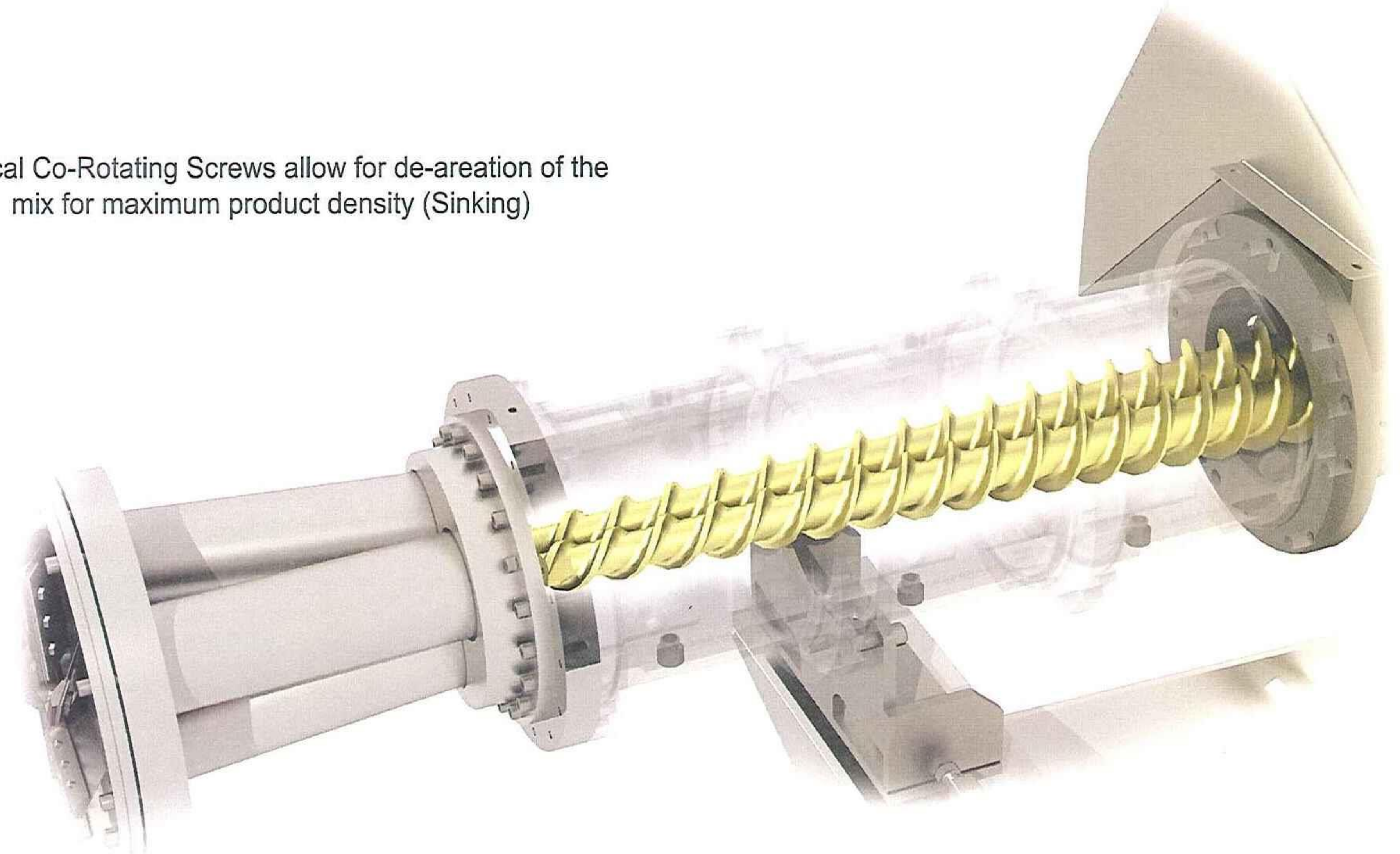
Effect of Protein on SME

Special Version of the C^2TX for shrimp and micro feeds

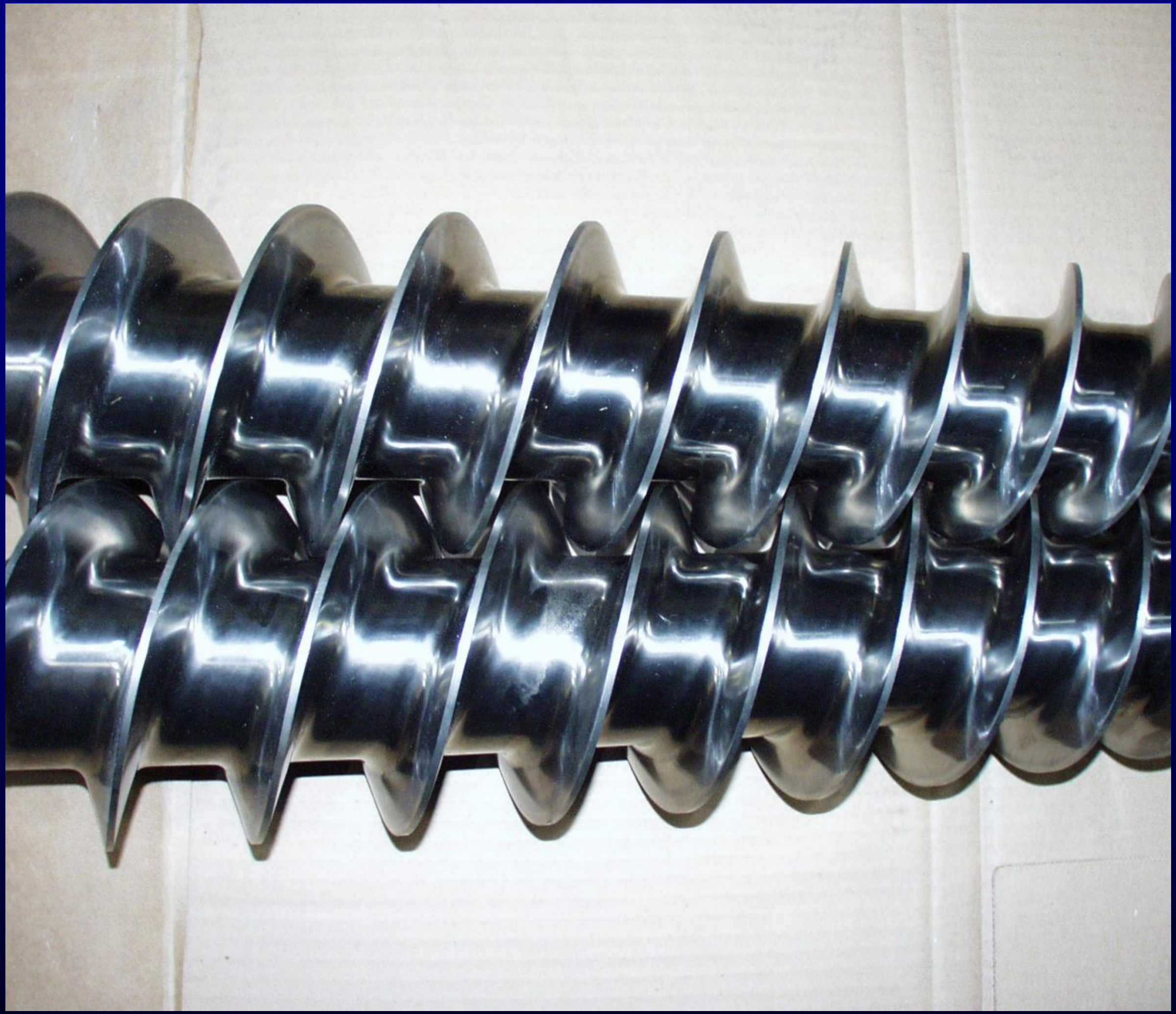
0.6 mm Sinking via Extrusion

Smallest die Wenger makes is a 0.8mm diameter die hole

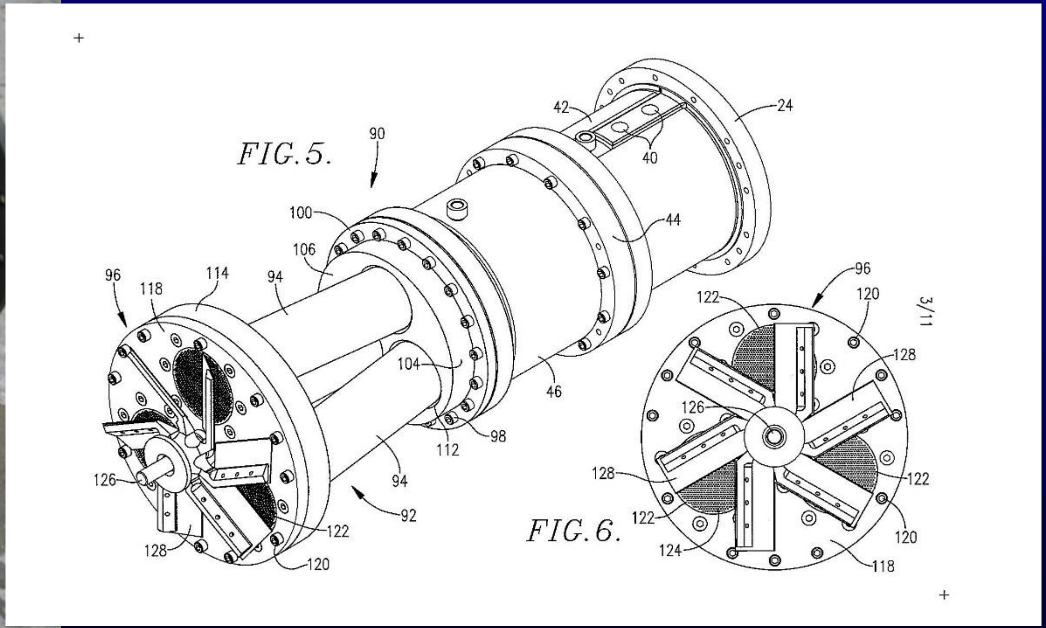
Conical Co-Rotating Screws allow for de-areation of the mix for maximum product density (Sinking)



Special High Capacity Oblique Tube Die Assembly for Sinking Aquatic



Technology for Shrimp Feed and Sinking Products Smaller than 3mm
(3 oblique diverging tubes)



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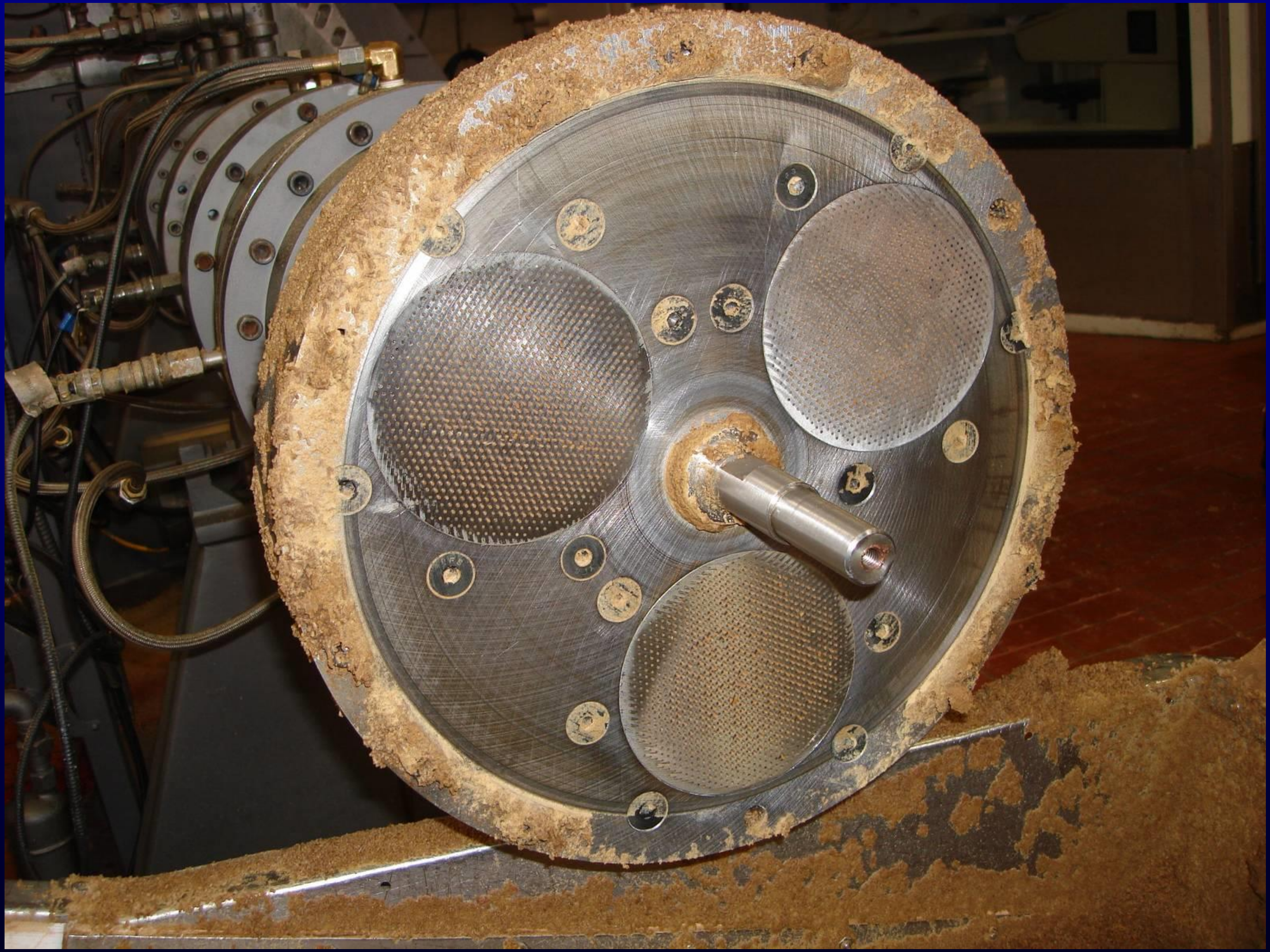

Pellets in Water approx 4 hours

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

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

Aquaculture Research

Aquaculture Research, 2009, **40**, 496–503 doi: 10.1111/j.1365-2109.2008.02124.x

Demonstration of alternative feeds for the Pacific white shrimp, *Litopenaeus vannamei*, reared in low salinity waters of west Alabama

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Abstract

The replacement of marine proteins with vegetable proteins or terrestrial animal byproducts in aquaculture diets has been gaining momentum. This study examines the viability of replacing fish meal in shrimp production diets with alternative protein sources (combinations of vegetable proteins) in inland low salinity waters of west Alabama. The test diets were formulated to contain 36% protein and 8% lipid. The basal diet contained 10% fish meal. The fish meal was then replaced (on a weight to weight basis) with poultry meal (PM), pea meal or distiller's dried grain with solubles (DDGS). Two separate experiments (laboratory trial and farm trial) were devised to test the efficacy of the diets for *Litopenaeus vannamei* reared in low salinity waters. The labora-

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Table 1 Ingredient composition of diets for laboratory and farm trials (g kg^{-1} dry weight)

Ingredient	Diet 1 (Poultry meal)	Diet 2 (Fish meal)	Diet 3 (Distiller's grain)	Diet 4 (Pea meal)
Soybean meal	551.2	537.1	580.1	580.0
Milo	248.1	261.9	163.4	153.3
Poultry-byproduct	99.9	–	–	–
Menhaden select	–	100.1	–	–
Peas, ground	–	–	–	100.0
Distillers grain	–	–	100.0	–
Corn gluten yellow	–	–	48.3	48.3
Dicalcium phosphate	29.0	29.0	33.8	34.2
Fish oil	50.8	50.9	48.3	58.2
Lecithin	5.0	5.0	5.0	5.0
Bentonite	15.0	15.0	15.0	15.0
Squid meal	–	–	5.0	5.0
Vitamin premix*	3.3	3.3	3.3	3.3
Mould inhibitor, Myco	1.5	1.5	1.5	1.5
Mineral premix*	0.8	0.9	0.9	0.9
Stay-C 35%	0.2	0.2	0.2	0.2
Copper sulfate	0.1	0.1	0.1	0.1

Diets were formulated to contain 36% protein and 8% lipid. Diets were commercially manufactured by Rangen® (Angleton, TX, USA) using extrusion processing.

*Vitamin premix and mineral premix are proprietary products,

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Table 4 Initial weight (g), final weight (g), survival (%), weight gain (%), biomass (g) and FCR for *Litopenaeus vannamei* offered diets with alternative protein sources in low salinity water during the lab and farm trials

	Initial weight (g)	Final weight (g)	Biomass (g)	Weight gain (%)	Survival (%)	FCR
Lab trial						
Poultry meal	0.59	8.89 ± 0.45	99.4 ± 6.6	1398.5 ± 115.6	93.3 ± 7.0	2.22 ± 0.12
Fish meal	0.61	9.46 ± 0.42	107.8 ± 13.8	1447.1 ± 96.3	95.0 ± 11.2	2.10 ± 0.16
DDGS	0.61	9.68 ± 0.67	105.8 ± 7.3	1492.7 ± 107.7	91.7 ± 11.8	2.10 ± 0.1
Pea meal	0.63	9.74 ± 0.36	112.9 ± 5.8	1453.7 ± 101.9	96.7 ± 4.6	1.98 ± 0.12
P-value	0.129	0.052	0.160	0.583	0.841	0.059
PSE	0.011	0.24	4.47	52.8	4.56	0.07
Farm trial						
Poultry meal	0.45	24.1 ± 0.71	476.2 ± 32.7	5200.2 ± 147.2	98.0 ± 4.5	0.70 ± 0.02
Fish meal	0.45	24.2 ± 1.0	474.4 ± 29.9	5293.3 ± 310.7	98.0 ± 2.7	0.70 ± 0.03
DDGS	0.45	23.4 ± 1.6	435.1 ± 39.4	5118.0 ± 297.8	93.0 ± 4.5	0.73 ± 0.05
Pea meal	0.45	23.3 ± 0.84	423.2 ± 14.1	5107.3 ± 332.6	91.0 ± 5.5	0.73 ± 0.03
Reference 1	0.46	23.7 ± 1.80	445.3 ± 47.0	5109.7 ± 542.9	94.0 ± 6.5	0.72 ± 0.06
Reference 2	0.44	23.4 ± 0.99	425.8 ± 18.8	5194.1 ± 181.7	91.0 ± 2.2	0.72 ± 0.03
P-value	0.78	0.78	0.049	0.94	0.064	0.81
PSE	0.008	0.61	16.2	164	2.3	0.02

Values represent the mean ± standard deviation of five replicates. FCR, feed conversion ratio; DDGS, distiller's dried grain with solubles; PSE, pooled standard error.

to ANOVA ($P = 0.049$). Excellent growth was observed across all treatments with shrimp growing from 0.45 to 23.1–24.2 g in the 9-week culture period. Weight gain (%) was over 5100% across all dietary treatments whereas survival of the shrimp ranged from 91% to 98%. Food conversion ratios were also excellent, ranging from 0.70 to 0.73 across all dietary treatments. The low FCR is presumably due to the high primary productivity of the shrimp pond supplying water to the culture tanks throughout the experimental period. As the farm trial was conducted

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reared in low salinity culture systems. Results from this study confirm that fish meal can be removed from production diets without reducing growth and survival of shrimp reared in low salinity waters. Farmers can save money on feed by not including fish meal in their production diets and utilizing plant–animal protein combinations (PM and soybean meal) or all plant protein alternatives such as pea meal or DDGS.

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JPK7/13/12

C^2TX 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**

12.50 US Difference

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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% for pelletmills, more room for protein sources at lower protein levels.
- Lower feed costs with similar results, or better.
- Total cost is less but extruder system is more expensive to operate and purchase.

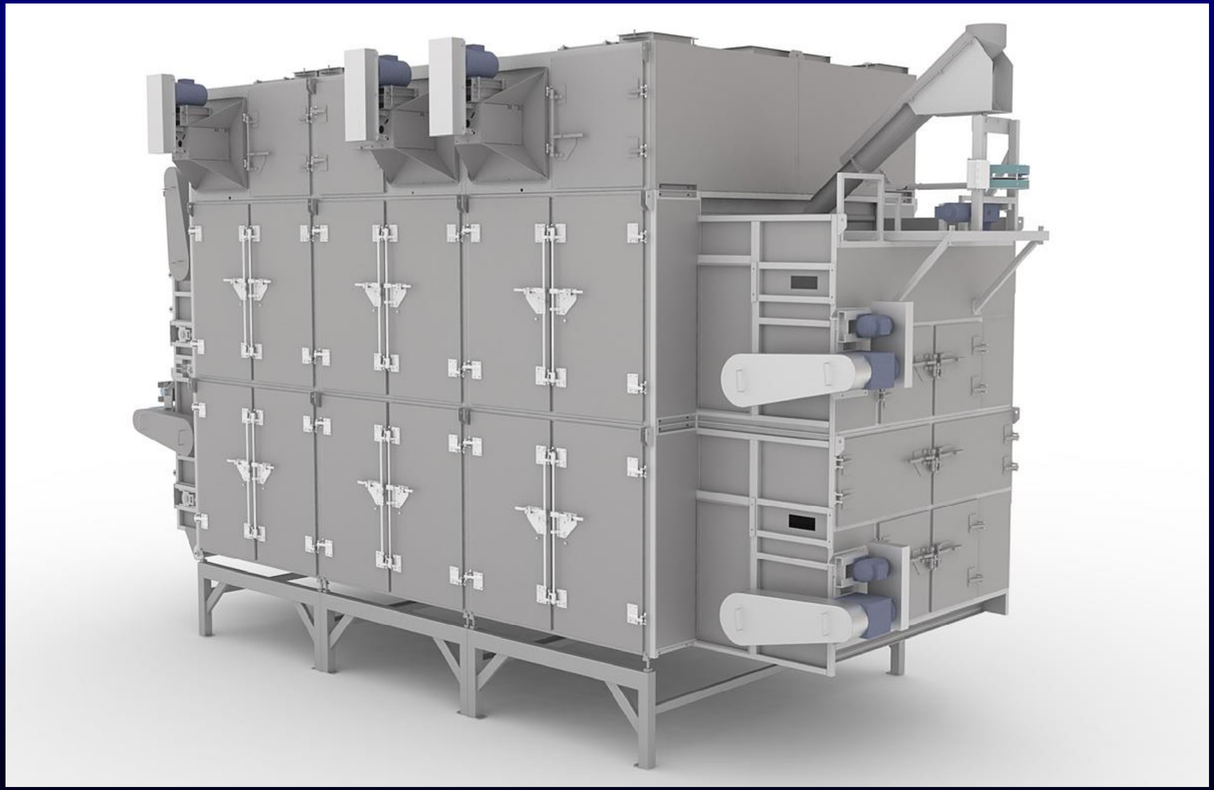
Potential Savings in Recipe Costs

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)

Wenger Shrimp Feed Dryer

4500 kg/hr dry shrimp feed

1.5 – 3.0 mm pellets

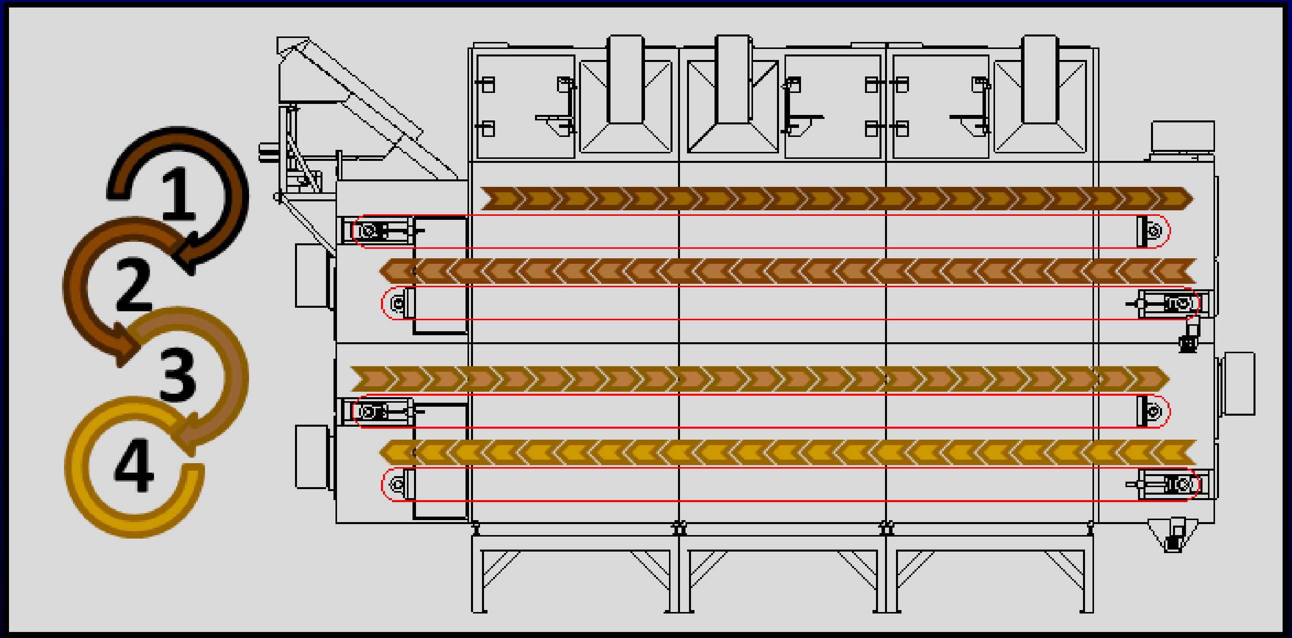


WENGER®
DRYING TECHNOLOGY

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

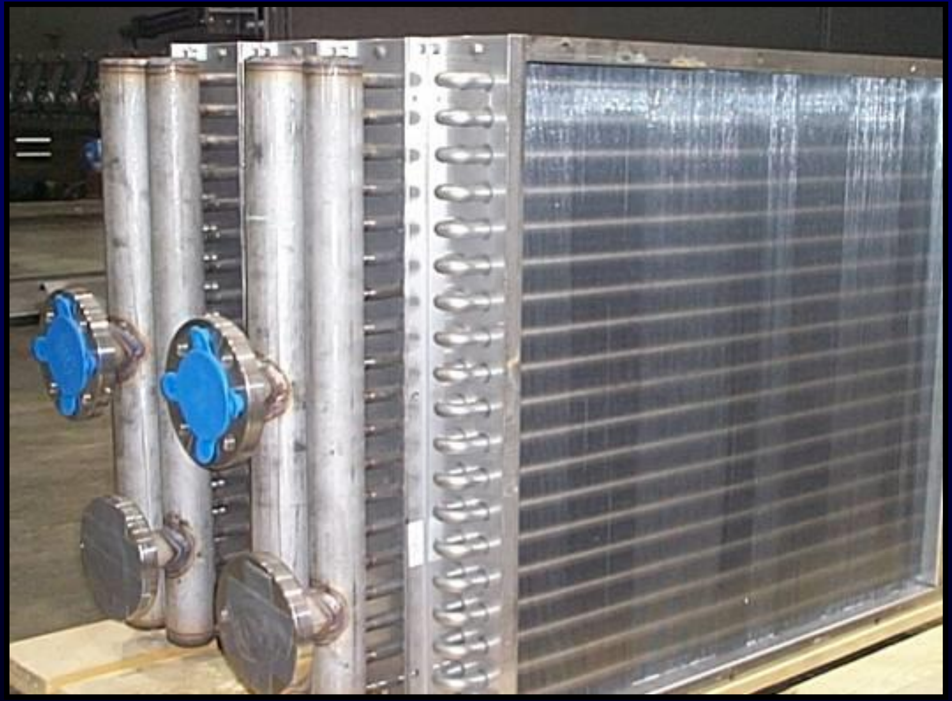
Mesh Screen Conveyor

- 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



Wenger Shrimp Feed Dryer

New Direct Drive Spout Spreader

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

Example of a Good Dryer Product Spread

Sea Bass Sea Bream Feeds
Sinking Medium Fat Content

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

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Future Requirements?