

Randcastle Extrusion Systems

Introduction To Compounding

by

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Historically

Extruders

Single screw

Melt

Develop High Pressures

Stable Pressures

Make Product

&

Are Poor Compounders

(Using Shear)

Are Self Cleaning

Twin Screw

Melt

Develop Low Pressures

Less Stable Pressures

Make Pellets

&

Are Good Compounders

(Using Elongation)

Are Self Wiping

Randcastle Recirculator Extruders

Single screw

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Develop High Pressures

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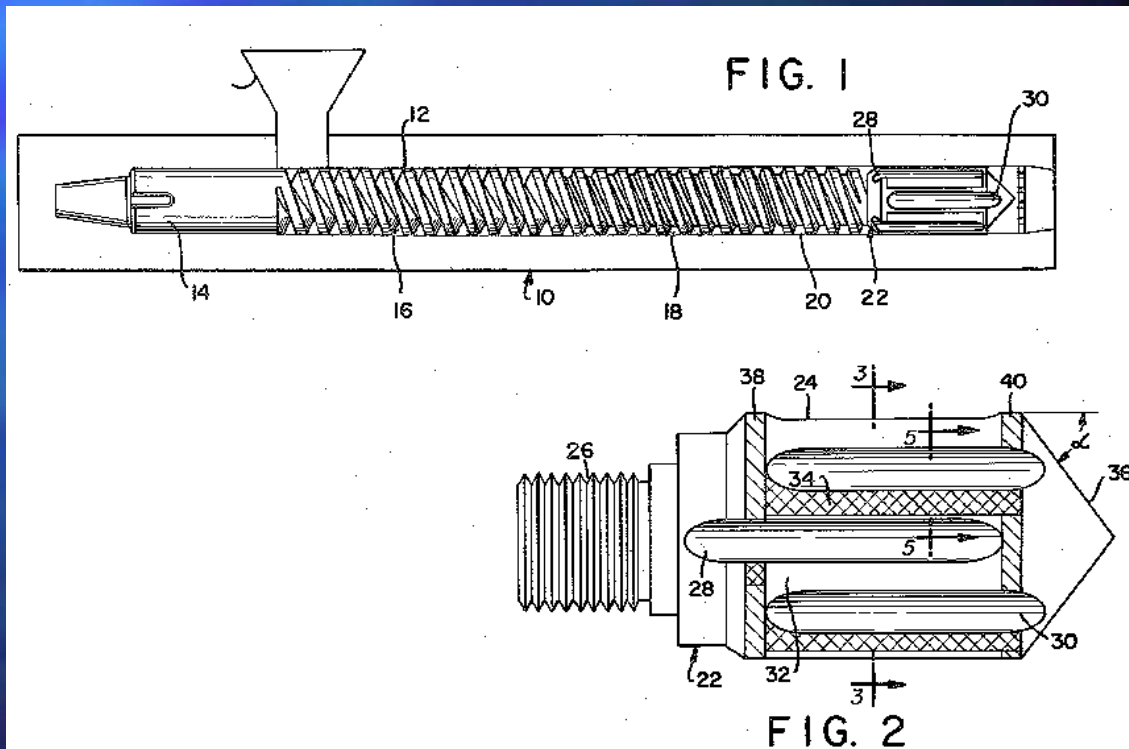
Using Elongation

Are Self Wiping



Historically, how single screw mixers have worked

- Located after melting (after viscosity drops).
- Using Compressive flow.
- Planar shear.



Randcastle Recirculator Does Not Use Compressive Flow

1. Randcastle uses elongational flow.

← A-A-A-A-B-B-B-B → = A-A-A-A-B-B-B-B

Elongation is good. It does not create agglomerations!

2. Classic extruders use compressive flow.



→ A-A-A-A-B-B-B-B ← = AB

Compressing two materials is bad. It creates unbreakable agglomerations!

How Randcastles Builds A Better Compounder

1. Starve feed the extruder.
2. Long screw is critical (The longer the screw, the more time you have for process steps).
3. Multiple Elongational Flow Fields

How Randcastle Builds A Better Compounder

1. Starve feed the extruder.
2. Long screw is critical.
3. Better mixing section.

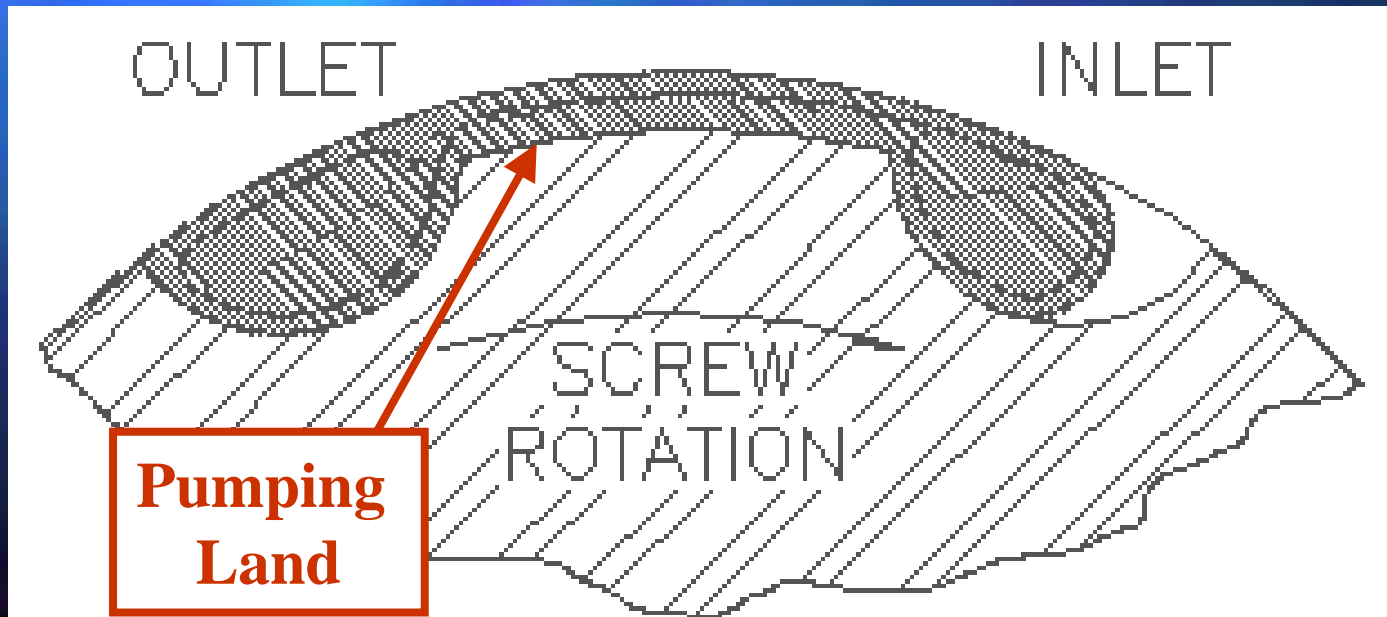
Stretching two materials is good because you prevent agglomerations!

A-B-A-B-A-B → A-----B-----A-----B-----A-----B

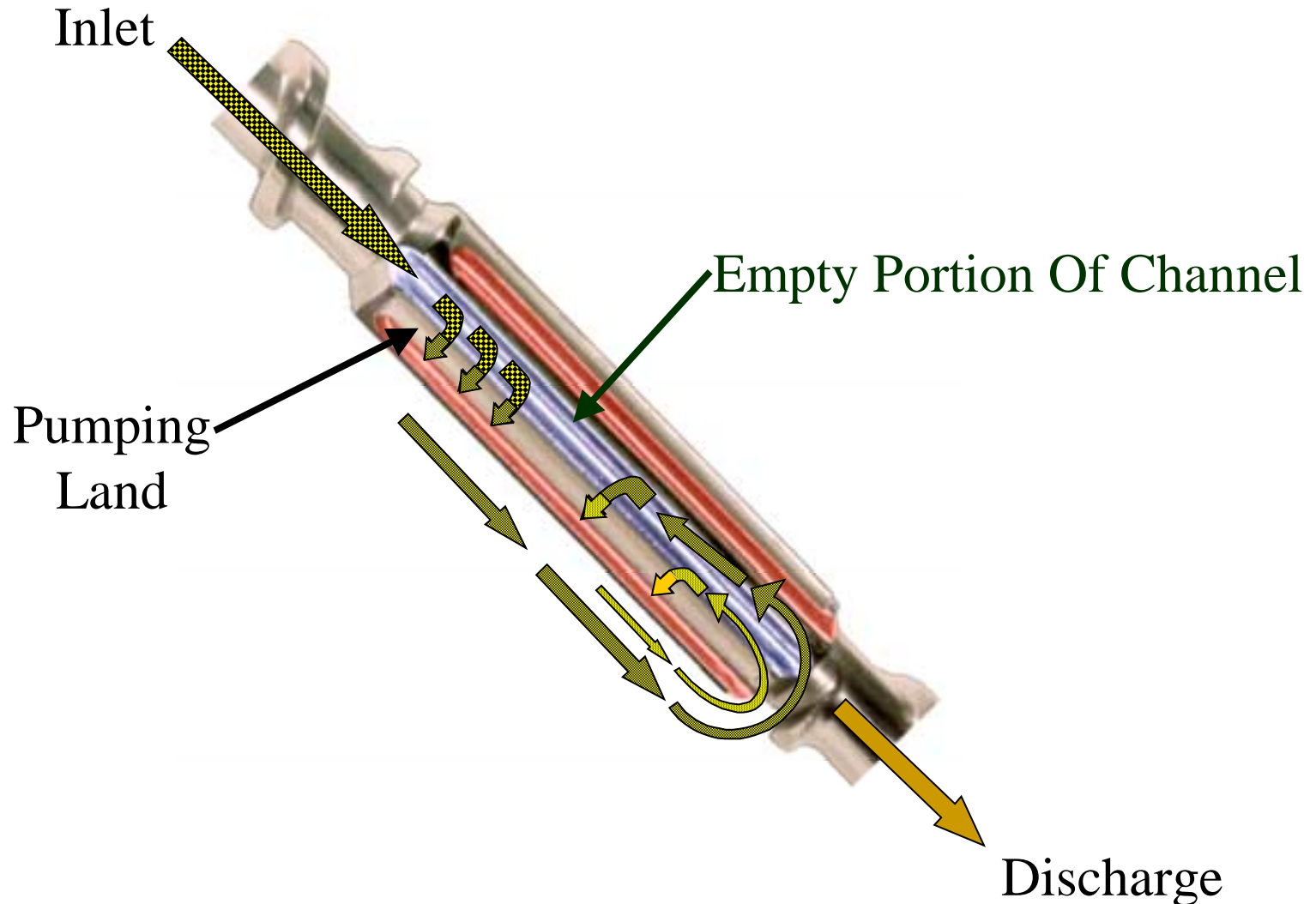
A-A-A-B-B-B → A-----A-----A-----B-----B-----B

How The Recirculator Works

- The Pumping Land, By Drag Flow, Pulls Material From The Inlet Channel
- The Pumping Land's Rate Exceeds The Starved Inlet Flow.
- This Partially Empties The Inlet Channel



How Each Recirculator Works



Four Recirculators



Classic Single Screw Results: 24/1 UC Mixer

Flood feed, single gray pellet (Sample 1)



Classic Single Screw Results: 24/1 UC Mixer

Flood feed, two gray pellets



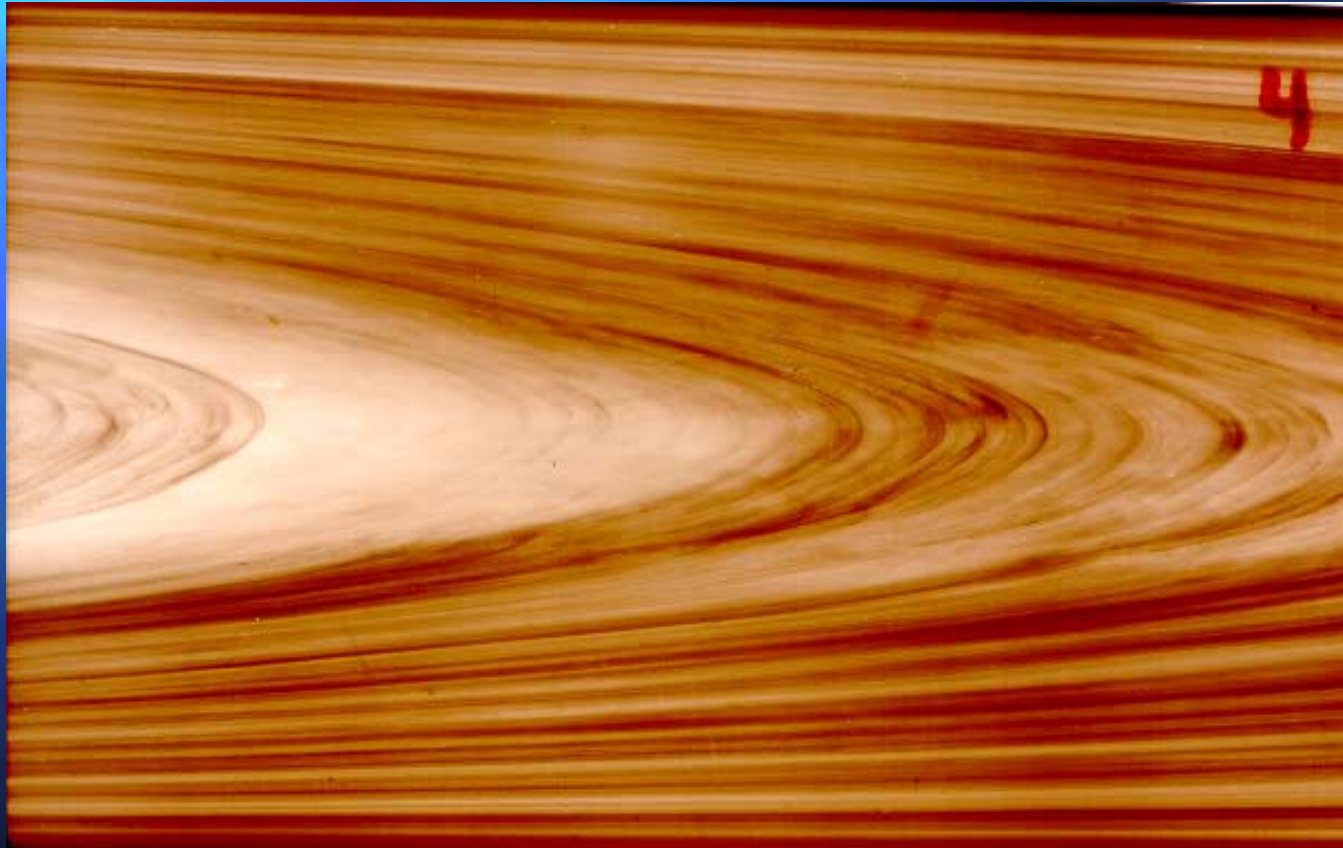
Classic Single Screw Results: 24/1 UC Mixer

Flood feed, two gray pellets, 6 revolutions apart



Classic Single Screw Results: 24/1 UC Mixer

Flood feed, 10% gray elastomer



Classic Single Screw Results: 24/1 UC Mixer

Flood feed, 20% gray elastomer

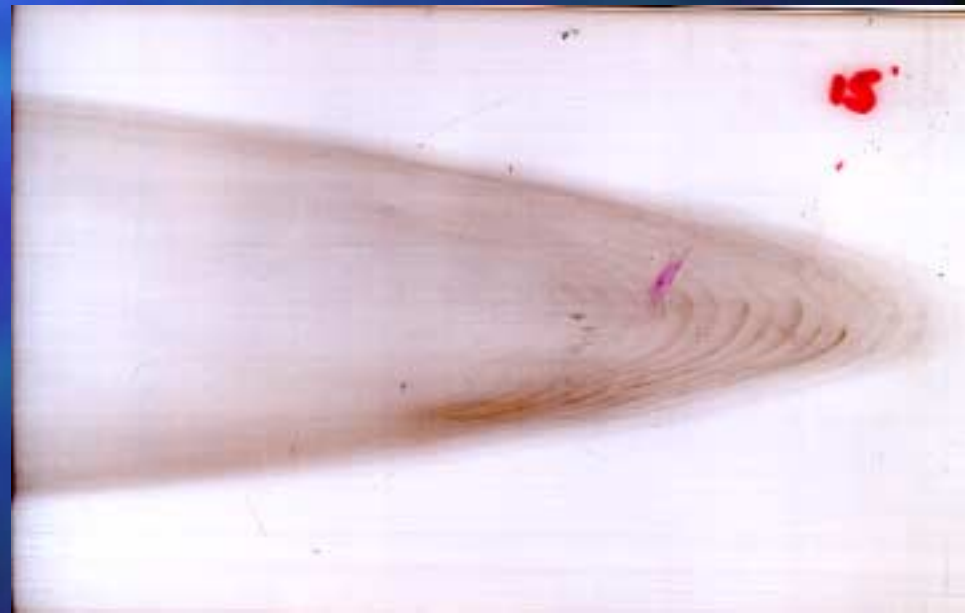


Classic Single Screw Results: 24/1 UC Mixer

Flood feed, two
gray elastomer
pellets



Starve feed, two
gray elastomer
pellets



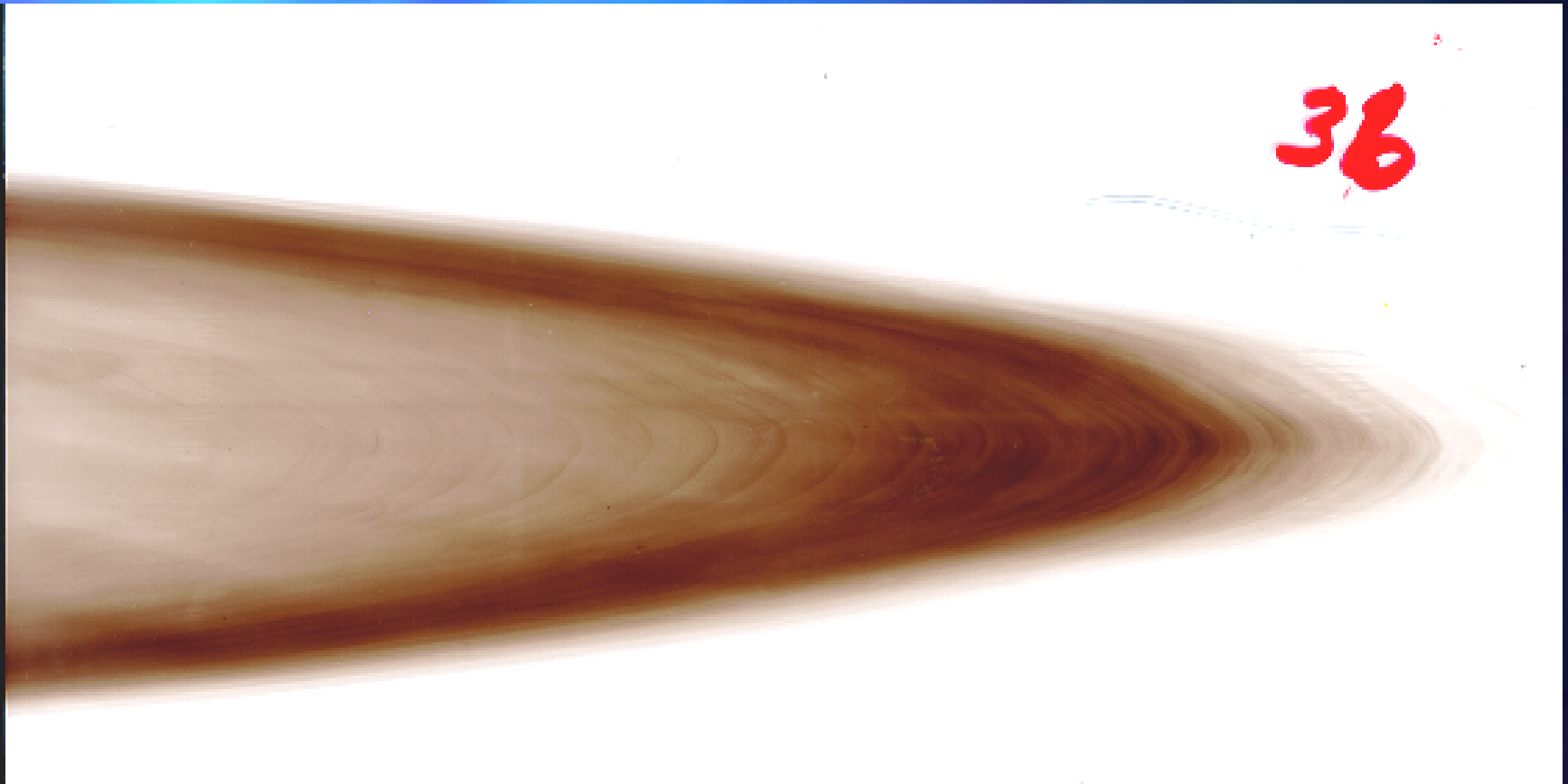
Classic Single Screw Results: 24/1 UC Mixer

Starve feed, 15 gray elastomer pellets



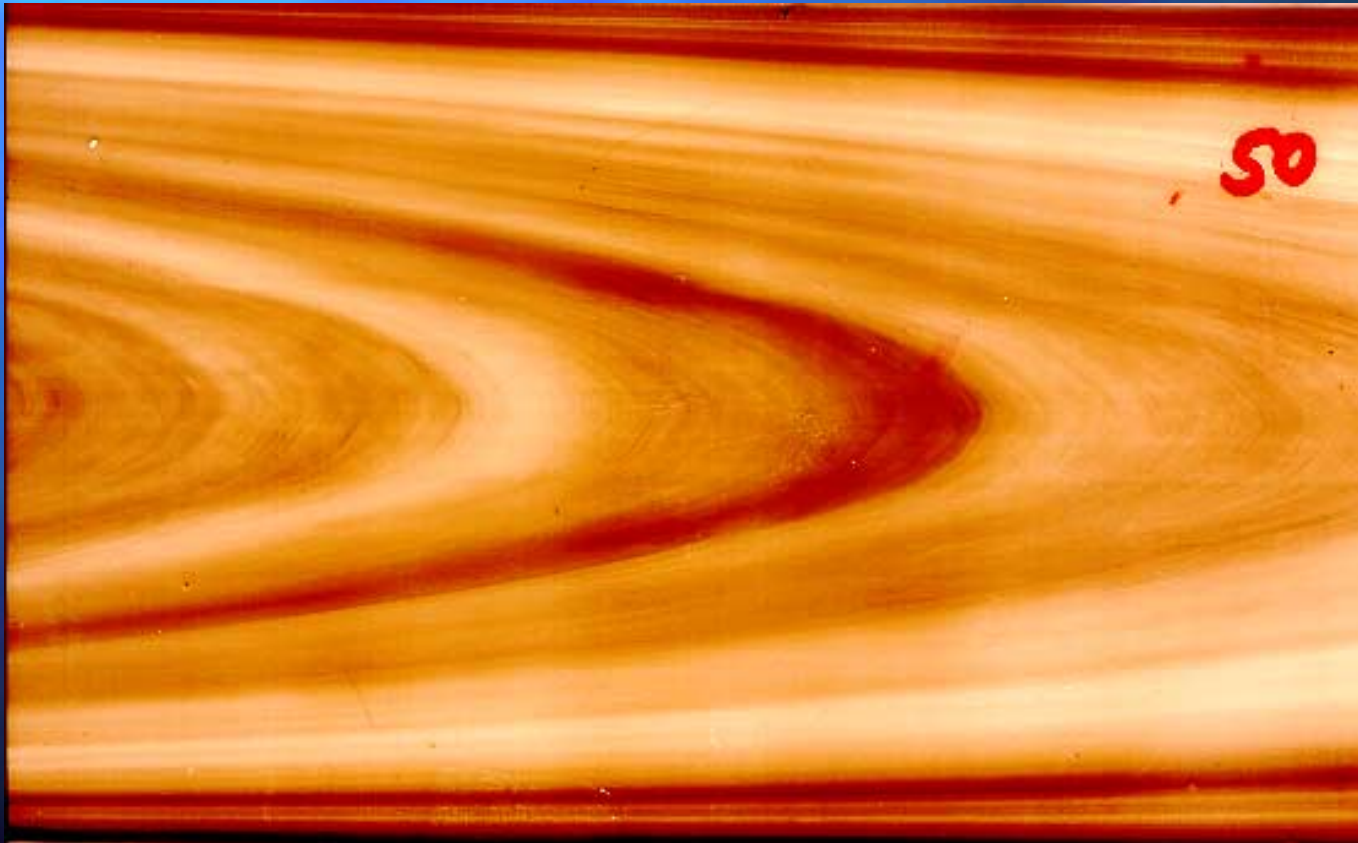
Classic Single Screw Results: 24/1 UC Mixer

Starve feed, 30 gray elastomer pellets



Classic Single Screw Results: 24/1 UC Mixer

Super Starve feed, 10% gray elastomer pellets



Recirculator Results: 50/1 Mixer

Starve feed, two gray pellets

|| → No Sample! ← ||

There is no sample because we could not distinguish mixture of the two pellets from the background haze of the polyethylene.

Recirculator Results: 50/1 Mixer

Starve feed, two gray pellets

||| → No Sample ← |||

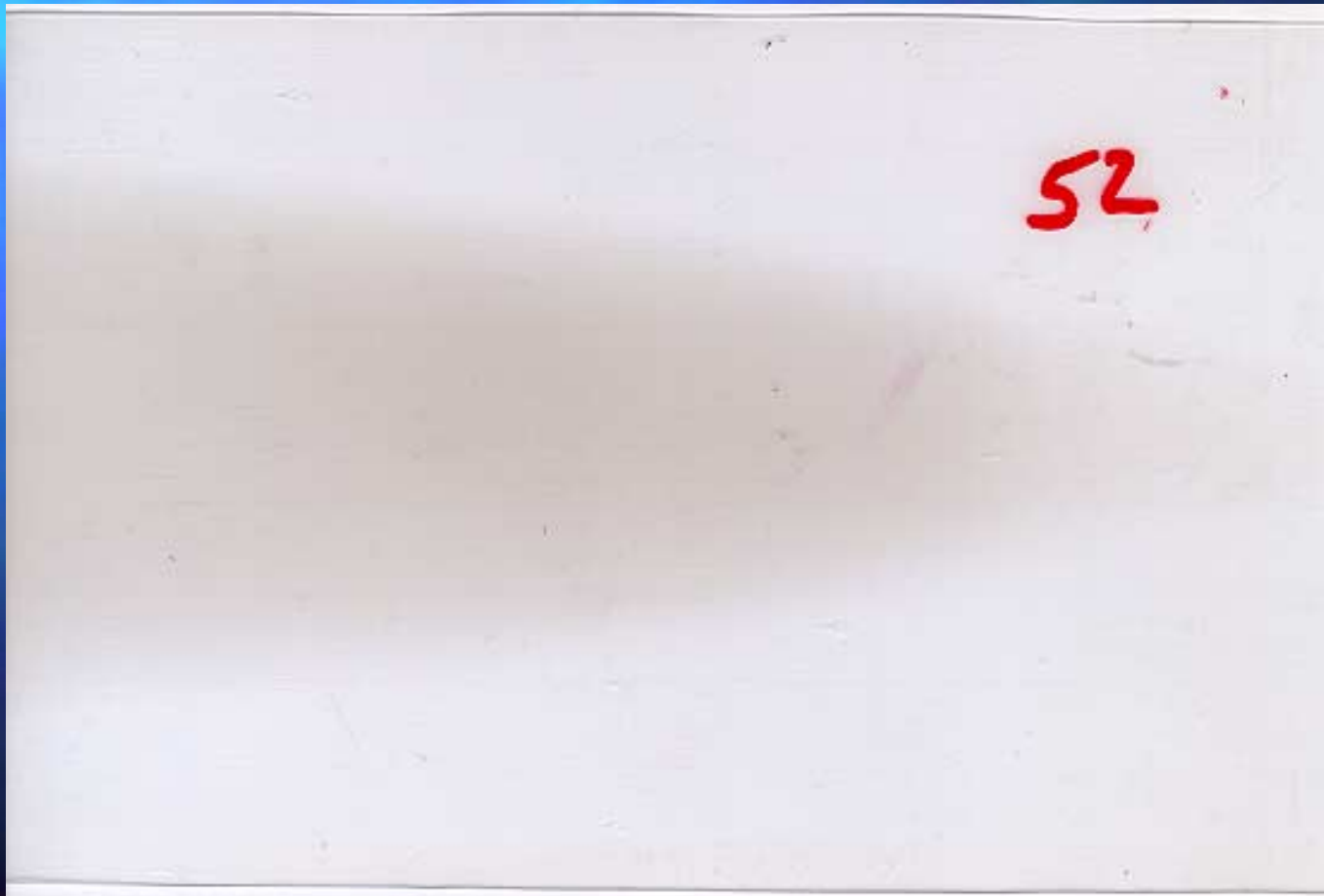
24/1 UC MIXER, FLOOD

2

24/1 UC MIXER STARVED

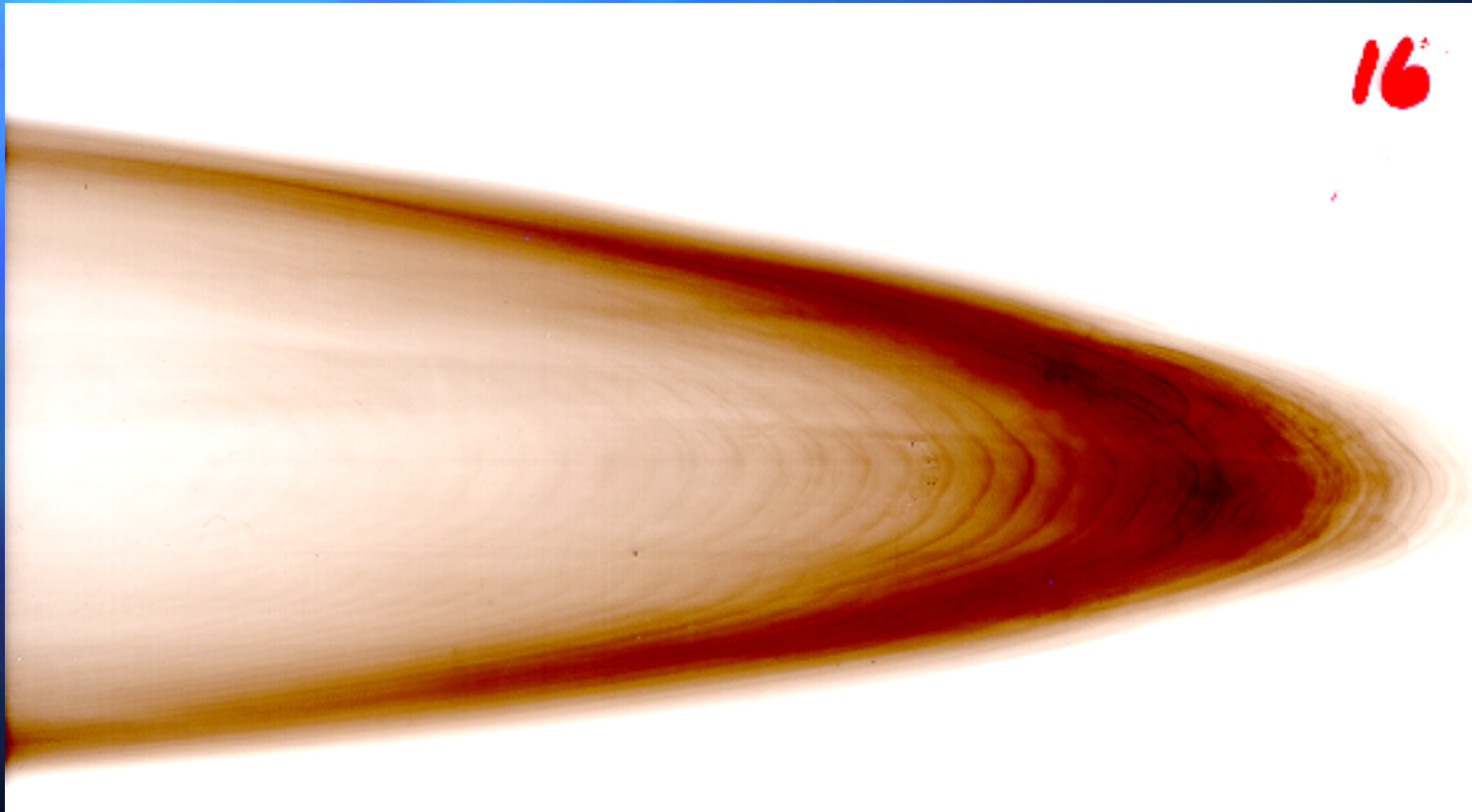
Recirculator Results: 50/1 Mixer

Starve feed, 10 gray pellets



Classic Results: 24/1 UC Mixer

Starve feed, 15 gray elastomer pellets



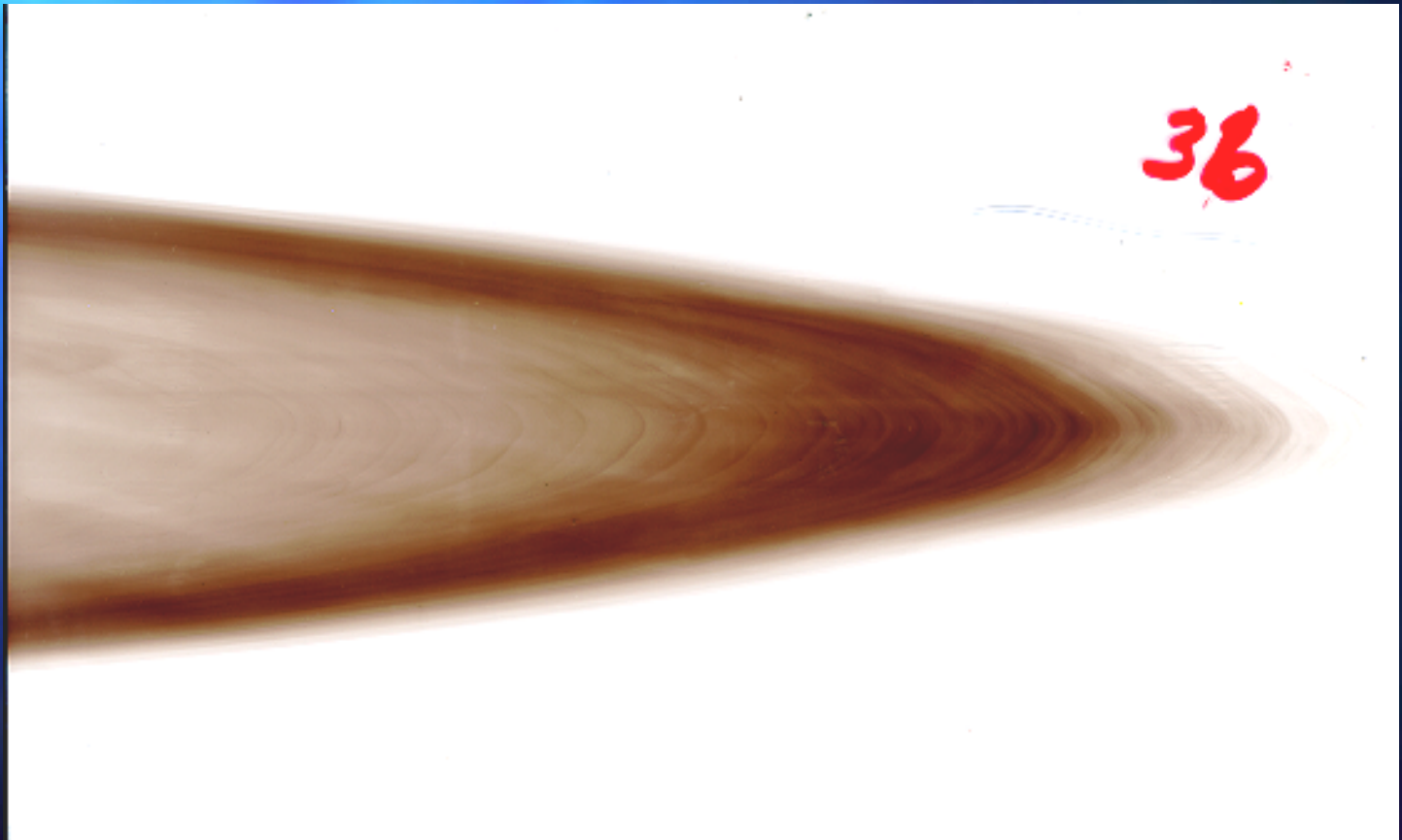
Recirculator Results: 50/1 Mixer

Starve feed, 15 gray elastomer pellets



Classic Results: 24/1 UC Mixer

Starve feed, 30 gray elastomer pellets



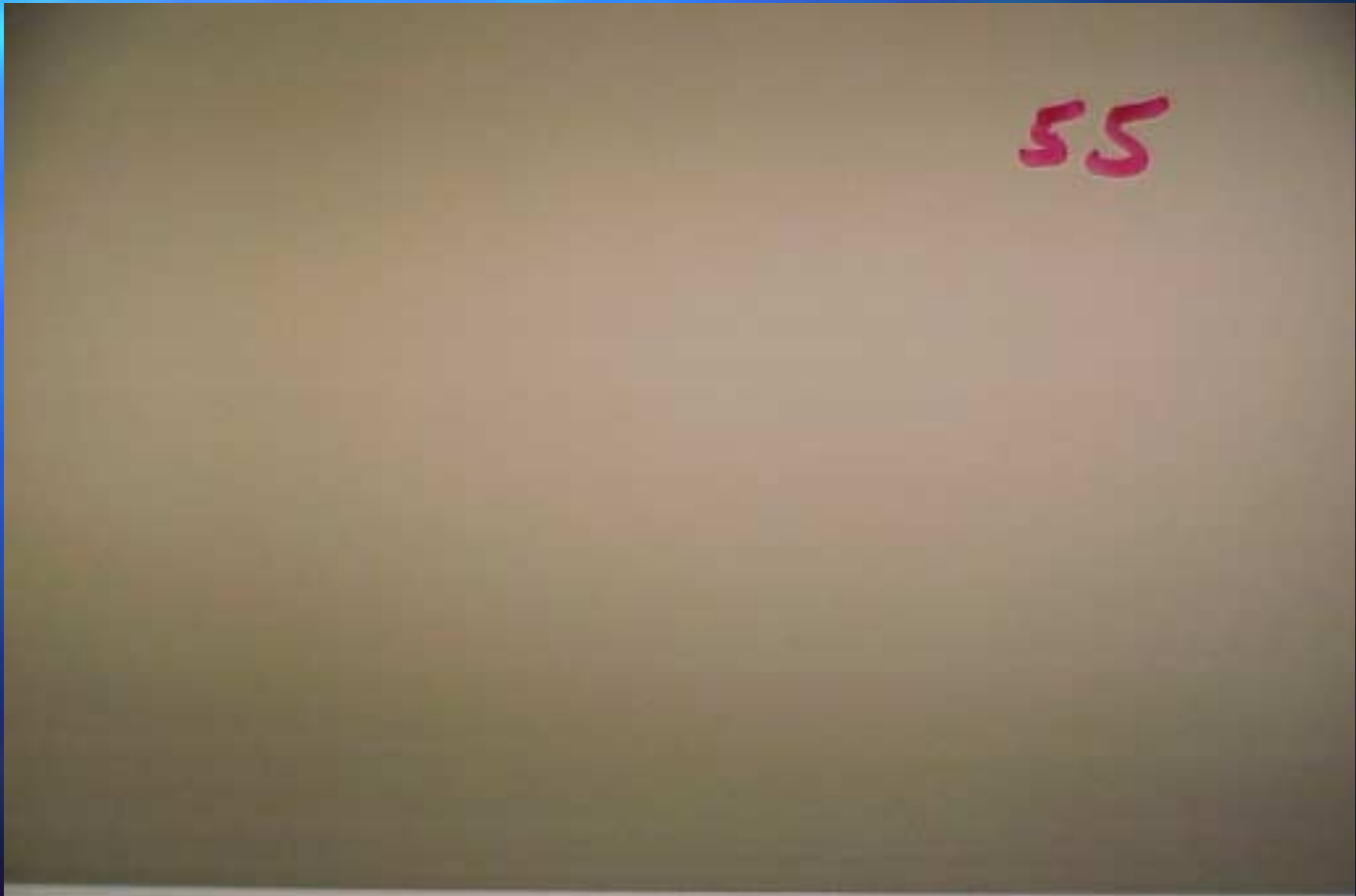
Recirculator Results: 50/1 Mixer

Starve feed, 30 gray elastomer pellets



Recirculator Results: 50/1 Mixer

Starve feed, 10% gray elastomer pellets



Recirculator Results: 50/1 Mixer

Starve feed, 20% gray elastomer pellets



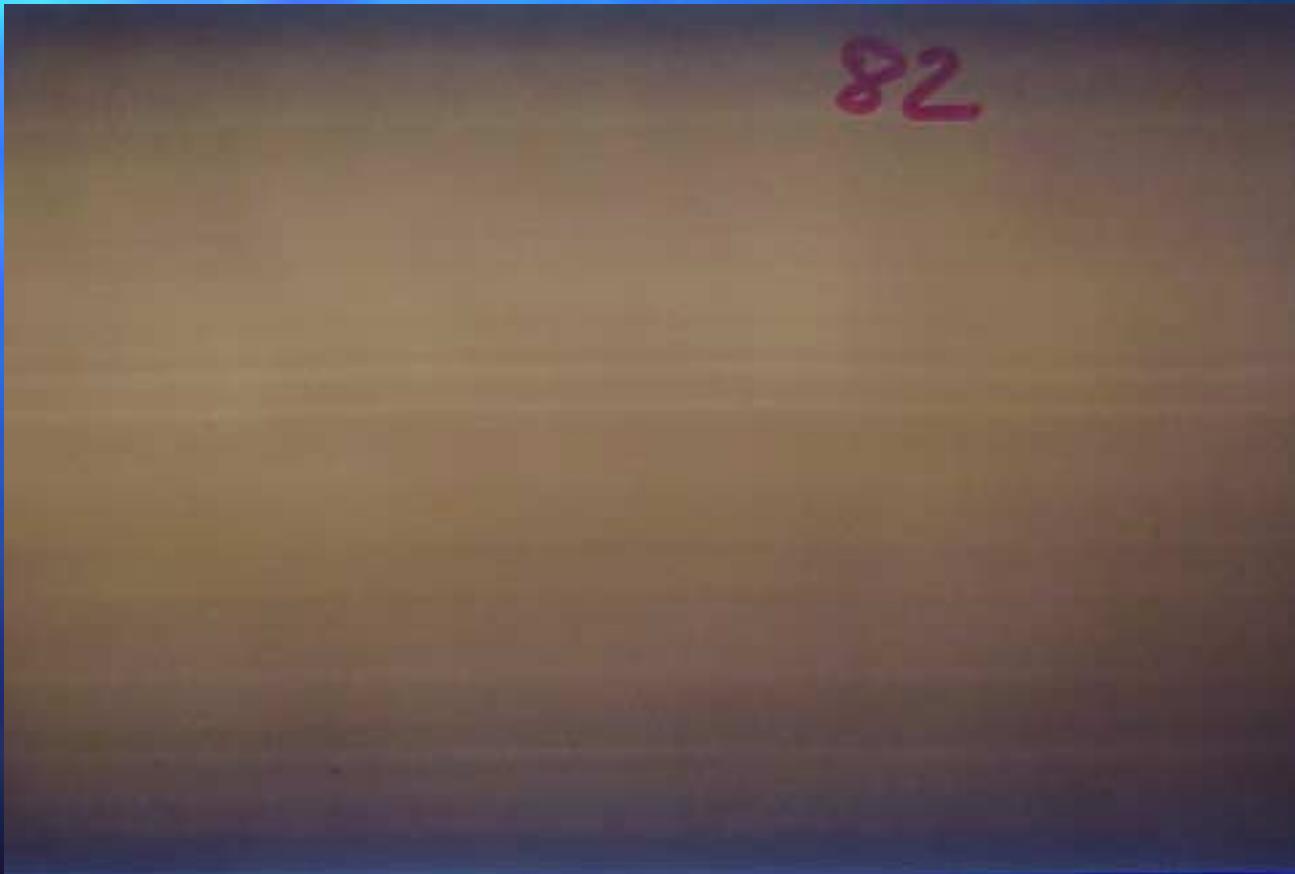
Recirculator Results: 50/1 Mixer

Starve feed, 40% gray elastomer pellets



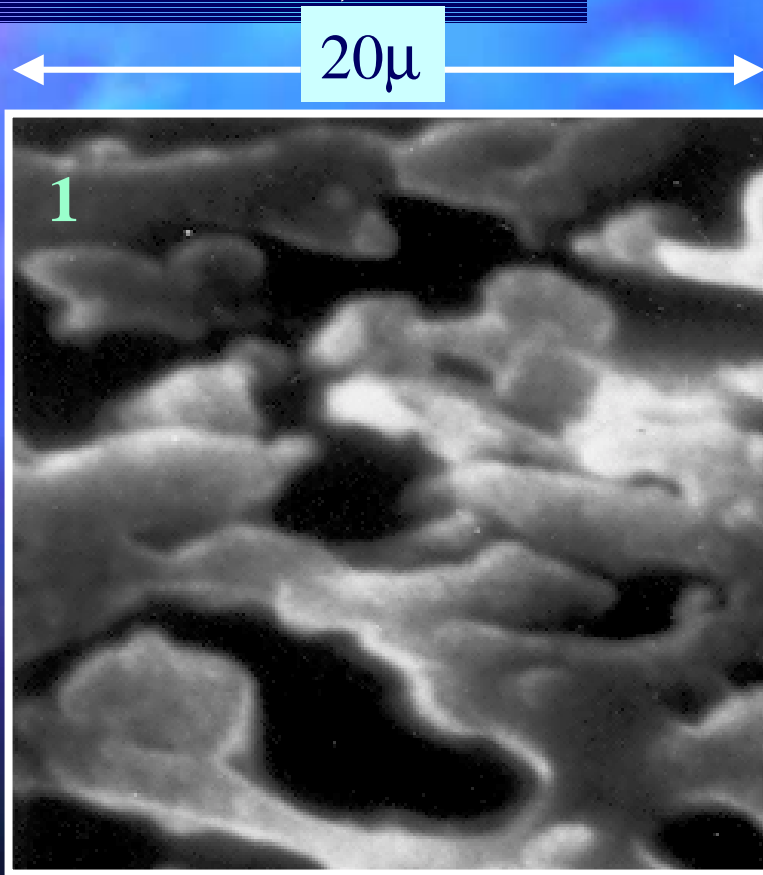
Recirculator Results: 50/1 Mixer

Starve feed, 60% gray elastomer pellets

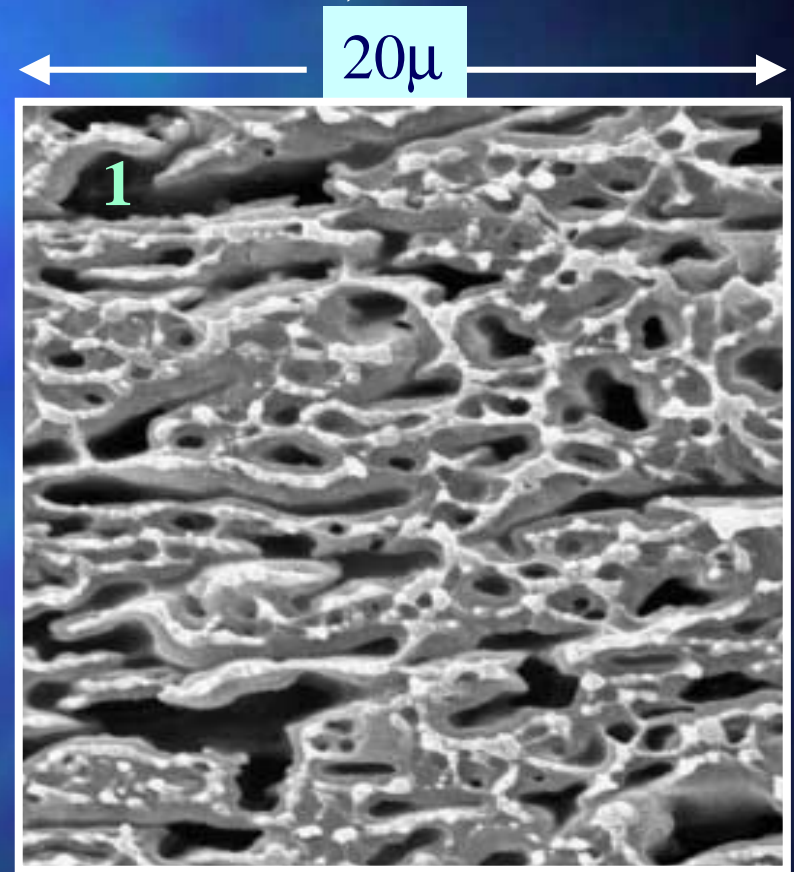


Effects of Processing PS/PE Mixture

Classic “Compounding” single screw extruder (co-continuous coarse structure)



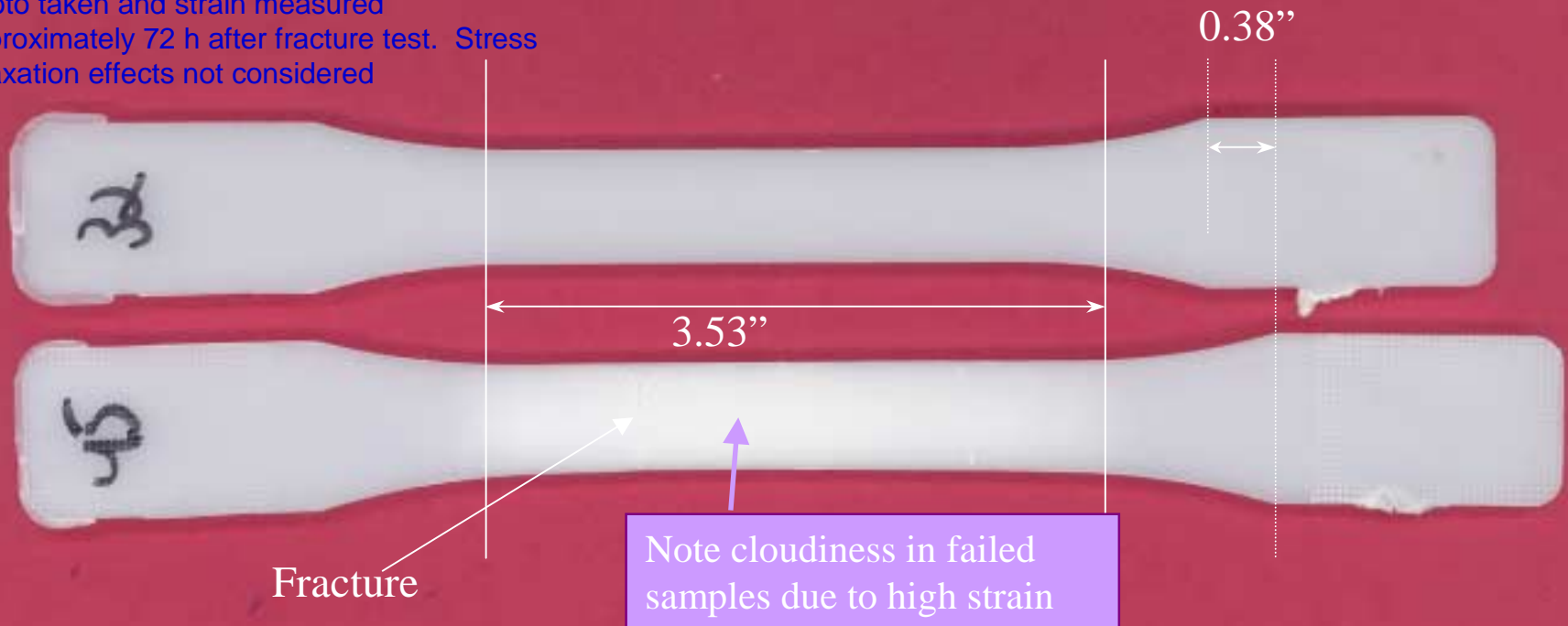
Randcastle Recirculator, single screw extruder (co-continuous fine structure)



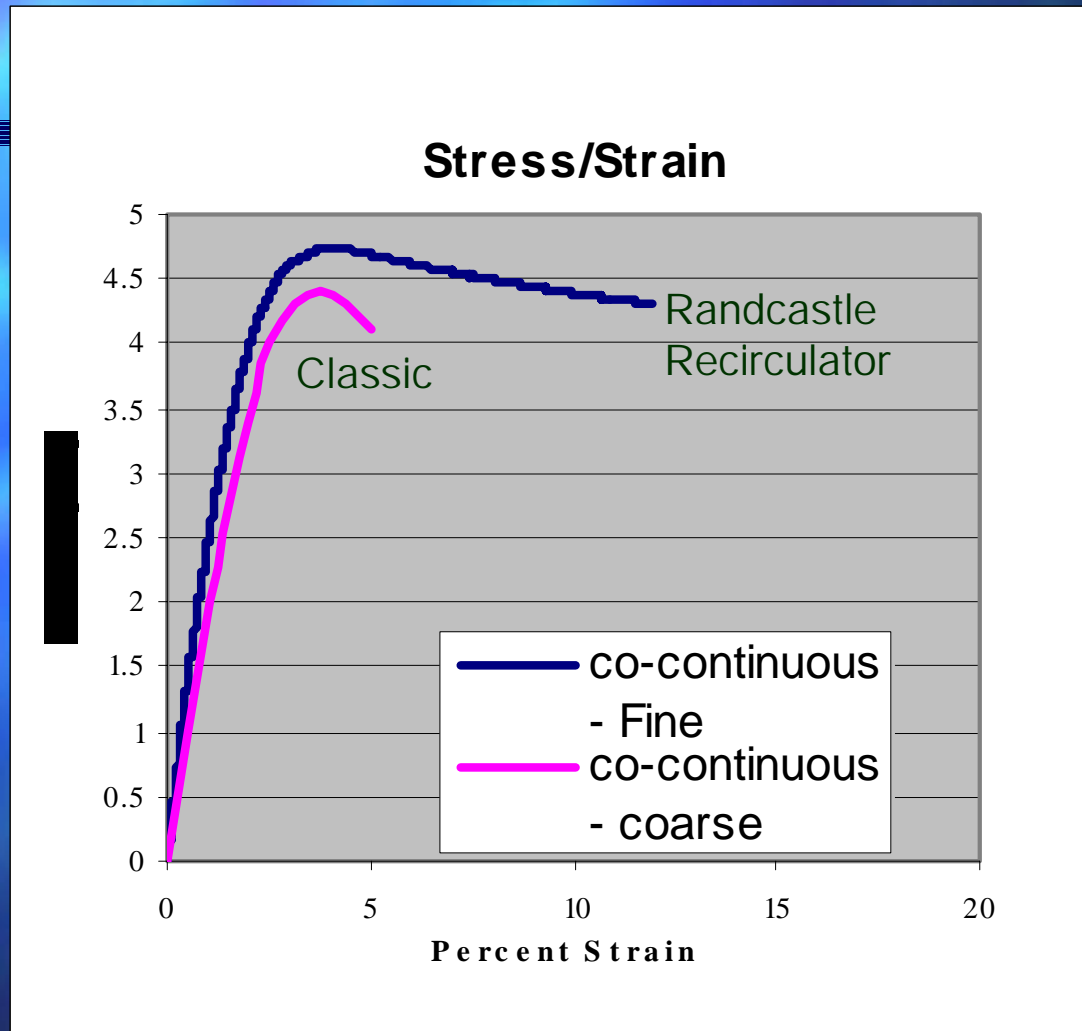
High Strain to Failure in Ultra-fine Structured PS/PE Composites

[12% strain to failure]

Photo taken and strain measured approximately 72 h after fracture test. Stress relaxation effects not considered



Increased Strain to Failure for Fine Structure

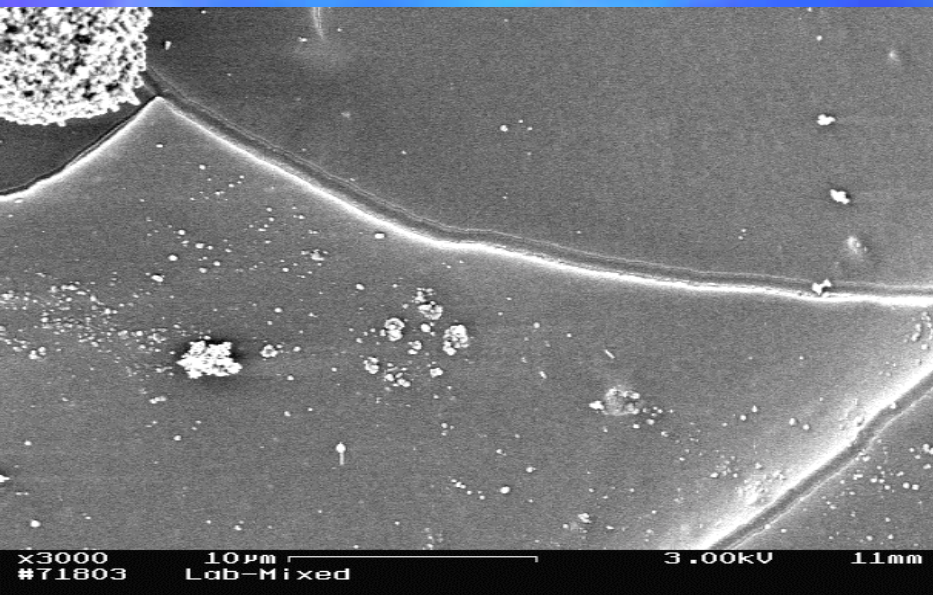


Ceramic Nano-Composites

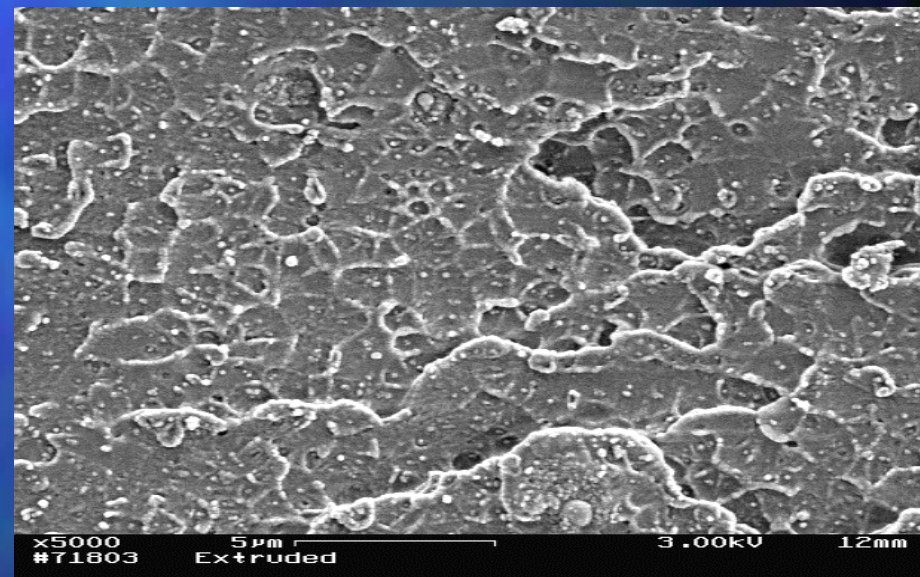
Acrylic Pellets & 5% Nano Powder

In 30 to 60 nm Range

Solution Mixed



Randcastle Recirculator



Ceramic Nano-Composites

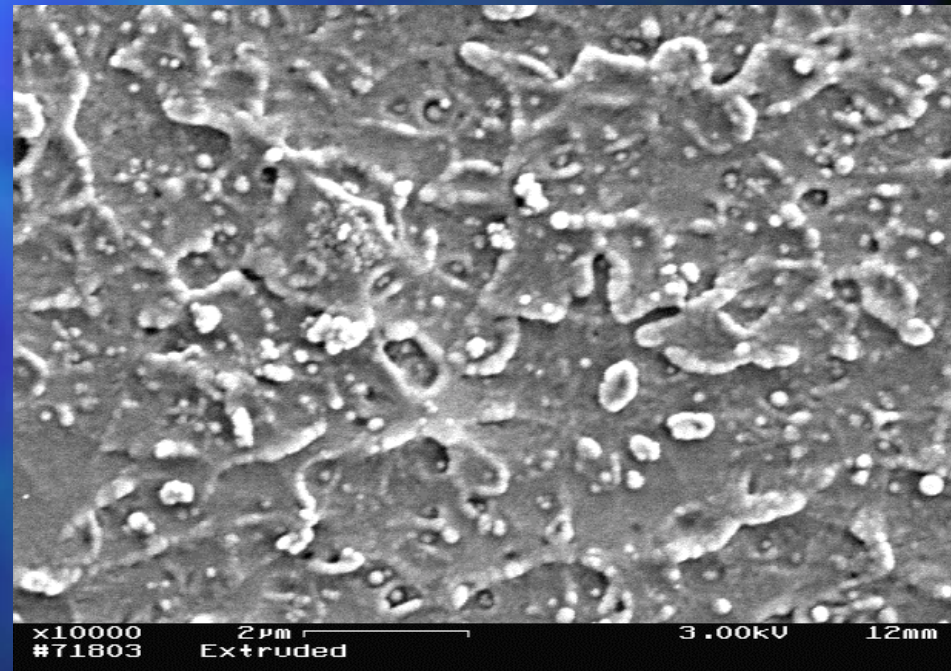
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Randcastle Recirculator



Ceramic Nano-Composites

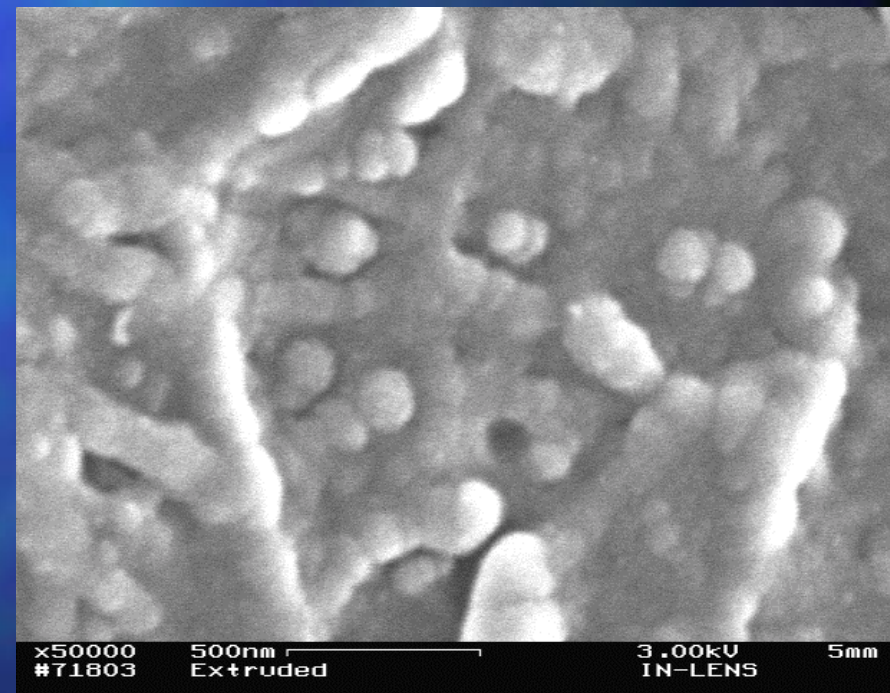
Acrylic Pellets & 5% Nano Powder

In 30 to 60 nm Range

Solution Mixed



Randcastle Recirculator



Note About "Classic" Screw Nano- Compounding

- Trials of conventional extruders with a typical high shear compounding elements (classic technology) are known to agglomerate nano-compounds.
- *The agglomerations are visible without magnification.*

Recirculator

40% Wood Flour in RPVC

100% PVC Powder

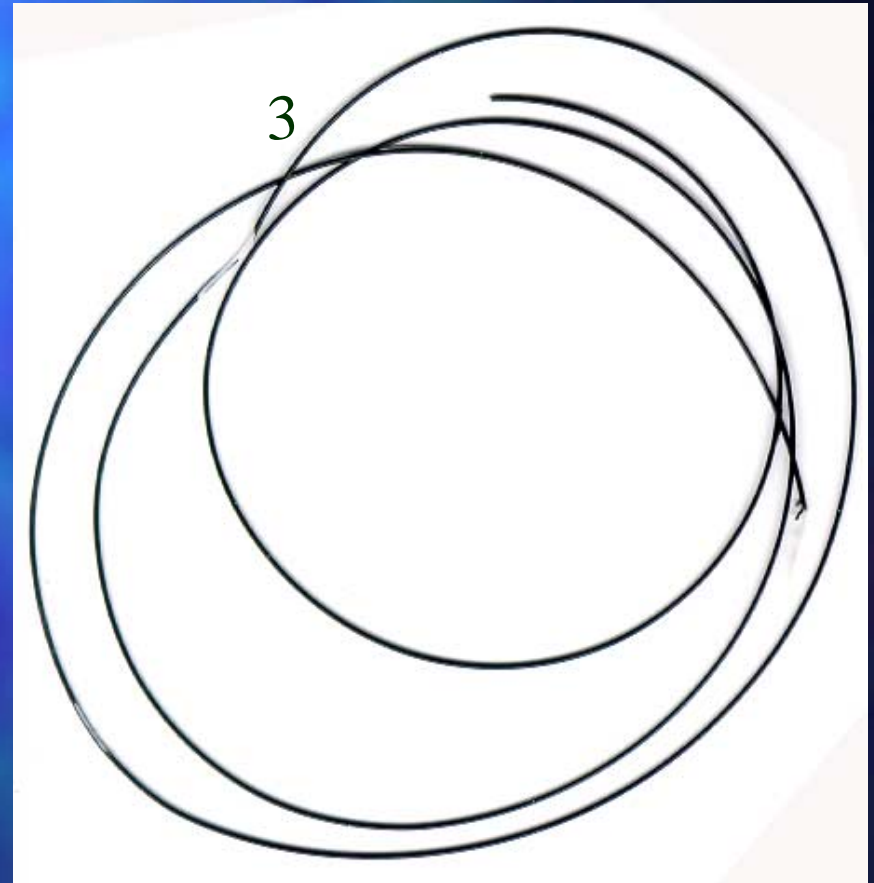
**Wood Before
Degassing**

**0.125 x 1 inch
For Tensile Bars**

0.062 x 1 inch



Recirculator Re-Agglomeration Nylon & Filler



Twin screw compounding produces smooth, well compounded pellets. But, when these pellets are processed in a classic single screw, only a rough strand (1) can be produced after months of effort. The Recirculator takes the same pellets and makes a smooth strand immediately (2) and then the final product: a 3 mil coating over a white 29 mil rod of PET (3).

Recirculator Summary

■ The Recirculator Compounding Results Are Twin-Like And Demonstrate:

- Nano-scale processing
- High Filler compounding
- Thermally sensitive material processing
- Reagglomeration prevention
- Thinner films at lower temperatures
- Improved properties

Recirculator Summary

■ Randcastle retains the advantages of single screws:

- Generating high pressures
- Stable pressures
- In a single heat history
- Without the need for a gear pump