"Blending and Feeding Options for Extrusion"

by
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Types of Feeding & Blending Systems

- Volumetric Feeders
- Gravimetric Feeders
  - Auger, Vibratory, Belt
- Volumetric Blenders
- Batch Gravimetric Blenders
- Loss-in-Weight Blenders
  - Target Rate & Target Weight
- Special Fluff Feeders & Reclaim Systems

Volumetric Feeders - *Strengths*

- Low Cost
- Simple to use
- Easy to maintain
- Bolt direct to extruder throat

Volumetric Feeders - *Weaknesses*

- Poor Accuracy
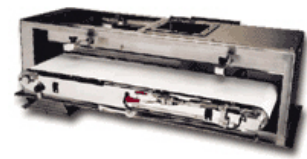- Calibrate for different materials
- No material usage information

Gravimetric Feeders - *Strengths*

- High Accuracy
- Adjust for changing bulk densities
- Material usage information

Gravimetric Feeders - *Weaknesses*

- High cost
- Maintenance intensive
- Difficult to install
- Sensitive to vibration

Volumetric Blenders - *Strengths*

- Low Cost
- Easy to use & maintain
- Immune to vibration
- Simple to install

Volumetric Blenders - *Weaknesses*

- Poor Accuracy
- Requires frequent calibration
- No inventory or extrusion control

Batch Gravimetric Blenders - *Strengths*

- Lowest cost gravimetric
- Easier to maintain
- Compact designs
- More accurate then volumetric
- Documents material usage

Batch Gravimetric Blenders - *Weaknesses*

- More expensive then volumetric
- Maintenance intensive
- Lower weighing resolution & difficult mixing
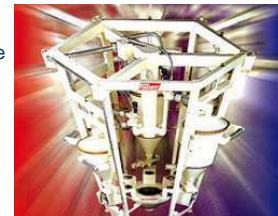- Sensitive to machine vibration

Loss-in-Weight Blenders - *Strengths*

- Highest accuracy
- Load cell for each material
- Best for mixing
- High output
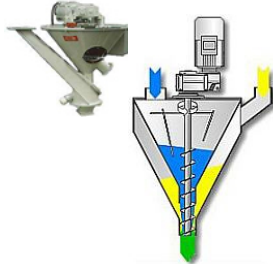- 8 ingredients or more
- Extruder output control

Loss-in-Weight Blenders - *Weaknesses*

- Highest cost system
- Maintenance intensive
- Vibration sensitive
- Difficult to install

Fluff Reclaim Systems - *Strengths*

- Direct film recycling
- No additional heat history
- Less contamination
- Lower overall energy cost
- Saves personnel cost

Fluff Reclaim Systems - *Weaknesses*

- Limited reclaim percentages
- Dust around extrusion line
- Complicates blending and extrusion control
- Can make extruder more unstable
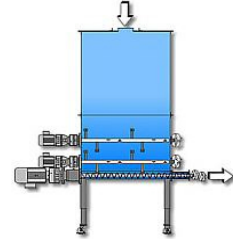
Blending for Sheet/Film/Profile

- Volumetric blending/feeding is rare
- Gravimetric systems are the norm
- Type, configuration and features
- System elements
  - Metering/proportioning
 - Blending/mixing

Gravimetric System Types

- Gain in weight – Batch
- Loss in weight – Target weight
- Loss in weight – Target rate
- Additive proportioning – Throat feeding
- Common elements
  - Weighing system
  - Material storage/surge
  - Feeding/metering devices

Basic Configurations

- Extruder throat mounted
- Mezzanine mounted
- Floor mounted
- In combination with online scrap systems

Weighing System Basics

- Strain gauge load cells
  - Shear beam load cell (below left)
  - "S" beam load cell (below right)
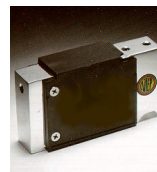
Scale Basic – Analog Signals

- Load cell output
  - 0 – 45 mV
  - 0 – 10 V DC
  - 4 – 20 mA
  - Digital (converted at the load cell)
- Converted close to the load cell
- Mechanical overload protection
- Minimize electronic 'noise' effects

Scale Basics – A/D Converters

- Digitizes Analog Signal from Load Cell
- Filters out electrical noise and vibration
- Resolution Rules Performance
  - 8 Bit is 2^8 = 256 Divisions
  - 12 Bit is 2^{12} = 4,096 Divisions
  - 16 Bit is 2^{16} = 65,536 Divisions
  - 20 Bit is 2^{20} = 1,048,576 Divisions
  - 65,536/4,096 = 16 Times the Resolution

Metering Devices

- Gates and Valves
  - Free Flowing Materials
  - Lowest Cost & Maintenance
- Vibratory Pan Feeders
  - Simple and reasonably accurate
  - Moderate Cost & Maintenance
- Auger Feeders
  - High Stability & Control
  - Highest Cost & Maintenance

Blending/Mixing Options

- Passive – Static mixing (below left)
- Active – Dynamic mixing (below right)

Blending/Mixing Devices

- Passive (Static) Mixers
  - Require Gravity Flow
    - Cascade Baffle for Free Fall
    - Stream Splitting for Plug Flow
  - Difficult to Change Performance Characteristics
  - Simple to Use and Maintain
 - Requires proportional accuracy

Blending/Mixing Devices

- Active (Dynamic) Mixers
  - Does Not Require Gravity Flow
  - Easy to Change Performance Characteristics
    - Mixing Time
    - Mixing Speed
  - More Complicated to Use
  - Higher Cost & Maintenance
  - Blending of layered ingredients

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Gain in Weight – Batch

- Single weigh hopper for multiple ingredients
- Second weigh hopper for ingredients < 5%
- Ramping/self adjusting feeders
- Layered ingredients into an active mixer
- Multiple batches for averaging inaccuracies
- Large batch size – slow to respond

Gain in Weight – Batch
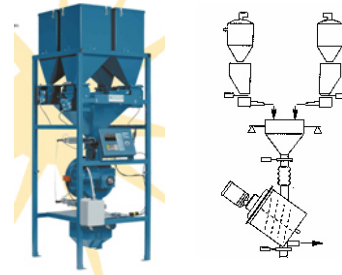
Loss in Weight – Target Weight

- Load cell/weighing hopper for each ingredient
- High accuracy proportioning and ease of mixing
- Feeder coupled to the weight hopper
- Materials metered simultaneously to an active mixer
- During weigh hopper refill, feed cycle is paused
- Combination weigh hopper/vacuum receiver
- Compact arrangement requires minimum headroom

Loss in Weight – Target Weight
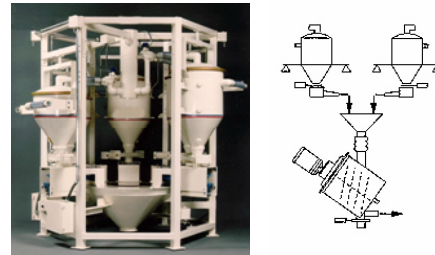
Loss in Weight – Target Rate

- Arguably most prominent method for extrusion
- Individual ingredients are continuously fed/proportioned
- Static or occasionally dynamic mixers
- Material flow rate is the target being controlled
- Match extruder rate for overall thickness/layer control
- During refill, proportioning system is in volumetric
- Responsive, cleanable, simple, extrusion control

Loss in Weight – Target Rate
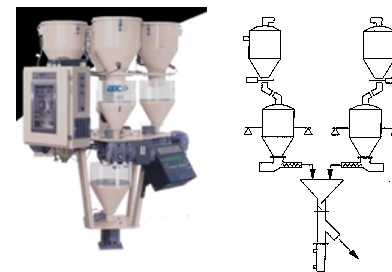
Additive Proportioning – Throat Feed

- Used primarily in film and sheet extrusion
- Extruder acts as the primary material feeder
- Weigh hopper used to measure material consumption
- Minor ingredients metered proportionally by augers
- Weigh hoppers de-coupled from feeders/extruder
- Control extruder speed for accuracy/responsiveness
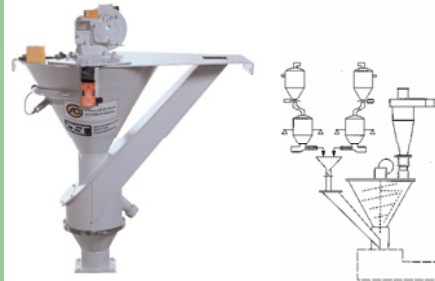- Well suited for gravimetric extrusion control

Additive Proportioning – Throat Feed
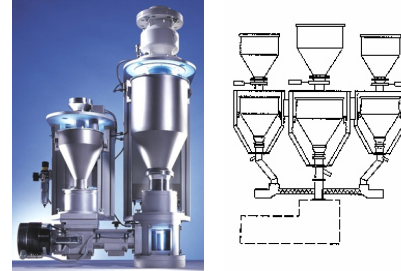
Volumetric In-Line Scrap Recovery

- Gravimetric blending/control – volumetric scrap
- Scrap and pellets handled separate or as a mix
- At low levels of scrap (15 – 20%) assumed constant
- Typically edge trim only reclaim
- Most extruders can handle up to 25 – 30% scrap
- Melt pumps can reduce surging/increase rates
- Effective alternative to repelletizing scrap

Volumetric In-Line Scrap Recovery

Gravimetric In-Line Scrap Recovery

- Fluff loader to a fluff feeder
- Dual chamber re-feeder or crammer feeder
- Fluff loader to on demand fill fluff feeder
- Fluff metered continuously by weight
- Precise gravimetric extrusion control
- Systems are temperamental and expensive

Gravimetric In-Line Scrap Recovery
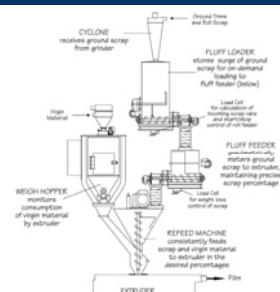
Gravimetric Extrusion Control
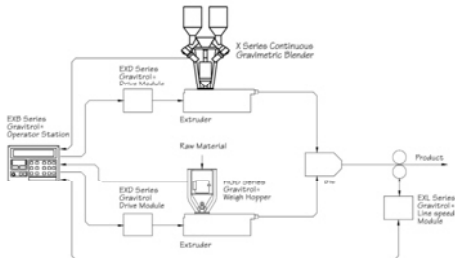
Gravimetric Extrusion Control

System Prices – 4 component, 1000 PPH

- Large capacity, central volumetric - $ 18,000
- Extruder mounted, single loadcell batch - $ 12,500
- Central, dual loadcell batch - $ 29,500
- Loss in weight, target weight, w/ receivers - $ 43,000
- Loss in weight, target rate - $ 25,000 to $ 30,000
  - Add extrusion control, with line speed - $ 4,000 to $ 9,000
- Single component extrusion control - $ 16,500

Summary

- Gravimetric systems in extrusion
- Loss in weight feeders for twin screw extruders
- Batch and continuous blenders for single screw
- Integrated extrusion control for film/sheet/profile
- In-line scrap reclaim for light gauge film/sheet
- Gain in weight – batch most economical
- Loss weight – target weight most accurate
- Loss weight – target rate most versatile

Suppliers

Company	Material Handling/Blending Products	Location
The Conair Group, Inc	Conveying, Blending, Scrap Reclaim	Pittsburgh, PA
Process Control Corporation	Conveying, Blending, Control, Scrap Reclaim	Atlanta, Georgia
TSM	Conveying, Blending, Control	Atlanta, Georgia
Osprey Corporation	Conveying, Scrap Reclaim/Pelletizing	Atlanta, Georgia
Foremost Machine Builders	Conveying, Blending, Scrap Reclaim	Fairfield, New Jersey
ACS Group - AEC/Colortronics	Conveying, Blending and Control	Flint, MI
CRG Logics	Conveying, Blending and Control	Appleton, WI
Inoex	Gravimetric Blending and Control	Lancaster, PA.Germany
K-Tron International	Conveying, Gravimetric Blending and Feeding	Pitman, NJ
L-R Systems	Conveying and Blending	New Lenox, IL
Maguire	Conveying and Blending	Aston, PA
Novatec, Inc.	Conveying and Blending	Baltimore, MD
Thoreson McCosh	Conveying and Blending	Troy, MI