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From lab to production,
providing a window into the process

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Understanding Pressure Measurement needs of Plastics Manufacturing

Topics

- Part I- Pressure Transducer Basics
- Part II- Types of Plastics Extrusion
- Part III- Benefits of pressure transducers

Introduction

Part I – Transducer basics

Transducer Basics

Q: What is the definition of a transducer?

A: A transducer is a device that converts one type of energy to another. The conversion can be to/from electrical, electro-mechanical, electromagnetic, photonic, photovoltaic, or any other form of energy

Q: What is a foil strain gauge ?

A: A strain gauge is a device used to measure the strain of an object ,the most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern.

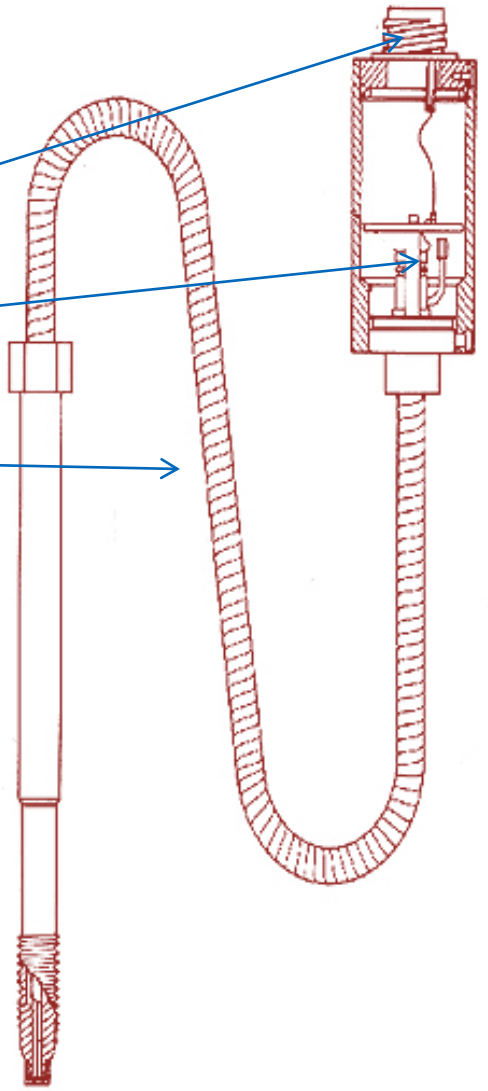
Q: How does a Dynisco melt pressure transducer work?

A: By incorporating the foil strain gauge, filled capillary, and diaphragm to obtain a controlled signal output, that is scaled to a specific pressure range.

Transducer Basics

Basic Construction of a Transducer :

- Electrical Connector
- Strain Gage
- Flexible Stem
- Rigid Stem (Snout)
- Capillary (Internal)
- Fill Medium
- Diaphragm



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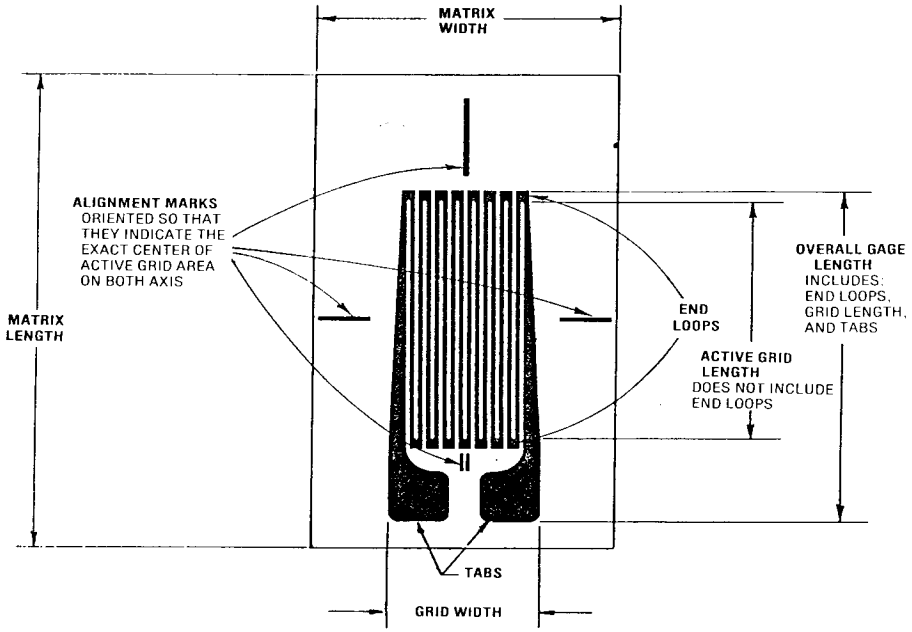
Transducer Basics

Strain gauge

basic components of a foil strain gage



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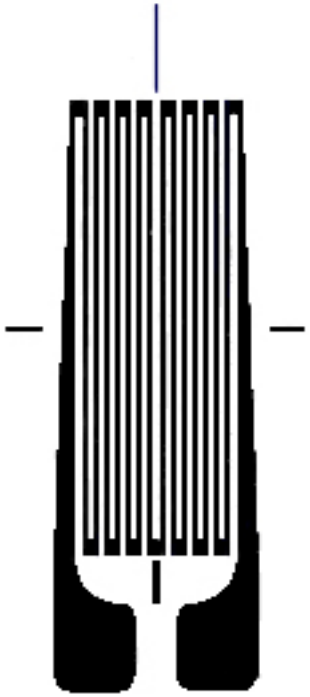
Transducer Basics

Foil Strain Gauge Features

- Small size and very low mass.
- Fully bonded to sensing element.
- Excellent linearity over wide strain range.
- Low and predictable thermal effects.
- Highly stable with time.
- Relatively low in cost.
- Circuit output is a resistance change.



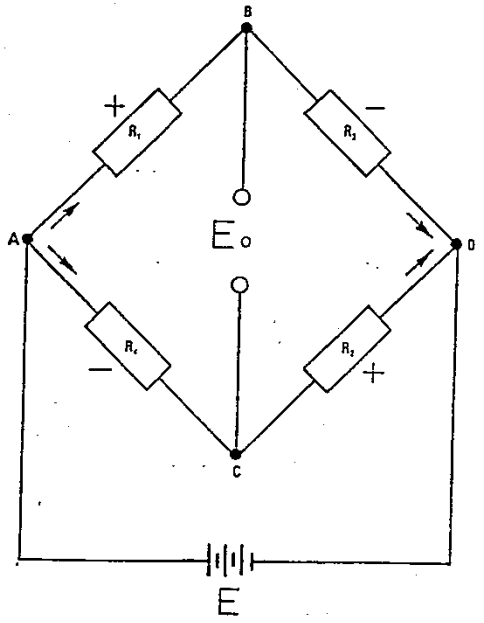
Transducer Basics

Electronics

- Industry Standard is 3.3 mV/V or (33mv Full Scale) using a 350 ohm Wheatstone Strain Gauge Bridge

Standard Dynisco Outputs

- 3.3 mV/V
- 0-5 Vdc
- 0-10 Vdc
- 4-20 mA



Transducer Basics

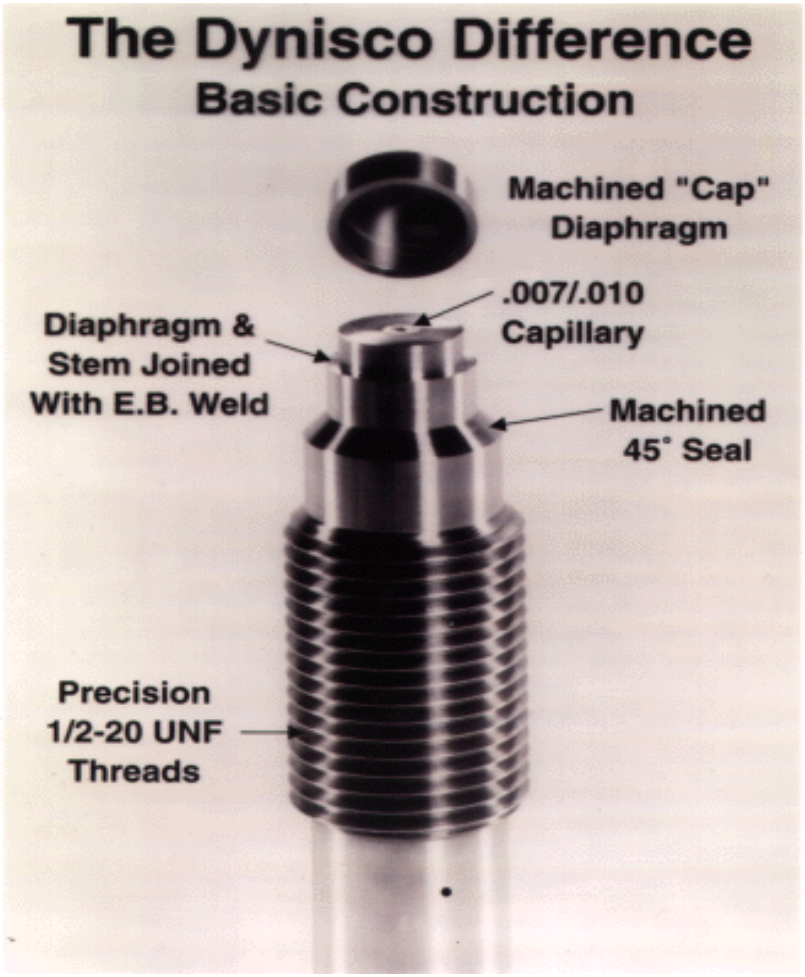
Questions to consider, when selecting a sensor:

- Configuration ? (Rigid or Rigid and Flex version)
- Output ?(mV/V or amplified)
- Accuracy ?(0.15% - 0.25% - 0.50% - 1.0%)
- Pressure range (0-25 PSI to 0-30,000 PSI)
- Optional Temperature Output?
- Application ?
- Process Parameters?
- Electrical Connection, Process Connection, Types of Approvals etc…?
- Additional Items….indicator/controllers/cable assemblies ?

Transducer Basics

- Machined “Cap” Diaphragm
- Machined 45 degree angle sealing surface with precision 1/2-20 threads

  Or
- Machined 90 degree angle sealing with o-ring on flange and button sealed units



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Transducer Basics

The Stem

Rigid (Snout)

- Standard length is 6”
- Also available in 3”, 9” and 12” lengths
- Other lengths available

Flex (Capillary)

- Standard flexible lengths of 18” and 30”
- Other lengths available

Transducer Basics

0.25% Accuracy

- High Accuracy
- Zero shift (15 psi/100 F)
- 8 pin connector

Strain Gauge units-

- PT420A (rigid)
- PT422A (flex)
- TPT432A (temp & pressure)

Amplified units -

- 2242 Series (threaded)
- 2243 Series (flange mount)
- 2290 Series (button seal)

0.5% Accuracy

- Industry Standard
- Zero shift (25 psi/100 F)
- 6 pin connector

Strain Gauge units -

- PT460E (rigid)
- PT462E (flex)
- TPT463E (temp & pressure)

Amplified units -

- PT46x4 = 4 to 20 mA
- PT46x5 = 0 to 5 Vdc
- PT46x6 = 0 to 10 Vdc

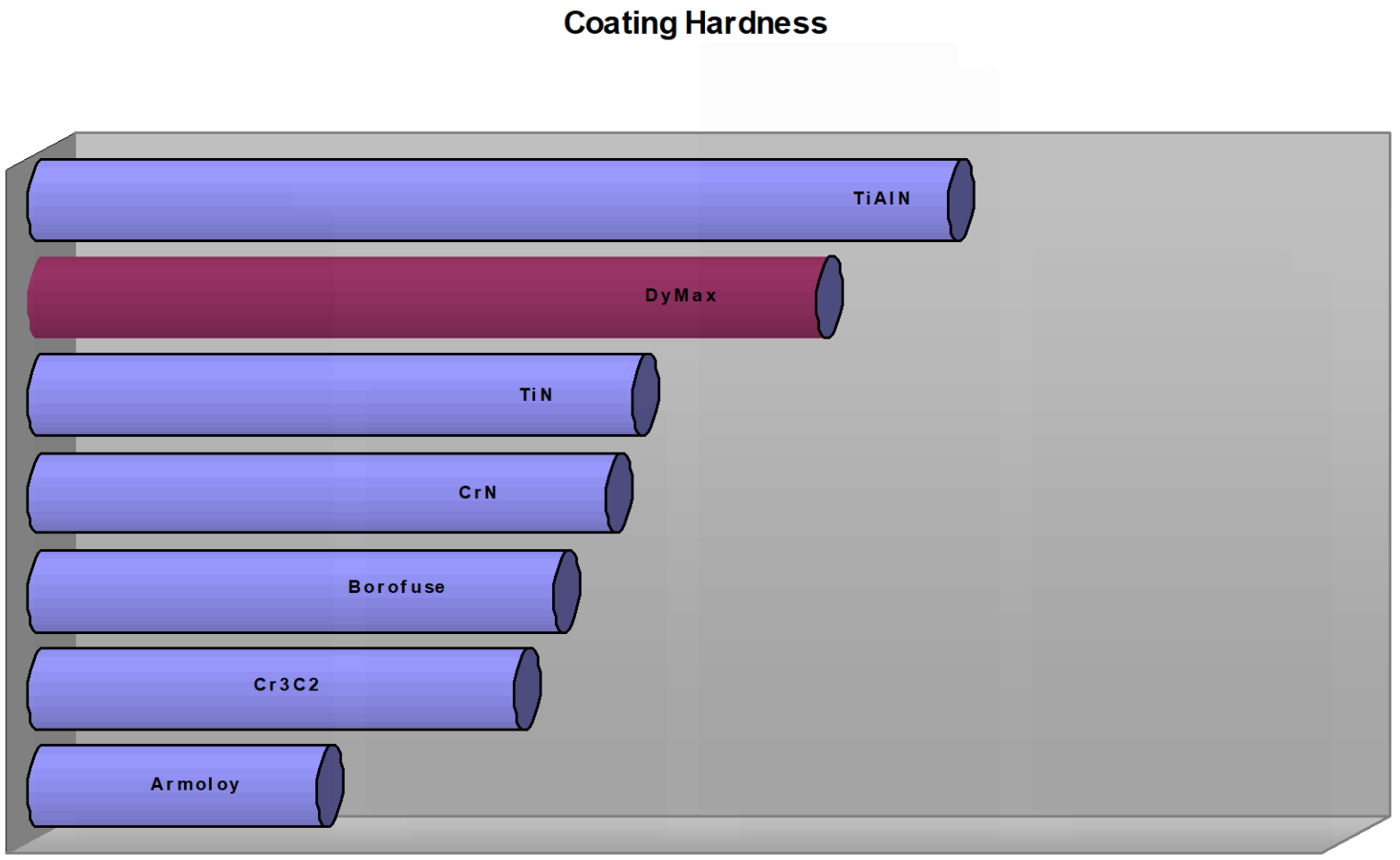
Transducer Basics

Diaphragm Options

- Dymax ™ - Standard coating on SS, abrasion resistant
- Hastelloy- Non-standard coating on SS, corrosion resistant
- Inconel 718 – Standard diaphragm, corrosion resistant
- Borofuse coated Inconel 718, abrasion/corrosion resistant
- Titanium Nitride on SS diaphragm, Polymer adhesion resistant

Customer applications, will determine the best option for diaphragm

Transducer Basics



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Transducer Basics

Transducer fill media options:

- Hg (Mercury) – Standard fill media used in all melt pressure transducers. Limits: 0-30,000psi / 750 degrees F
- Oil – Alternative fill media , available for most model of transducers. Limits: 0-10,000 psi/ 617 degrees F
- NaK (Sodium/Potasium) – Alternative fill media, available for most models of transducers. Limits: 0-10,000psi / 1000 degrees F
- Push Rod- No fill media, model codes EPR3/EPR4 only. Limits : 0-10,000 psi/ 750 degrees F

Transducer Basics

	Oil Filled	Push Rod	NaK Filled
Accuracy	±0.5% fso	±0.5% fso	±0.25% fso
Repeatability	±0.2% fso	±0.2% fso	±0.1% fso
Max. Temp.	325°C (617°F)*	400°C (750°F)	538°C (1000°F)
Min. Pressure	0 – 1,000 psi	0 – 1,500 psi	0 – 500 psi
Max. Pressure	0 – 10,000 psi	0 – 10,000 psi	0 – 10,000 psi
Max. Over Pres	2x	1.5x	2x
Dia. Zero Shift	36 psi/100°F	1% fso/100°F	30 psi/100°F
Cal Recomm'd	6 Months	12 Months	12 Months
EX Approved	Yes	No	No
I/S Approved	Yes	No	No

* Maximum temperature for the oil filled transducer is 325° C. However, it must be noted for optimum transducer longevity the recommended maximum temperature is 275° C. Above 275° C, the transducer may or may not operate within specification for the life of the transducer.

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Dynisco products

SPX series “Smart” Transmitters

SPX series transmitters

Standard features of the SPX4 & SPX2 series

- 4 – 20 mA with/ Optional HART Protocol
- Zero & Span Pushbuttons
- 3:1 Turndown Capability
- 2 wire Unshielded Cable
- Welded Stainless Steel Housing or Aluminum Housings with Set Screws
- Hg, NaK or Oil Filled
- Wide Variety of Process Connections & Electrical Connections

SPX series transmitters

Standard features continued

- Operating Temperatures
  - Electronics: - 20 to 185ºF (-29 to 85ºC)
  - Snout (1/2-20 UNF): 32 to 750ºF (-29 to 400ºC)
  - Snout (Button Seal): 32 to 600ºF (-29 to 315ºC)
- Compensated Temperature
  - Electronics: - 0 to 150ºF (-18 to 65ºC)
- Input Voltage
  - 16 – 36 Vdc (Non-Intrinsically Safe)
  - 16 – 26 Vdc (ATEX/Intrinsically Safe)

SPX series transmitters

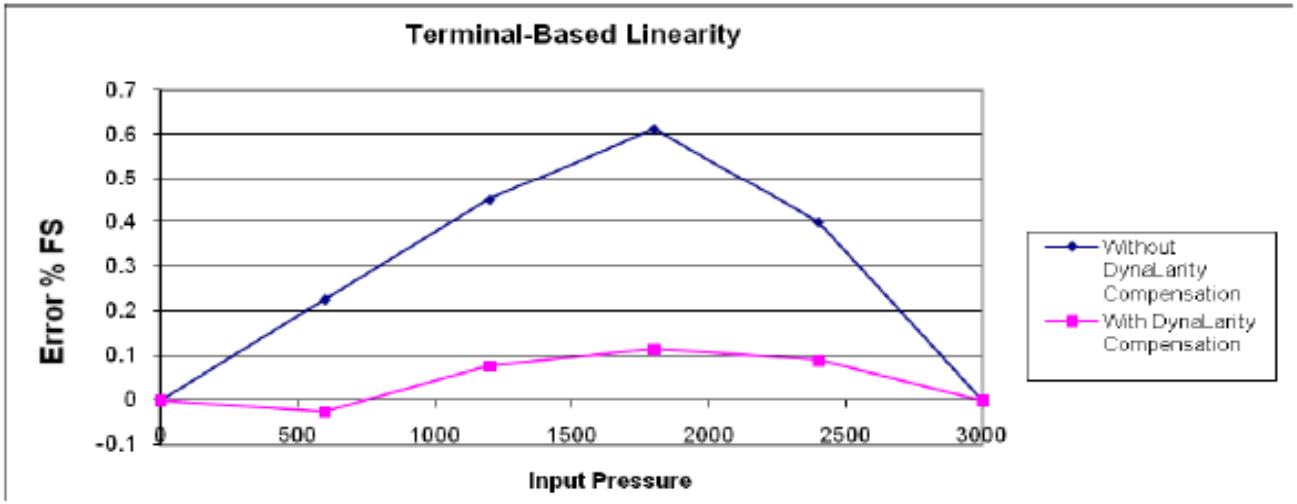
Standard features continued

- Meets CE & PED Requirements
- Meets NAMUR 21 & 43 Requirements
- Explosion Proof
  - Class 1, Division I, Groups A, B, C & D
  - Class 2, Division II, III, Groups E, F, G
- ATEX Approved
  - II (2) G ATEX 100a
  - Intrinsically Safe - Eex ia IIC T4

Dynisco additions to SPX family

SPX-L

Linearity Compensation for the SPX



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Dynisco additions to SPX family

Features

- 1/2-20 UNF thread pressure transmitter
- Improved accuracy with DynaLarity™ to +0.20% FSO
- HART™ digital communications
- ATEX Intrinsically Safe for hazardous environments
- FM & CSA approved Explosion Proof for hazardous environments
- Meets CE-PED requirements for European standards
- 0 – 250 to 0 – 30,000 psi customer-defined ranges
- 4-20 mA loop powered output supplied directly to DCS or PLC

Dynisco additions to SPX family

SPX-T =Pressure Sensing with Temperature Compensation

- The SPX-T is the SPX + SPX-L + Temperature compensation.

- By making an actual temperature measurement at the sensor tip, the SPX-T significantly reduces the effects of temperature drift.

- The SPX-T broadens the value choices…starting with low cost, few outputs, ranges, and installation configuration PT line through high accuracy compensated SPX line.

Dynisco additions to SPX family

SPX-T Features

- 80% reduction in drift due to temperature changes
- Choice of high accuracy (~0.25%, 32xx) or highest accuracy (~0.15%, 33xx)
- Option to output the 4-20mA temperature signal
- HART Communications
- No need to re-zero after process temperature variations
- Meets ATEX IS and Explosion proof requirements

Strategy

PT: low cost, few outputs, ranges, and install configs, no HART

SPX: HART compatible, expanded outputs and ranges, but non-compensated

> **SPX-L**: HART, expanded outputs and ranges, high accuracy, linearity compensated (Dynalarity™), but not temperature drift compensated

> **SPX-T**: HART, expanded outputs and ranges, Dynalarity™, selectable accuracy, temperature drift compensated

Review

Q: What is a transducer ?

A: A transducer is a device that converts one type of energy to another. The conversion can be to/from electrical, electro-mechanical, electromagnetic, photonic, photovoltaic, or any other form of energy

Q: What is a foil strain gauge?

A: A strain gauge is a device used to measure the strain of an object ,the most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern.

Q: How does a Dynisco melt pressure transducer work?

A: By incorporating the foil strain gauge, filled capillary, and diaphragm to obtain a controlled signal output, that is scaled to a specific pressure range.

Review

Q: What are the types of fill media offered in Dynisco transducers

A: Hg, NaK, Oil, No-fill (Push rod or Industrial)

Q: What are the types of coatings available for the transducer diaphragms?

A: Dymax ™ ,Titanium Nitride (TiN) , Hastelloy, Borofuse

Q: What is the process connection of the transducer?

A: ½ 20 UNF Threaded connection

Introduction

Part II- Types of plastic Extrusion

What is Extrusion?

Extrusion-

- The process in which material is pushed or drawn through a tool or“die” , to produce a specific shaped object in various lengths and thicknesses.
- May be continuous, in order to produce long materials or semi- continuous to produce smaller materials.
- Available in various orientation, to accommodate all manner of industry demands
- Not limited to one type of material, only requires that material have the ability to flow at controlled pressures and temperatures

Why Pressure measurement?

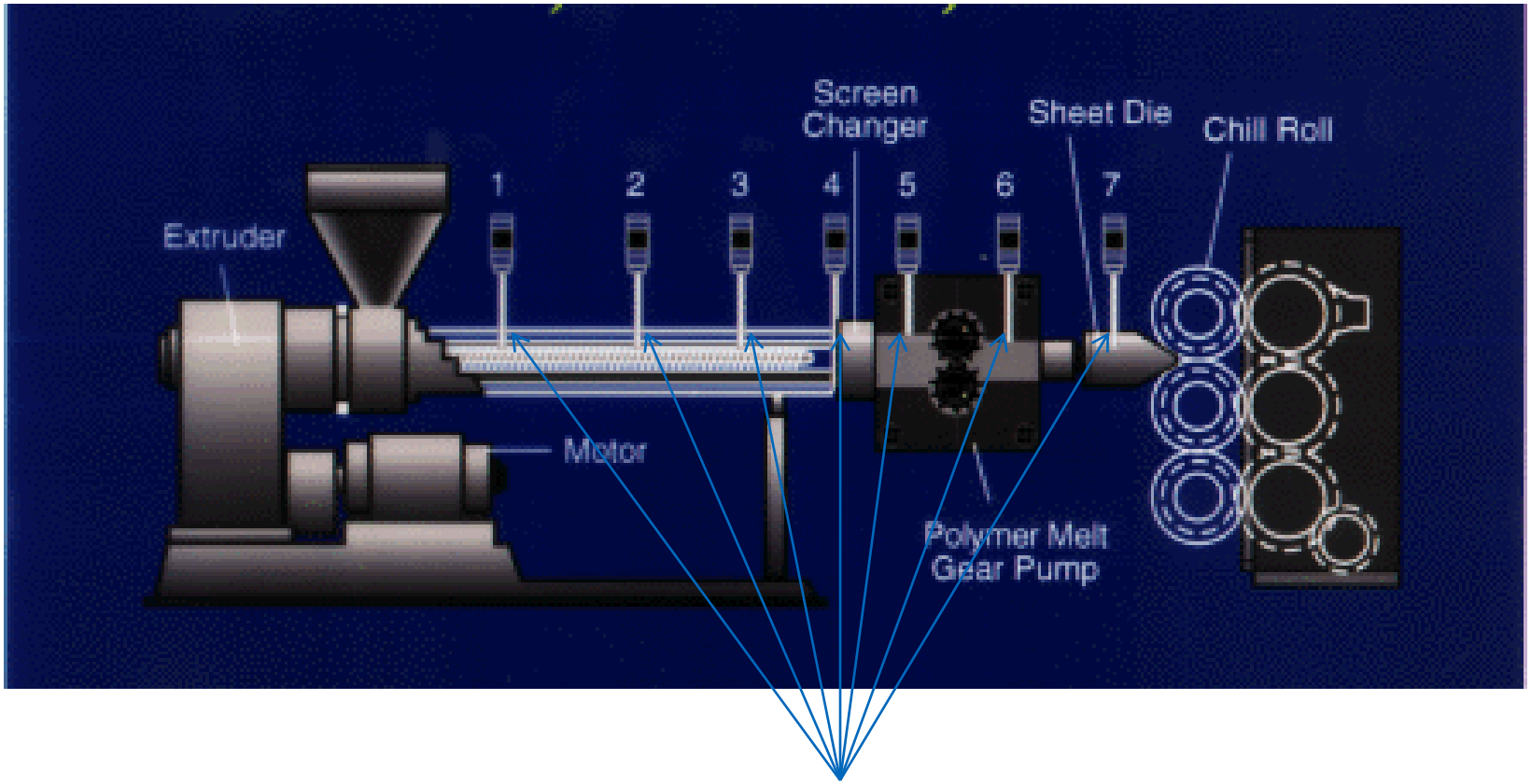
Dynisco pressure transducers enable the Extruder operator to monitor and control pressure conditions in production.

Pressure transducers also provide a safety mechanism to protect the Extrusion Equipment and Operators.

The recommended locations for mounting pressure transducers are:

1. **Before screen changer**
2. **Before melt pump**
3. **After melt pump**
4. **In the dies**

Plastic Extrusion



Pressure Transducer locations

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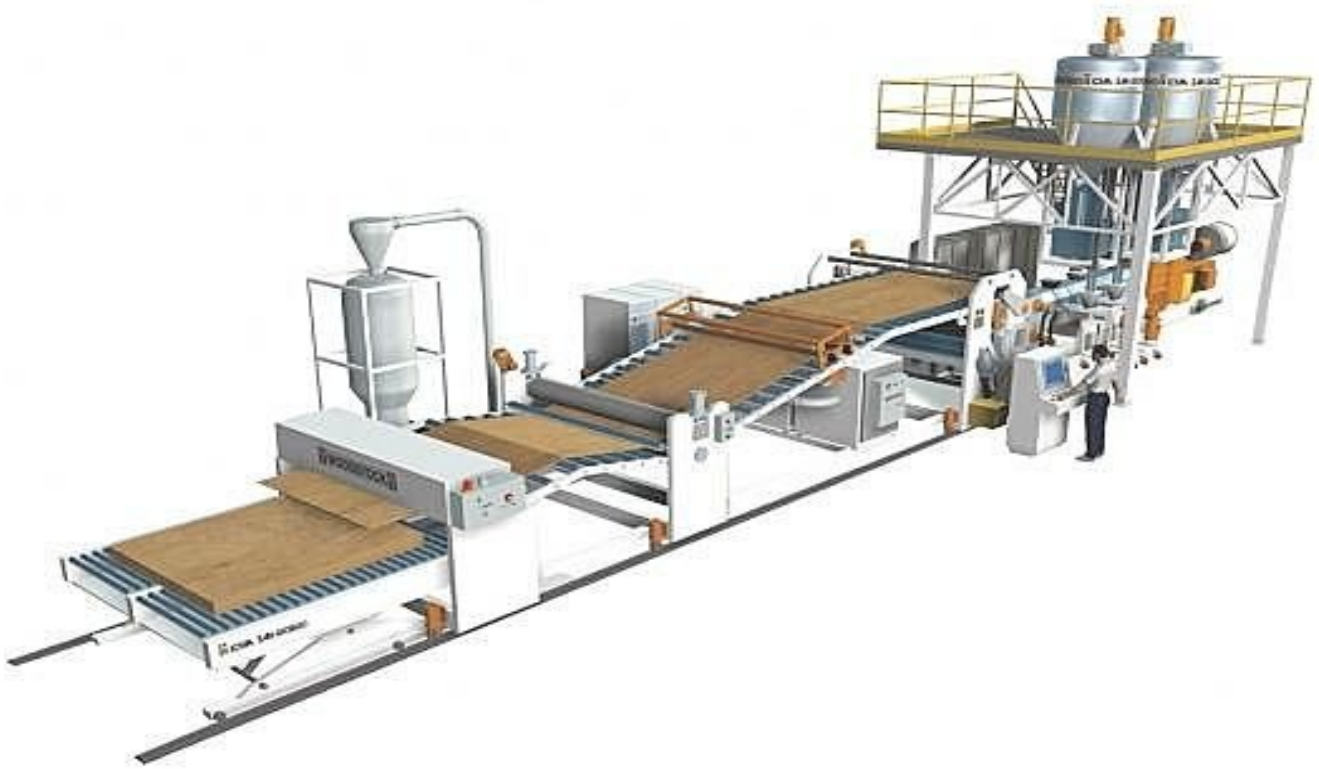
Sheet Extrusion



Plastic is melted into sheet form, and cut into various sizes.

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Pipe Extrusion

Process of forcing polymer through a shaped die, then cooled to form a pipe

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Profile Extrusion

Plastic is forced through a die under heat & pressure to form a part with specific cross section.

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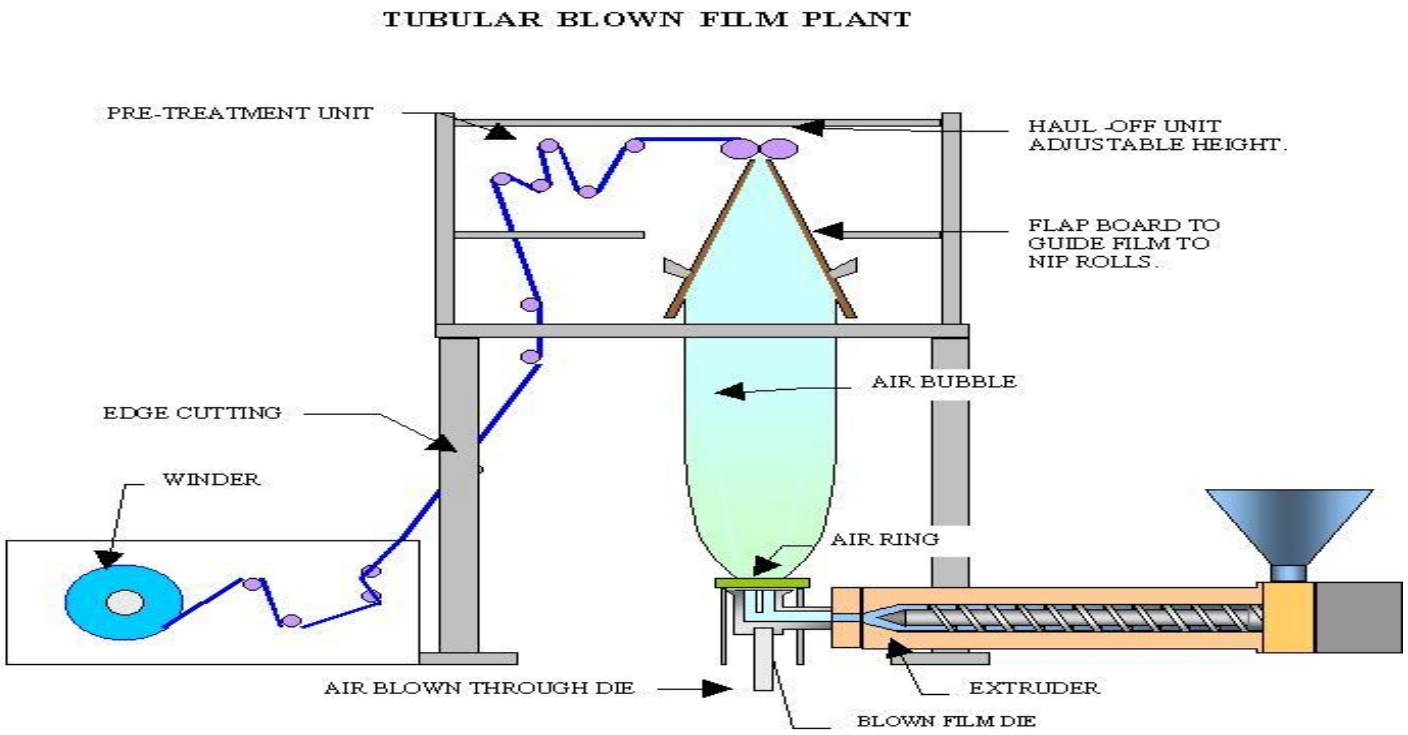
Blown Film Extrusion



Film is processed when blowing air at the extruder die creates a tubular cross-section and is extruded through a spiral die, inflated , then drawn to the winding device.

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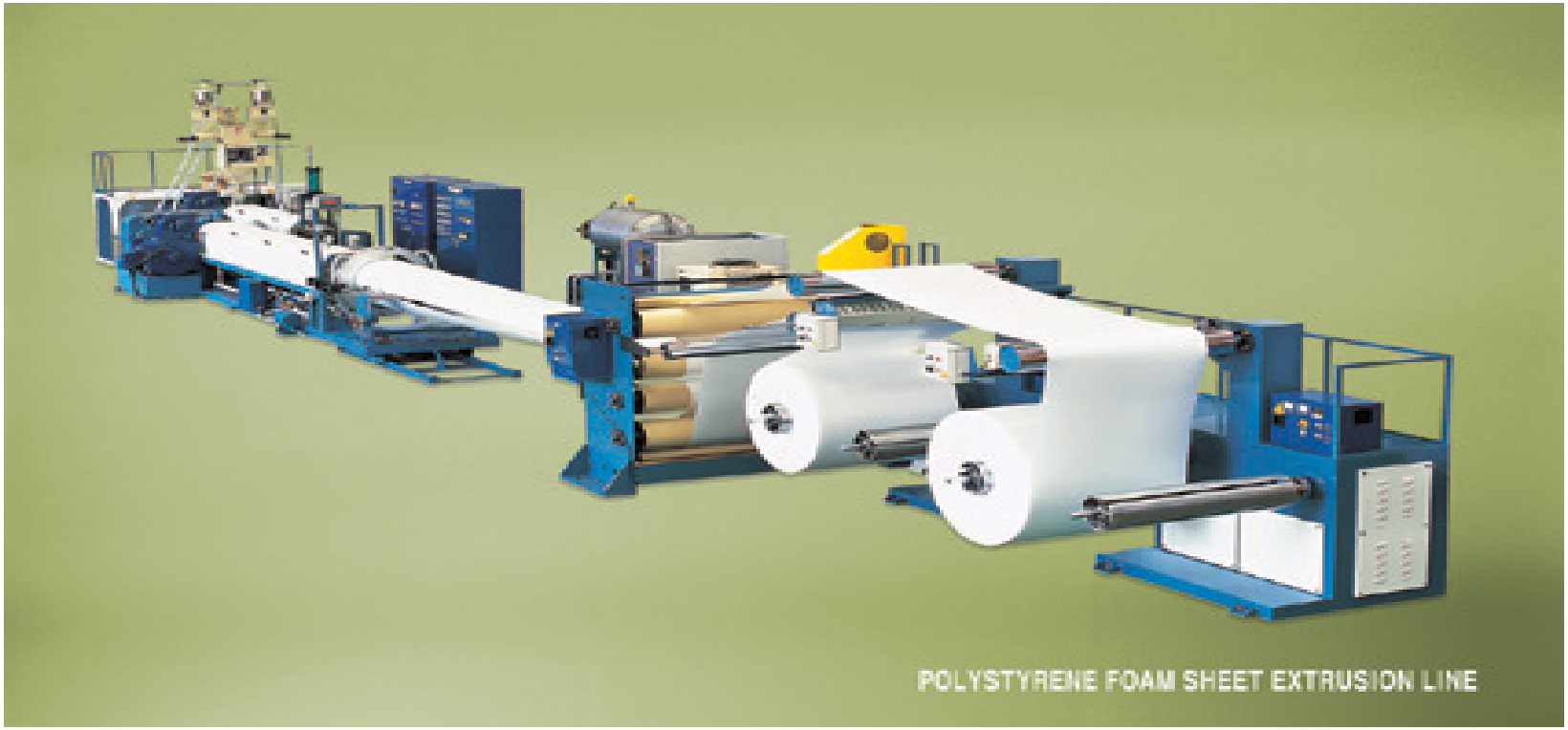
Foam Extrusion



Plastic resin is mixed with chemical foaming agents and melted.
The chemical foaming agent decomposes ,gas is dispersed in the polymer melt and expands upon exiting the die.

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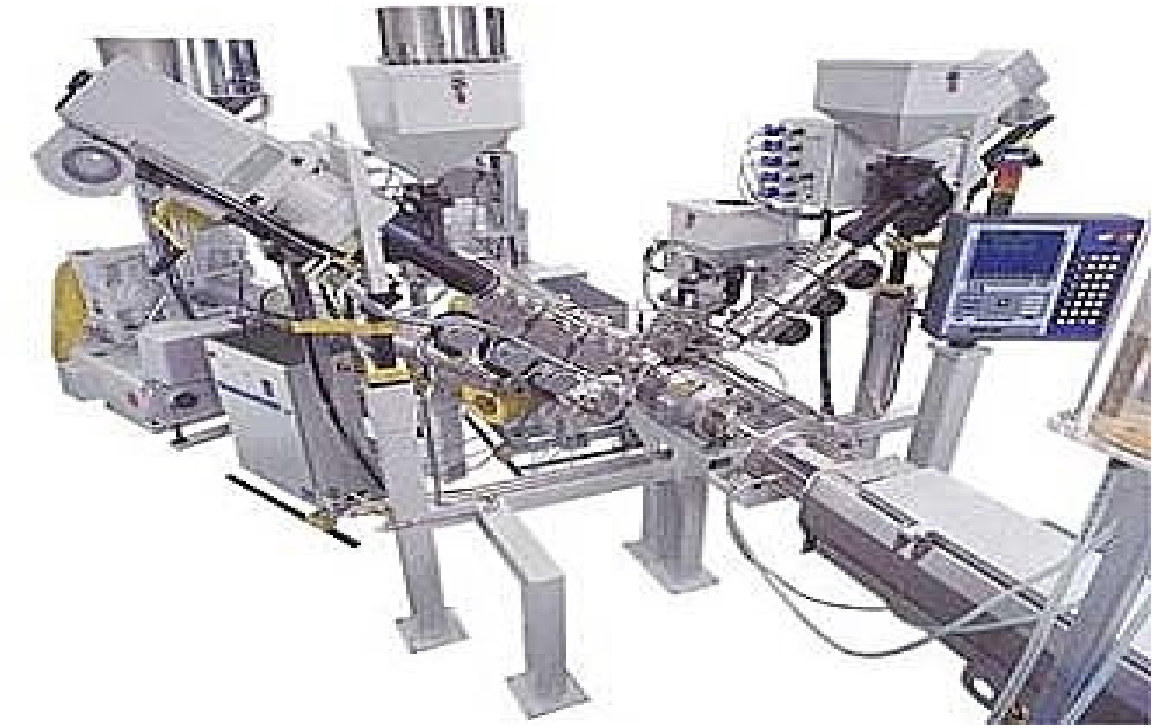
Co-Extrusion



The process of extruding two or more materials through a single die with two or more orifices arranged so that the extrudates merge and weld together.

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Review

Q: What is Extrusion ?

A: The process in which material is pushed or drawn through a tool or“die” to produce a specific shaped object in various lengths and thicknesses.

Q: Give 3 examples of different types of Plastic Extrusion

A: Sheet/Profile/Blown Film/Foam/Co-Extrusion

Q: What is the purpose of a pressure transducer in Extrusion?

A: Enable the Extruder operator to monitor and control pressure conditions in production.

Q: What is another use for pressure transducers in Extrusion

A: Safety mechanism to protect Extruder and Operators

Introduction

Part III- Benefits of pressure transducers

Why pressure measurement?

In Plastic Extrusion, pressure variation at the die entrance, could be caused be either an actual change in output from the extruder (pressure drops/increases), or variation in temperature (affecting viscosity)

1. Pressure fluctuations are typically controlled with gear pumps via pressure measurements.
2. Gear pumps are manufactured to have pressure transducer ports, that will enable operator to monitor inlet/outlet pressure to control flow.
3. Transducers will help the operator make changes to process variables,based on pressure readings. (captured via signal output to instrumentation)
4. Instrumentation can be programmed to stop the Extruder if a pressure condition exists that will compromise the equipment.
5. These instruments serve as a safety mechanism to prevent possible injuries to operators

Why pressure measurement ? (Cont…)

6. Indicators/Controllers used with transducers/transmitters are typically microprocessor based instruments.

7. Signal output from the transducers are used to control the extruder via scaled voltage and current outputs.

8. The signal output can also be used to control screen changers (Process filter)

9. Additional retransmission of the pressure signals, can be recorded and logged for future analysis of process variables.

10. The pressure transducer should be a prominent fixture of any extrusion control system, to ensure reliability of the process.

Summary-Pressure Measurement Benefits

- Increased productivity
- Quality products
- Reduced waste
- Reduced costs
- Less Down Time
- Increased Profits

Summary-Pressure Measurement Benefits

- Prevents pressure build up
- Insures adequate melt feed to pump
- Insures adequate pump pressure to die
- Insures adequate pressure for product
- ----------INSURES SAFETY----------