Ingredient Quality and Extruded Shrimp Feeds.

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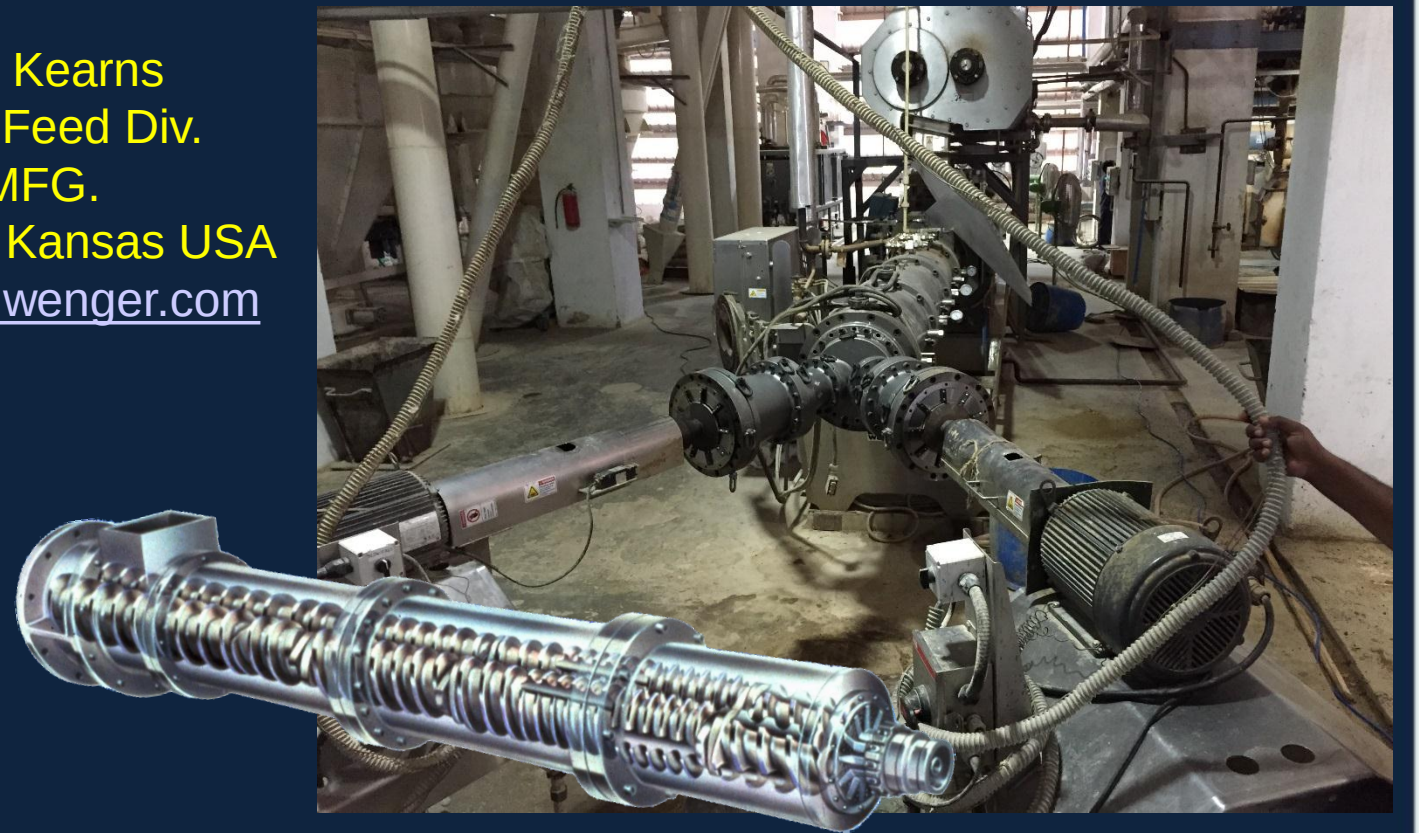


Shrimp Feeds

Ingredients in General

- Selected for their Nutritional Value, Cost and/or benefit for the formula
- Requires proper grinding, mixing etc. for the feed being produced
- Delivered to the extruder in good order.

Raw Material Preparation

Hammer Mill

- Limited to 2/64” (0.8mm) Grind Size

Air Swept Pulverizer

- 40 mesh (420 microns)
- 80 mesh (177 microns)

Note: Ground Materials must be sifted prior to extrusion!!!

Grinding Considerations

Pulverizer for Grinding

- Consistent, Fine Grinding
- Low Heat Grinding to Prevent Nutrient Degradation

Ground Material Sifting

- Essential to ensure continuous operation
- Recycle over-sized material
- Self Cleaning Screens

Fine Grinding at Reynolds Eng. Test Facility

Raw Material Grind is Important

Pellet : Side By Side

Sifting Directly Before Extruder

Insures particles are 1/3 the die opening

Removes any residual large particles which might be hung up in the system

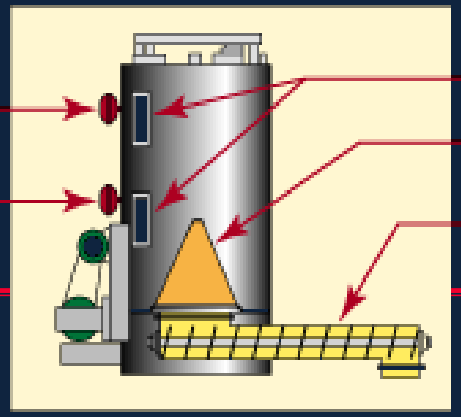
Allows for longer running times

Why Good Grinding and Sifting?

Grinding Considerations

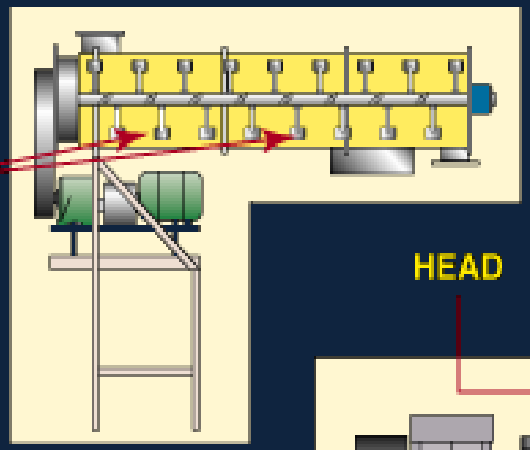
Sample #1B4 Pulverized	
Micron Size	% Through
450	99.8%
350	99.2%
250	98.6%
149	97.8%
75	77.7%

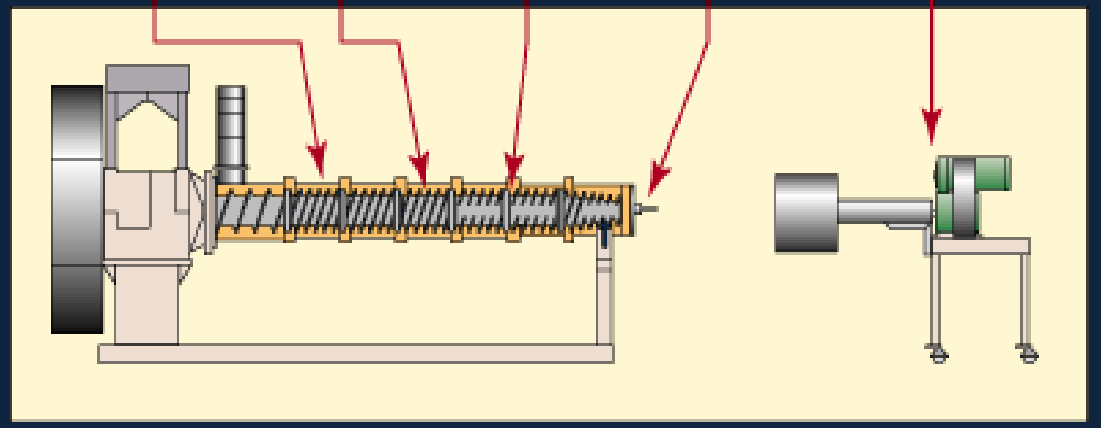
Sample #1B4 Pulverized & Sifted	
Micron Size	% Through
450	100.0%
350	100.0%
250	100.0%
149	99.8%
75	80.8%



FEED DELIVERY SYSTEM

PRECONDITIONING PHASE





EXTRUDER BARREL COMPONENTS

High Intensity Preconditioner

Excellent double shafted with maximum beater contact system

Specially good when using high levels of liquid ingredients as in ground up fish offal

Comparison of Particle Size Off Preconditioner at 70% Meat Addition

High Mixing Intensity

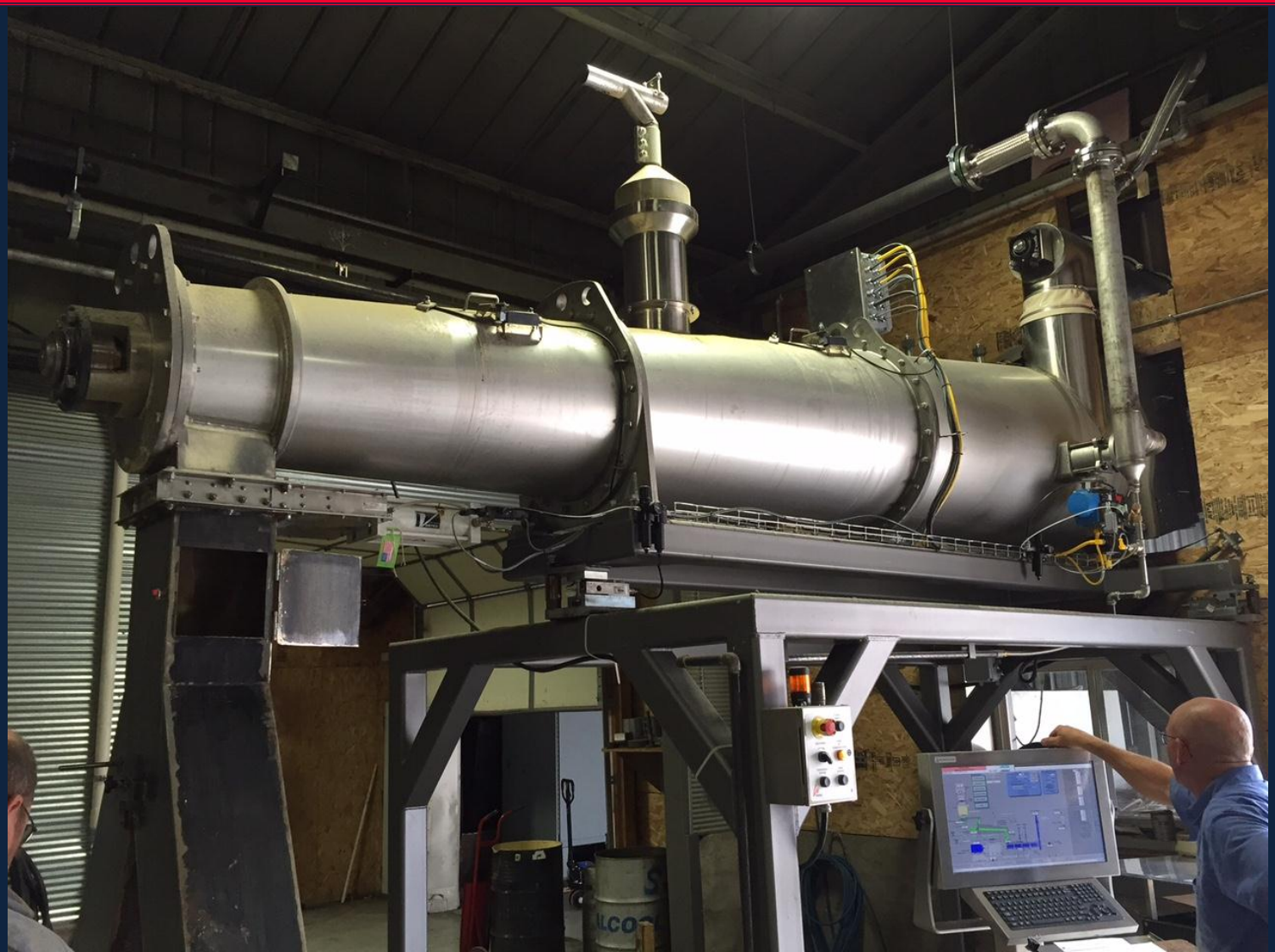
Low Mixing Intensity

Application of High Intensity Preconditioner

Sample off preconditioner:

- 50% fresh meat slurry
- 11.5% steam
- 3.4 minutes retention time
- 35% moisture

High Shear Conditioning, HSC



New Method of Steam Addition, SMI

Advantages of HSC

- HSC in combination with the SMI yielded very high downspout temperatures, approx. 97 degrees C
- Reduced steam inclusion of approx. 5%
- Virtually no losses out the atmospheric vent.
- The energy is being absorbed into the product matrix and allowing for much easier cooking in the extruder.
- < 26% Moisture Addition and <15% wet slurry addition

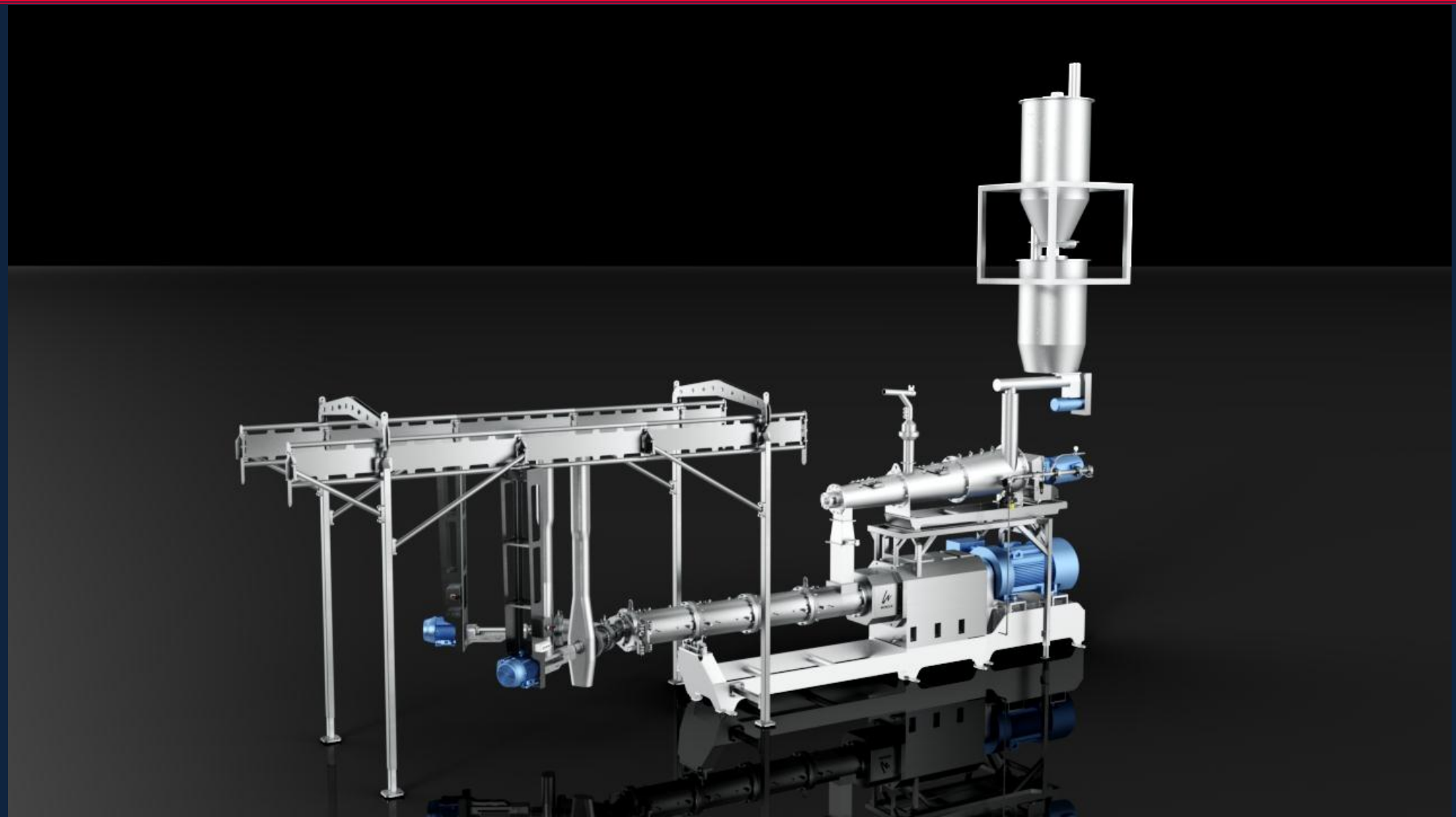
The Extruder

Mixing, Pressure Development, Venting, Liquid Injection

Shrimp Feed Extrusion

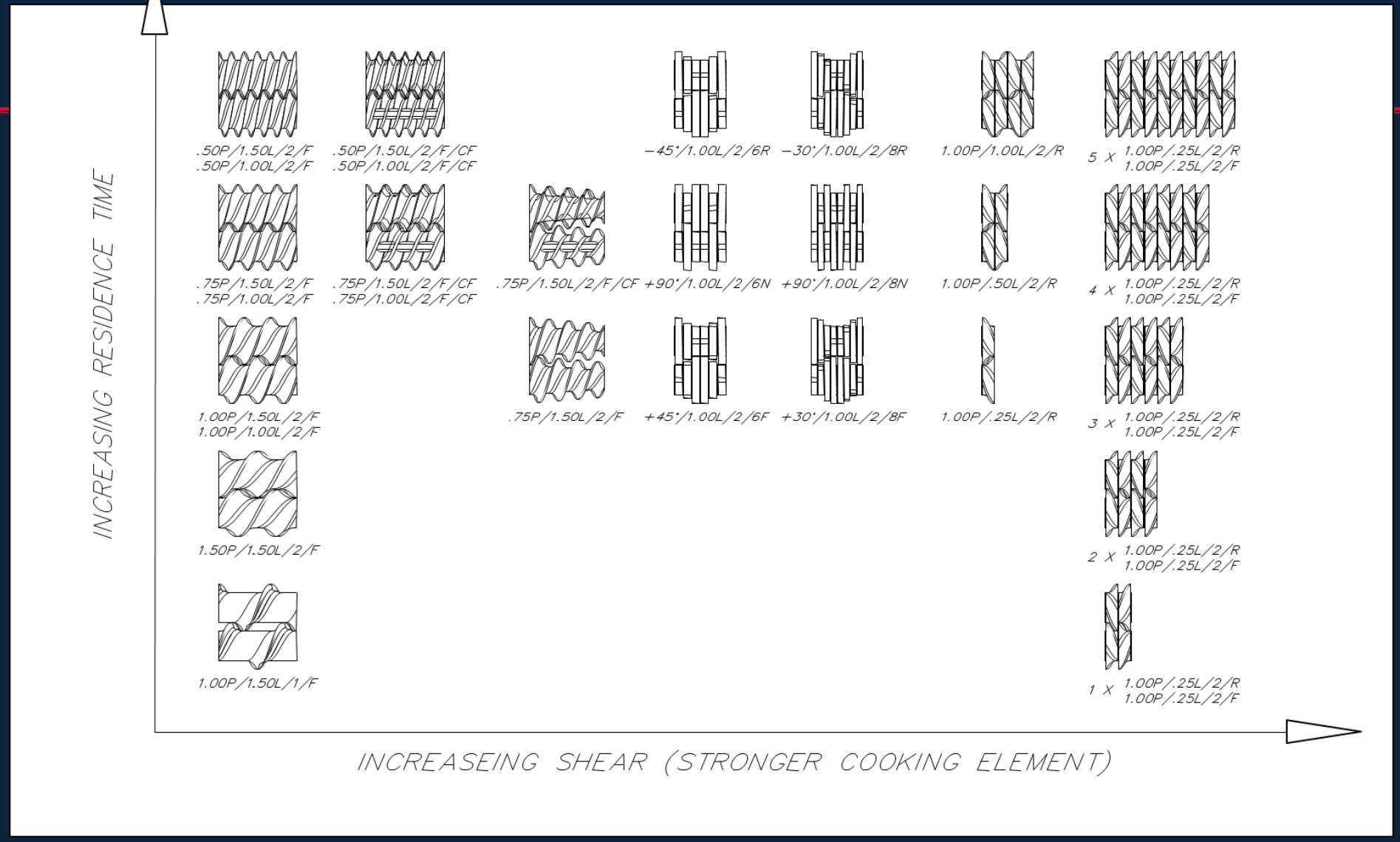
- Require 10% starch minimum
- Want to cook the starch to activate the binding but not expand the product
- Use elevated vegetable proteins for white shrimp
- Use high fish meal diets for carnivorous shrimp
- 100% sinking and good water stability, approx. 2 hours or more.

TX-3000 High Capacity Small Diameter Extrusion




ABB

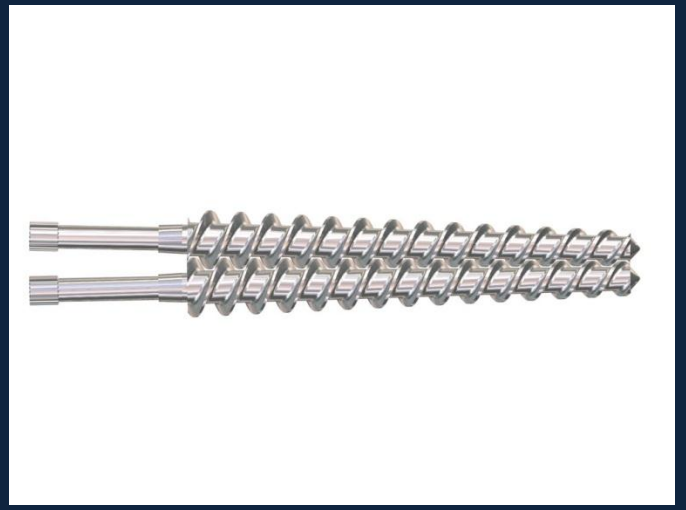
Twin Screw Rotating Elements



C²TX, Conical Co Rotating Twin Screw

Conical Twin Screw System

- Co-rotating / tapered shaft
- Positive conveyance
- Profile kneading
- Low moisture extrusion
- Wide ingredient flexibility
- No configuration changes
- Density range from 30 to over 700 g/l
- Control density ± 25% with same recipe



Combination of the Tapered Screws and Back Pressure Valve allow for complete cooking control

Ingredient Selection and Discussion

- 10% Starch as a minimum
- Proteins

1) Plant Sources
   - Soy, Legumes, Wheat/corn glutens, cereal grains
     - Good functional properties
     - Lower cost
     - Amino acid profile may require supplementation

2) Animal or Marine Sources
   - Meat, Fish, Poultry, Blood, Gelatin
     - Poor functional properties unless fresh or spray dried
     - Higher costs
     - Good amino acid profile

Vegetable Protein Sources with Substantial Starch Contributions

Faba Bean

Lupin

Field Peas

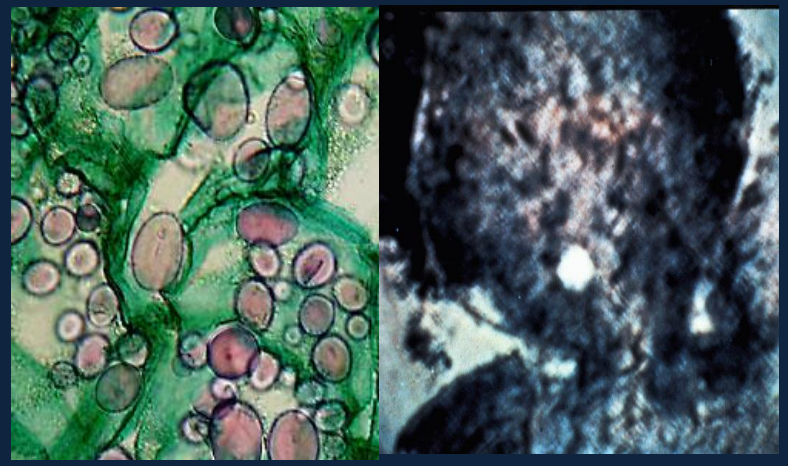
Component	Protein	Fat	Fiber	Starch
%	17 – 30	0.5 – 3.5	5.0 – 6.0	35 - 50

Processing Effects on Proteins:
Wet Chemistry Methods

1) Denaturation of Proteins
- Begins to occur at 55°C (130°F)
- Measure PDI (Protein Dispersibility Index) digestible in acidic environment

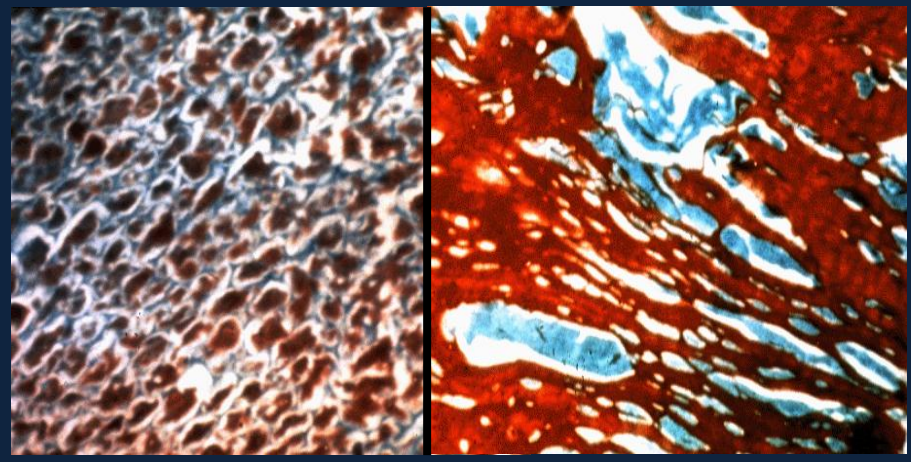
2) Heat- Damaged Proteins (poor digestibility)
- Can begin at 150°C (302°F)
- Measure N_2 in acid detergent fiber fraction
- Poor digestion in acidic environment

- 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

Flow Index Test for Fish Meals

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.

One of the first indications ingredient quality was important. Salmon industry back when high fishmeal diets were produced. As much fishmeal as you can achieve with the lowest starch level in the formula.

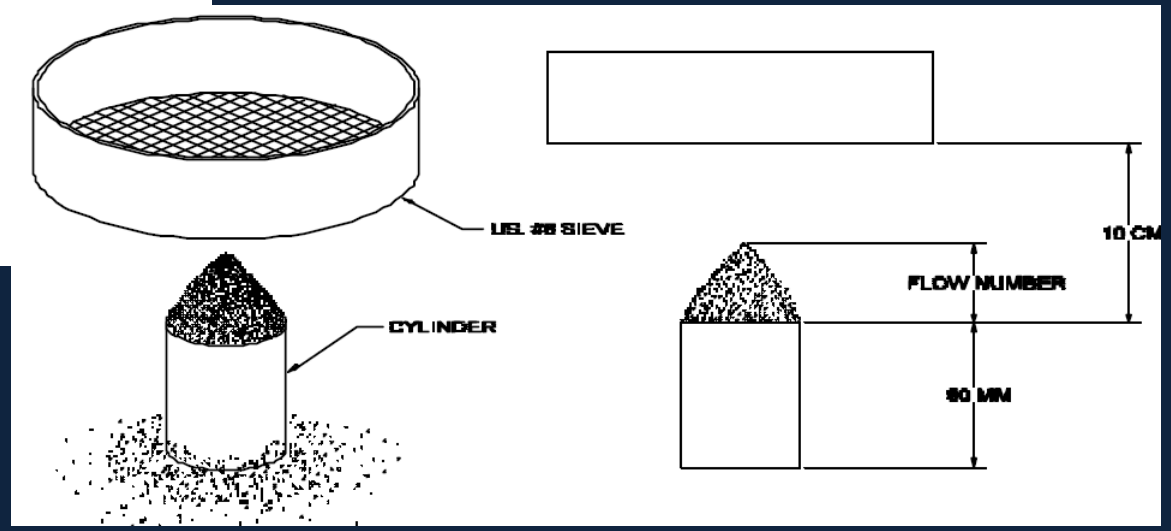
Source: SSF (Norwegian Herring Oil and Meal Industry Research Institute).

Equipment:

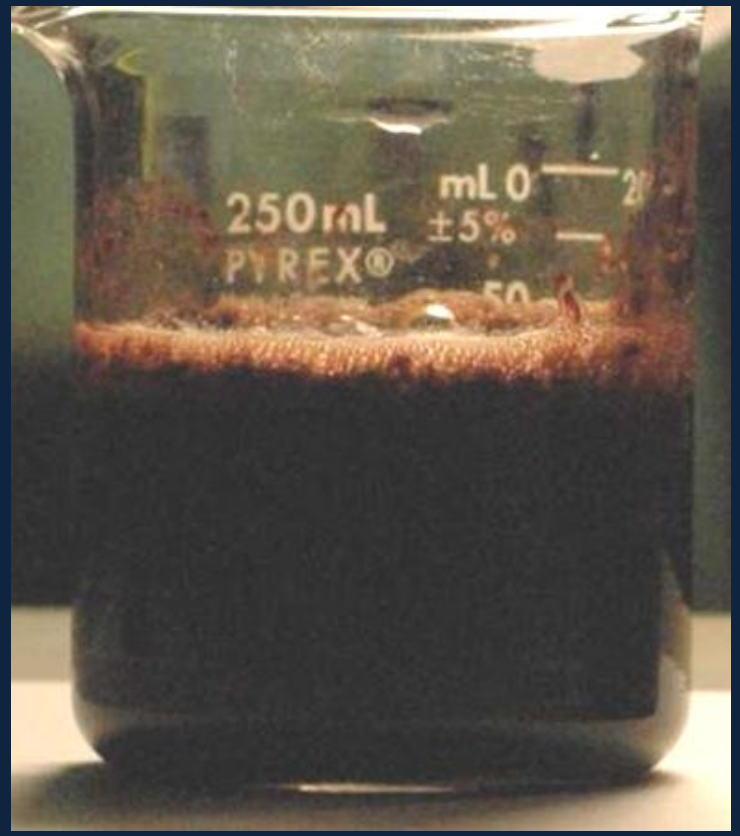
1. Steel Cylinder (50 mm Diameter, 80 mm High).
2. US Sieve No. 8 (7.89 openings / linear inch).
3. Electronic balance with 0.1g accuracy and resolution.
4. Spatula and Ruler.

Method:

1. Place steel cylinder on flat surface.
2. Weigh 50 g of fishmeal.
3. Hold sieve 10 cm above the top edge of the cylinder (see diagram below).
4. Pour fishmeal onto sieve.
5. Scrape the fishmeal through the sieve using a spatula.
6. The meal which falls off of the cylinder is added to the sieve.
7. When the cone (on top of the cylinder) can no longer be built up, measure the height of the cone (cm).
8. The height is defined as the flow number.
9. Use the below scale to rate the flowing properties of the meal
   - Flow # < 2 cm Good flowing properties (low internal friction)
   - Flow # > 5 cm Poor flowing properties (high internal friction)



Solubility Comparison of Animal Proteins

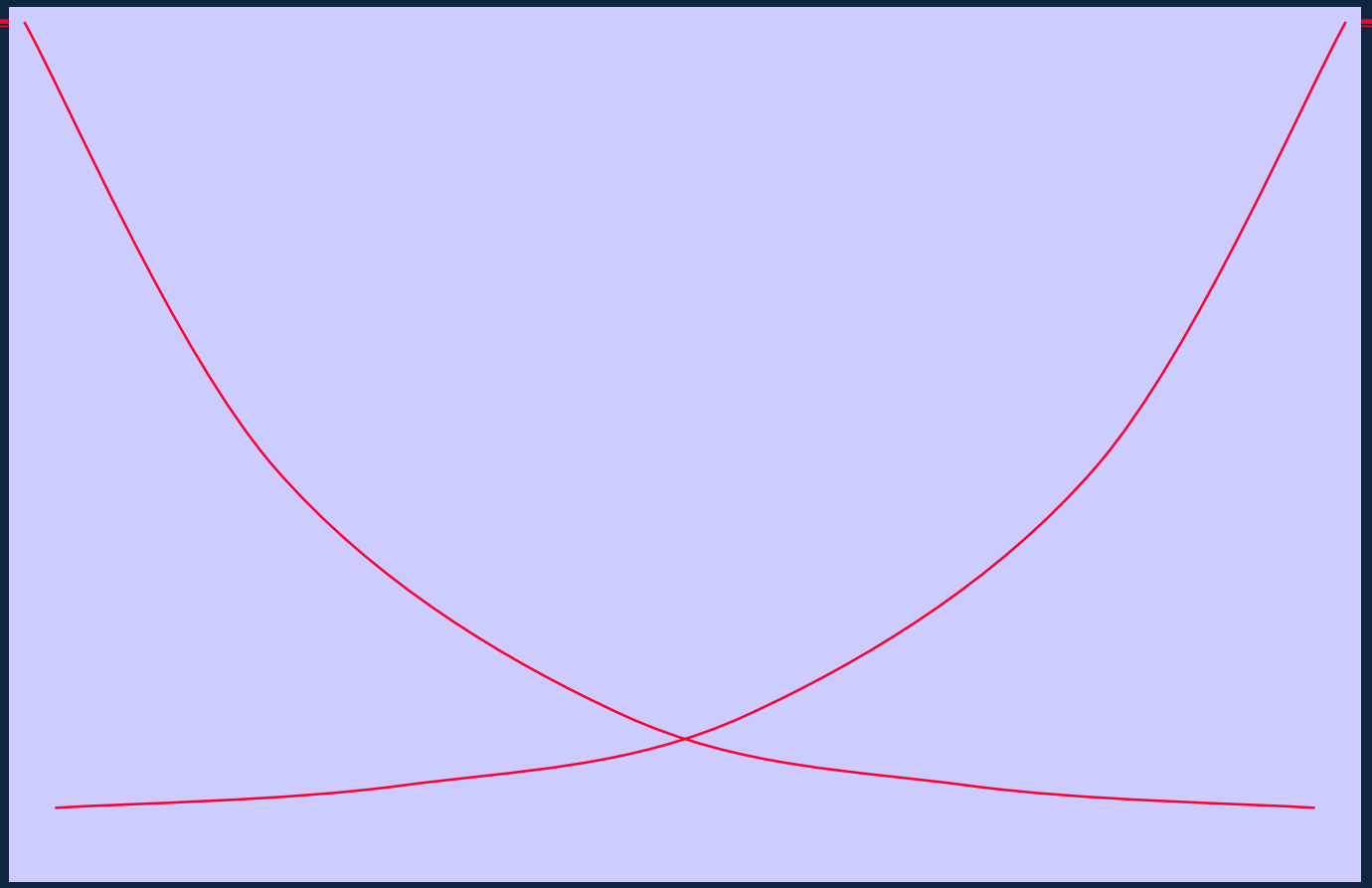


Spray-Dried
Blood Hemoglobin

Ring-Dried
Blood Meal

% Soluble Protein

% Heat Damaged Protein



Processing Temperature

Protein Source
Samples in Meeting

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.

Effect of Raw Material Protein Quality

7 PDI 12 PDI 30 PDI 54 PDI

PRODUCT COLOR

Very Dark

Very Light

Soy Proteins used for FEED
(Soybean Meal)

Soy Proteins used for FOOD
(Flour, concentrate, isolate)

Laboratory Procedure
Protein Dispersibility Index (PDI)

This method determines dispersible protein in soybean products under conditions of test. In contrast to alternate slow-stir method for Nitrogen Solubility Index (NSI) (AACC Method 46-23), the faster-stirring technique used in this method will give generally higher results.

Equipment

1. Hamilton Beach Drinkmaster No. 30, modified to accommodate Waring Blendor blade and cup.
2. Blade assembly with Cenco-Pinto blades. Central Scientific Co., No. 17251-L55. Use two blades, one horizontal and one with tips pointing down with cutting edge in direction of rotation.
3. Waring Blendor cup, 1-qt. Capacity; bottom sealed with No. 3 stopper.
4. Glassware; 300ml Volumetric flask, 15ml Pipet, 600ml Beaker.
5. Centrifuge; International type SB size 1,2,700 rpm, with 50ml tubes or any equivalent, capable of delivering 1,400 r.c.f. at tip.
6. Balance, 0.1g accuracy.
7. Timer, interval, alarm.
8. Variable transformer.
9. Standard Kjeldahl equipment (AACC Method 46-10).
10. Tachometer, range to 10,000 rpm.
11. Voltmeter.

Standardization of Blender

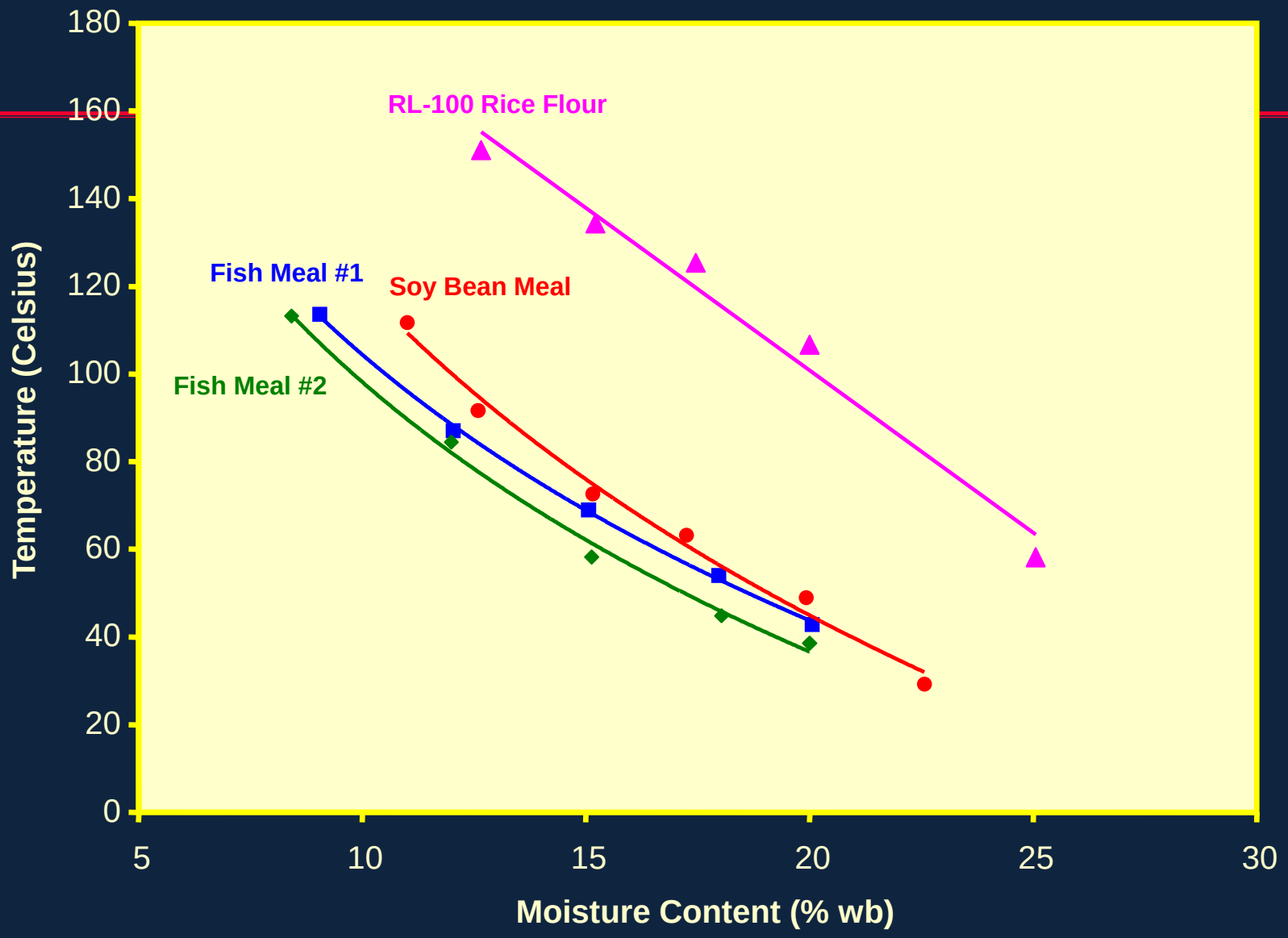
Measure 300 ml of water into blender cup and place in position on mixer. Remove chrome cap, which covers top of the drive shaft. Using proper tip, place tachometer in position on rotation shaft. With switch in high position gradually increase transformer setting until shaft shows 8,500 rpm on tachometer. Note voltmeter reading and transformer setting, and use for blending of sample. Standardization of machine should be done before each series of test to eliminate errors on account of fluctuation in line voltage.

Method:

1. Weigh 20.0g of soy product.
2. Fill 300ml volumetric flask with water at 25ºC. Pour approximately 50 ml water into the blender cup. (Note: Water-dispersible protein is related to temperature, so blender cup should be at room temperature.) Transfer weighed sample quantitatively to blender cup. Stir with spatula to form paste. Add remainder of water in increments, with stirring, to form smooth slurry. Use last of water to rinse spatula and blender cup walls. Place cup in position for blending.
3. Turn blender on with switch in high position and gradually adjust variable transformer to point indicated by water standard at 8,500 rpm. Blend at this speed for 10 minutes.
4. Remove blender cup and pour slurry into 600 ml beaker. After slurry has separated, decant or pipet portion into 50 ml centrifuge tubes and centrifuge 10 minutes at 2,700 rpm.
5. Pipet 15 ml of supernatant liquid into Kjeldahl flask, and determine protein by using AOCS Method Ac 4-41 (15ml = 1.0g sample)

Comparison of Protein and Starch Flow Curves

SBM and some starches are harder to cook then fish meal. Chart shows higher temperature and water are needed.



Laboratory Tests to Indicate Protein Functionality

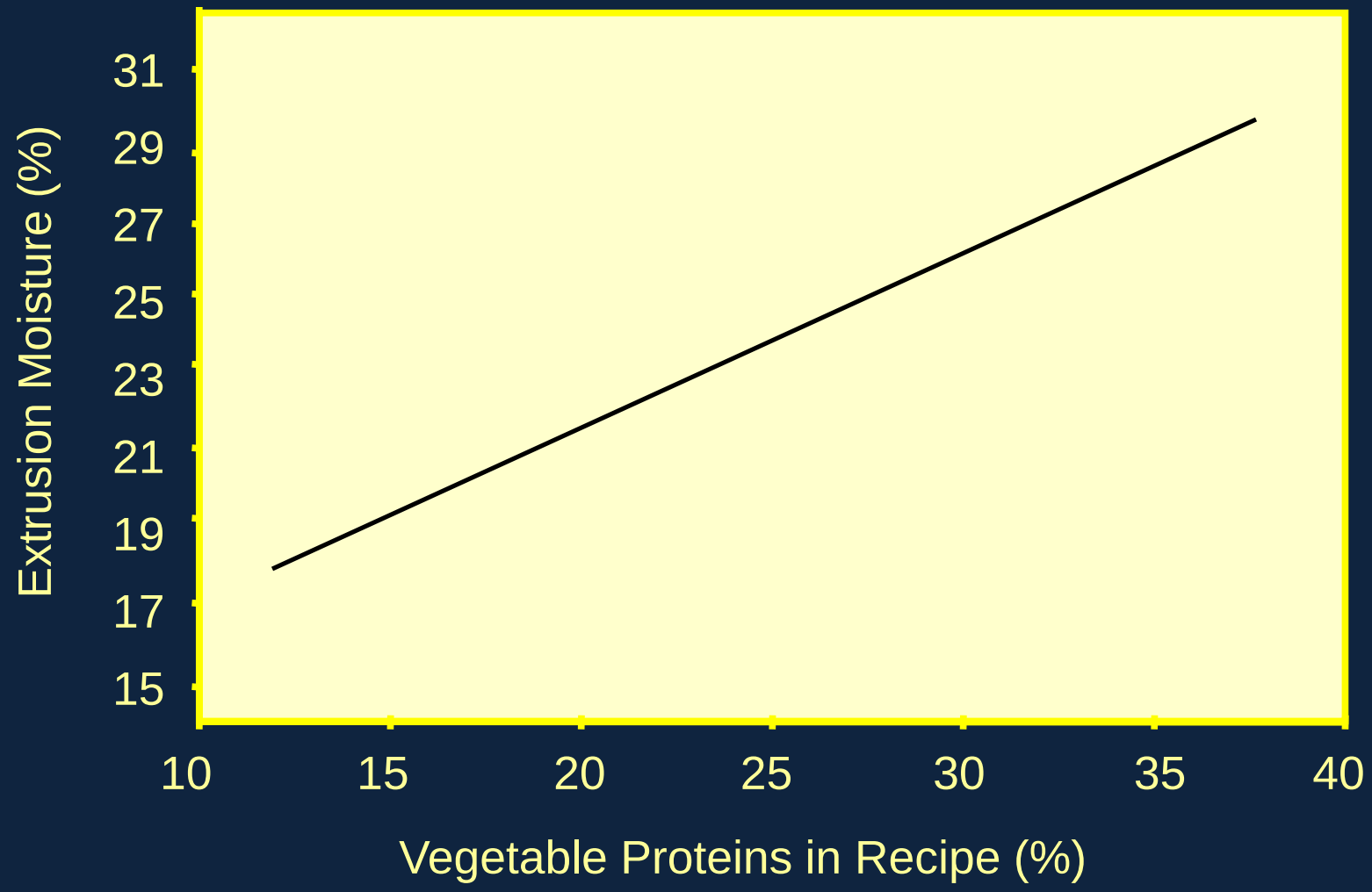
1) PDI (Protein Dispersibility Index)
2) NSI (Nitrogen Solubility Index)

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.

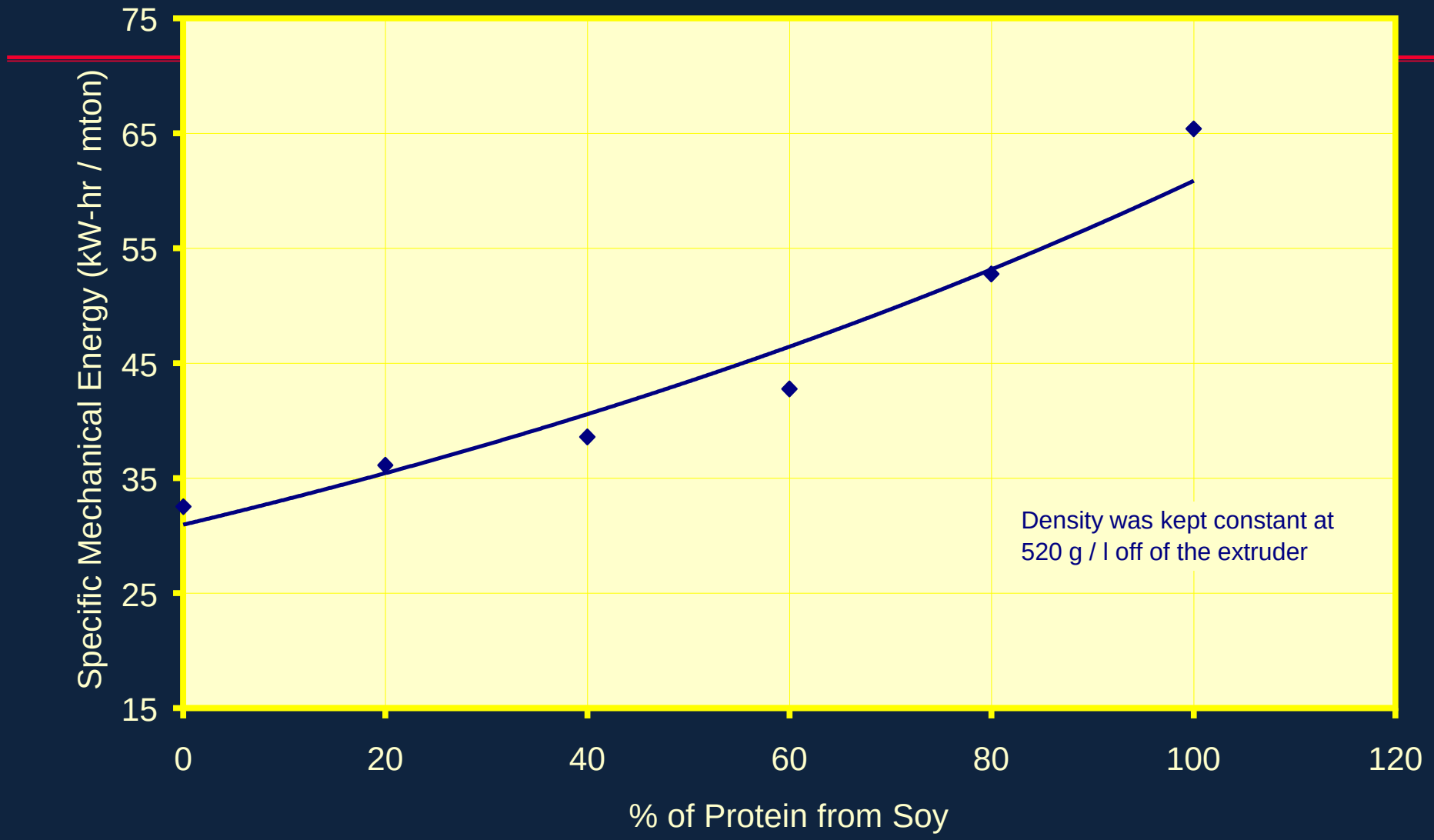
Crown Iron Works
Down Draft Desolventiser for High PDI Soya

- 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.

Effect of Vegetable Protein Levels On Extrusion Moisture



Effect of Protein on SME

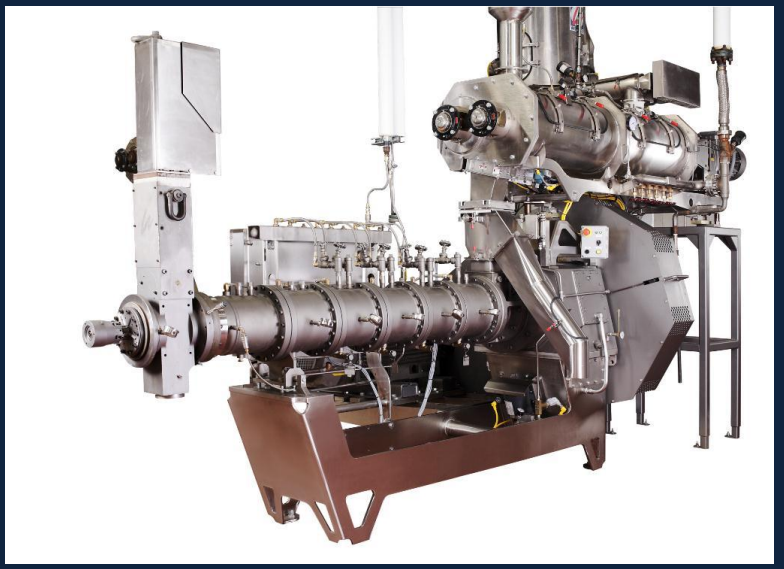


True Costs should be calculated:

The calculations can be made to see the best most cost effective approach. Higher temperatures and more water usually mean lower capacity as well as higher energy use. If higher temperatures, better starch sources and more water are needed to cook lower grade raw materials then how much does it cost to extrude and dry these ingredients over purchasing a better quality ingredient

The 4 Rules of Extrusion Cooking

1. Raw Materials, including quality specs.
2. Hardware arrangement
3. Running Conditions or software requirements
4. Finished Product Specifications

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