Troubleshooting:
Melt Delivery Systems Required for Scientific Molding

Molding 2019

March 19, 2019

Indianapolis, IN

Presented by: John Bozzelli, Rich Oles and Bill Hartwick

Troubleshooting:
Melt Delivery Systems Required for Scientific Molding

Q: *What is a **Melt delivery system?***

A: The **entire path** plastic contacts during the injection molding process.

Q: *What are the Melt delivery system requirements for **Scientific molding?***

A: **Engineering** maximizes conditions for:

- Melt uniformity
- Appropriate residence time
- Maximum process window
- Considers the application requirements, resin and equipment.
- Verify everything is manufactured as engineered.
- Considers the thermal dynamics of each individual component as well as an assembly.

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The Blocking and Tackling of Injection Molding

- Common events that prevent expected results from being achieved.
- Assume NOTHING, check EVERYTHING.
- Assess the issue
- Develop a logical thought process on the “Why” with a foundation based in “What” could be causing it.
- Go and see…….
- DON’T FORGET to look up from the specific issue and consider the environment your operating within.
- All problems have contributors. Assessing them and giving them a percentage of impact gives you focus on solving the problem.

Pellet to Part

from the

Plastics point of view

Machine: John Bozzelli

Hot Runner & Mold: Rich Oles

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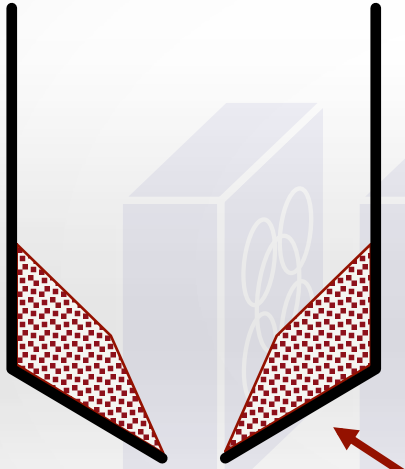
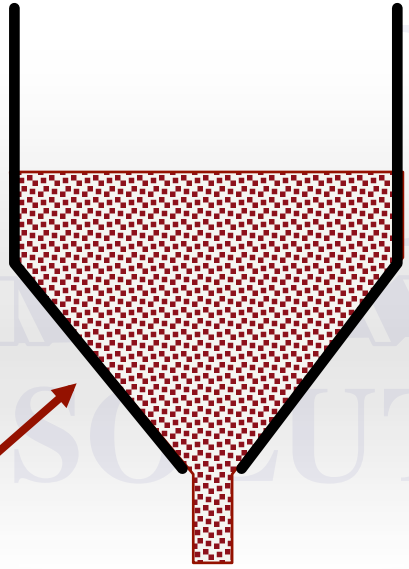
Hopper Types

Funnel



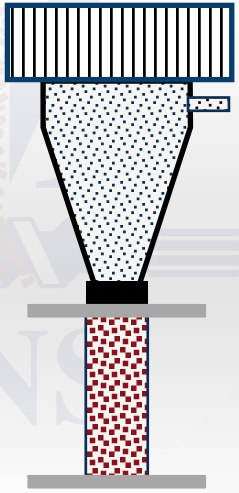
Bad

Mass



Good

Single



Good

Vacuum leak?

Note Angle!

[Video]

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Melted

vs

Melt Uniformity

The Injection Screw

- Purpose:
  - –To feed, melt and deliver ***uniformly*** melted plastic to the mold.
  - –Consistency & Temperature

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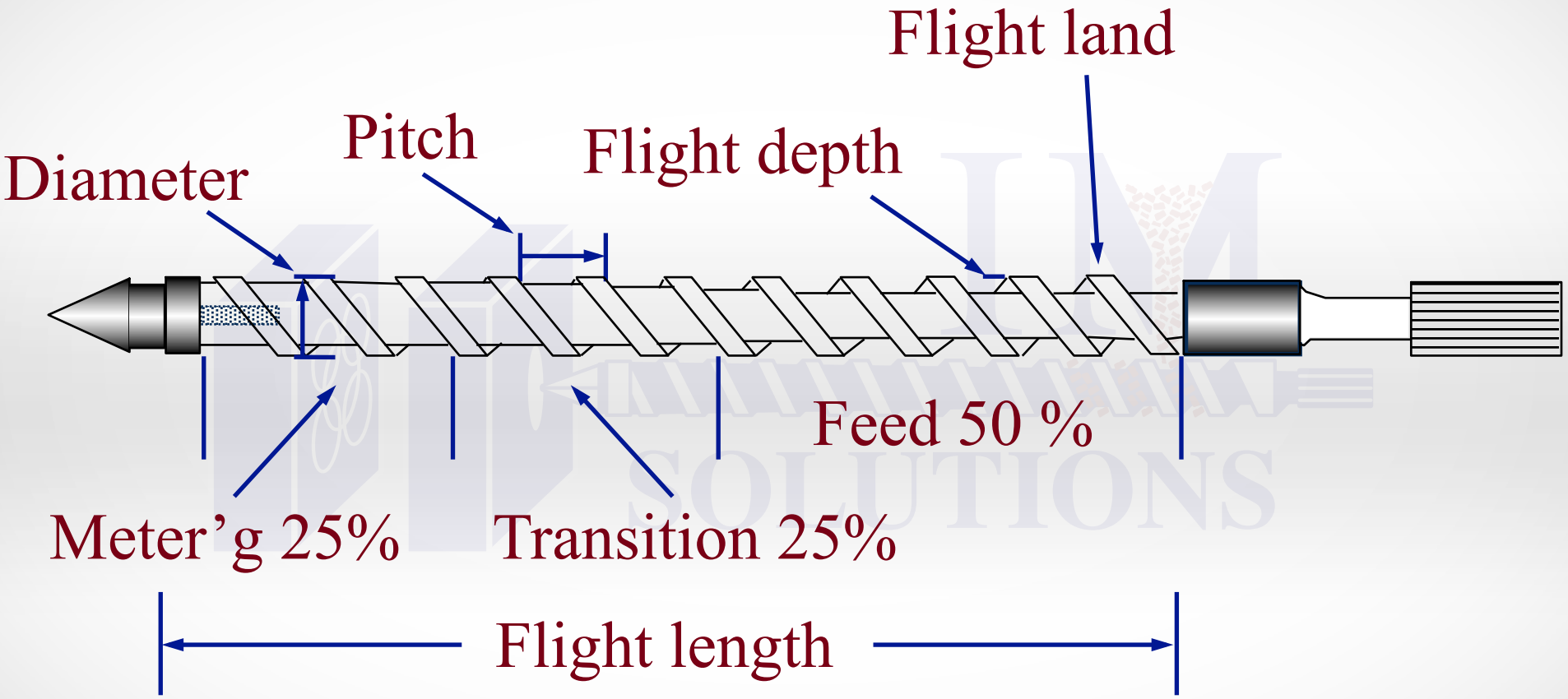
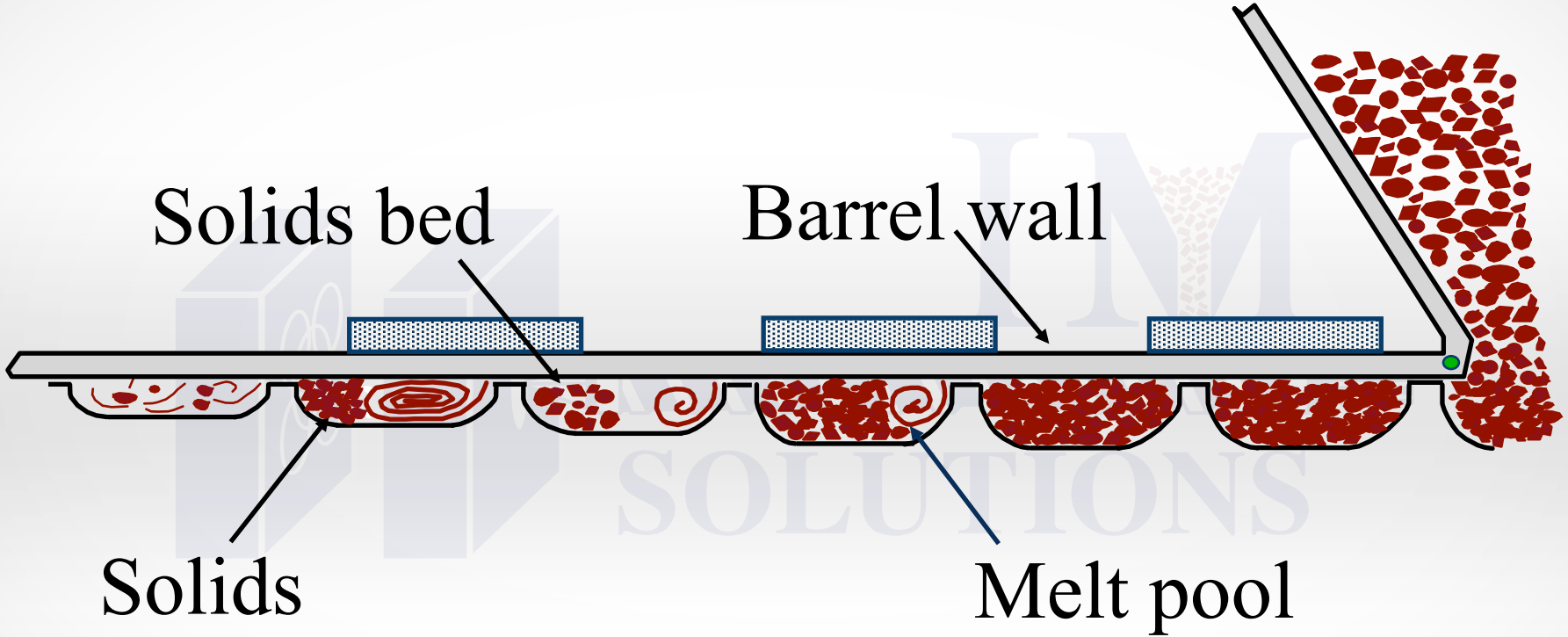
Screw Components



Melt Model



RNB

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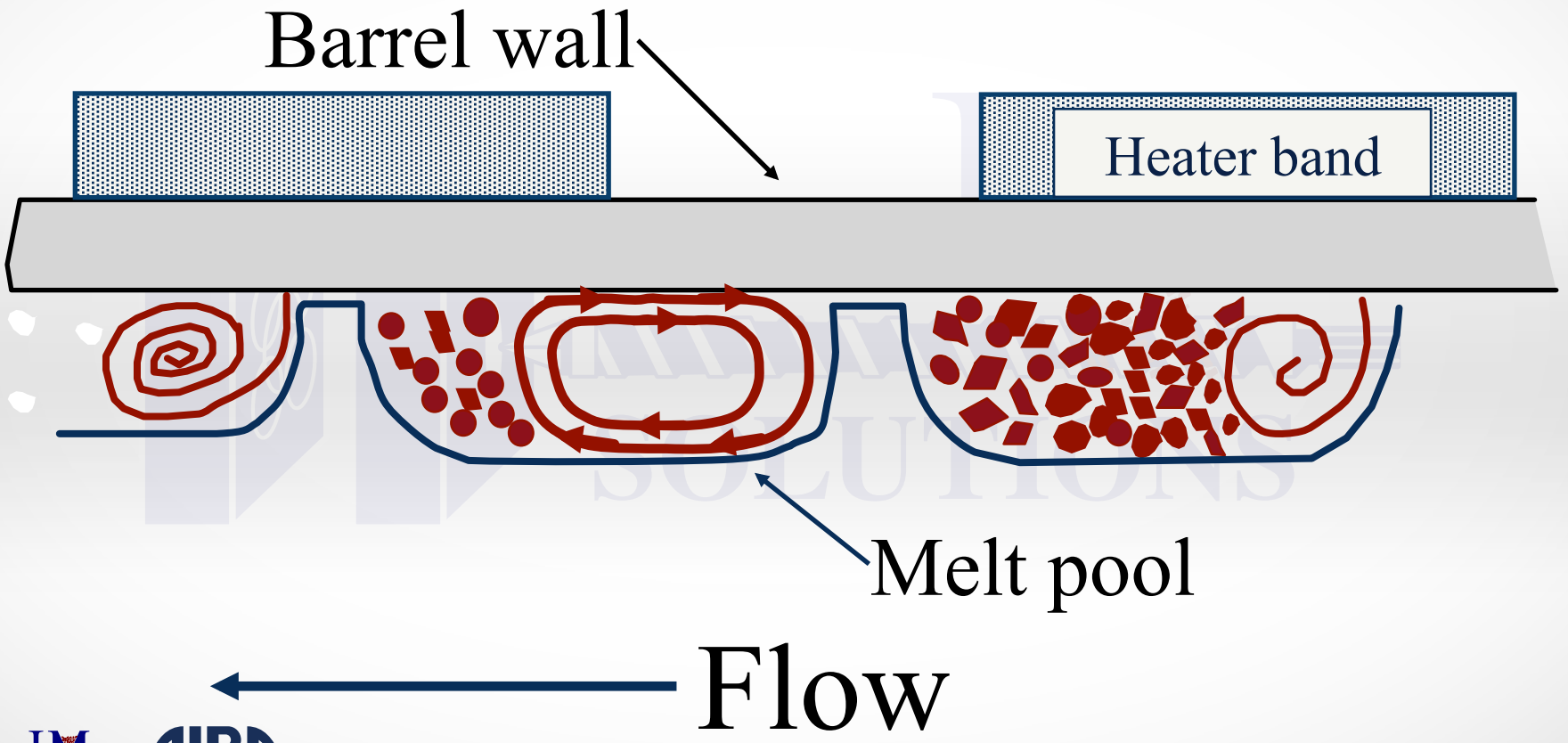
Melt Model



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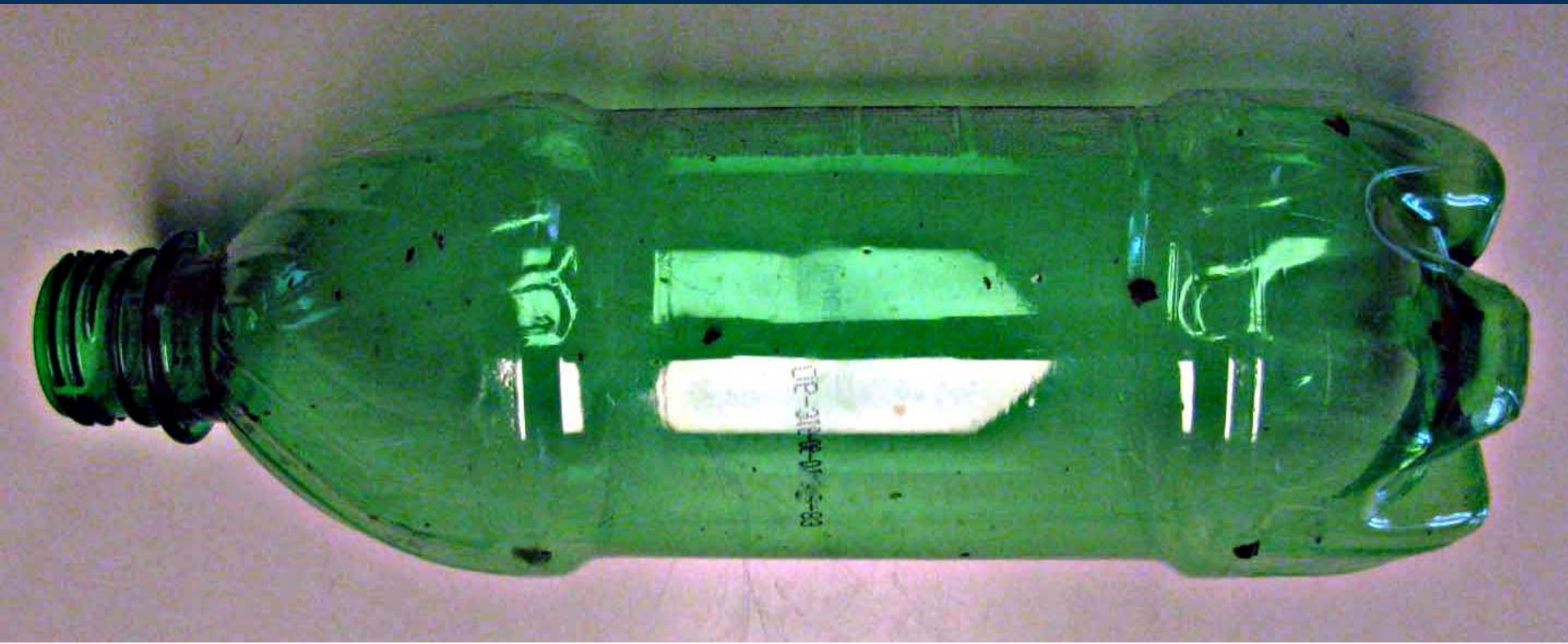
Carbon From Screw Flights



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Unmelted Solids

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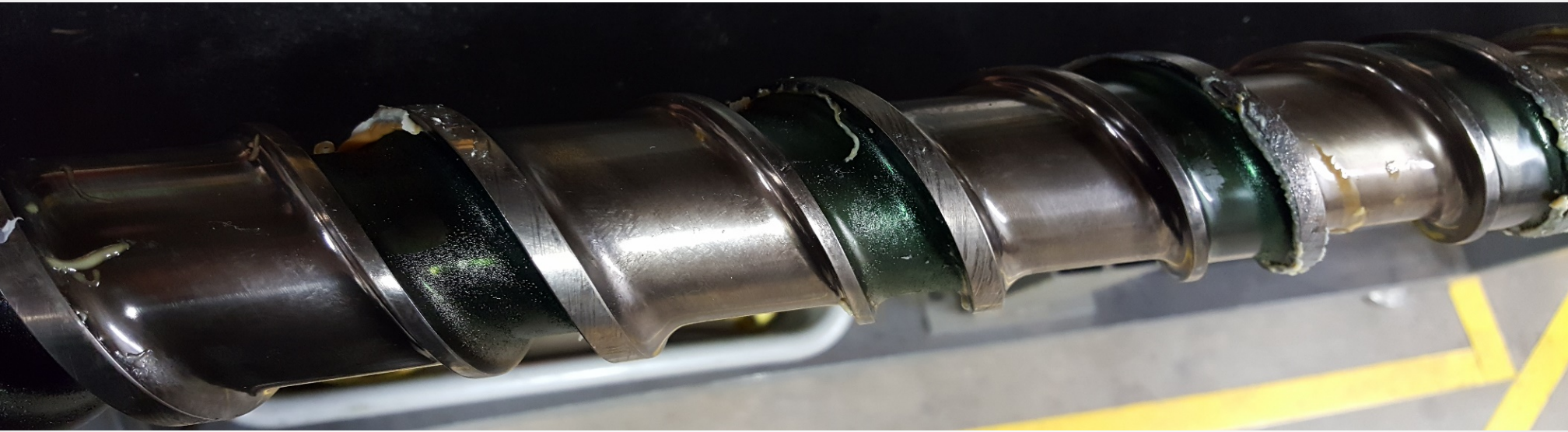
Barrier Screw Issues



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Melt Uniformity Screw

Meter’g

Feed

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Criteria 7 Machines	**GP Screw**	**Adv. Screw**
Run Size	1,348,559 Parts	1,512,055 Parts
Marbling Rejects	3,466 Parts	952 Parts
Drop in rejects due to marbling	75%	
Time Required	24 Weeks	21 Weeks
Good Parts/Hour	702 Parts	900 Parts
Production Gain	---	28%

Savings 7 Machines > ***$550,000***

Hey John, Jan 5, 2016

I just want to thank you for your help with this. We have been running with the new screw since October and have had very positive results. We ran a comparative study over two months and reduced carbon by 29% along with a 75% reduction in overall scrap. During the same period of time we never pulled and cleaned the new screw where as we had to clean the screw three times using the old design. We are currently in the process of purchasing a screw and barrel for one of our other presses. …… Dan

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The Goal

- Melt uniformity
- Consistent temperature for rest of flow path; i.e., everything after the center zone on acts like a thermos & does not alter melt temperature!

The Fundamentals

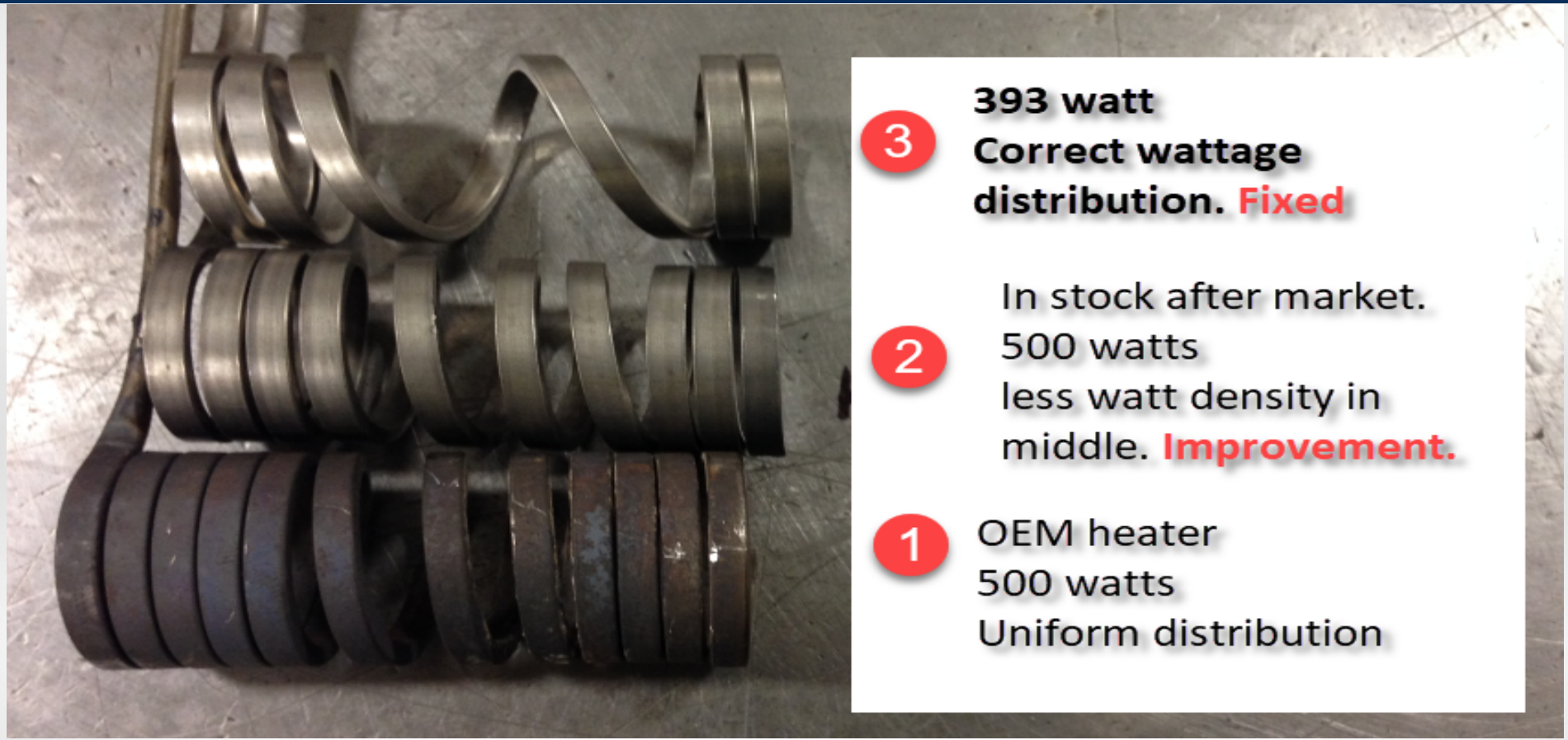
1. Plastic is a non-Newtonian fluid: Meaning its viscosity changes during the injection molding process.
   a) Viscosity is plastics resistance to flow.
   b) Shear rate; the more plastic volume flowing through a fixed vessel the higher the shear rate and the lower the viscosity becomes.

2. Heat (and how its applied) effects viscosity and the overall melt condition.
   a) We will discuss two sources of heat:
      - Conduction: Physical contact
      - Shear: As plastics layers flow over each other temperature increase

3. Uniformity of the melt is effected by:
   a) The Watt to mass ratio determines the time it takes for a vessel to reach the targeted set-point **at the TC location.**
   b) Correct wattage distribution considers the vessels mass and heat sinks as an assembly.
   c) Improper configuration of either may result in high pressure, freeze off, drool, degrading resin or 'burning' of the resin against the flow path wall.

4. Using a hot runner controller as a diagnostic tool can save time and make **root cause troubleshooting** much easier.

Watt to Mass Ratio/Wattage Distribution



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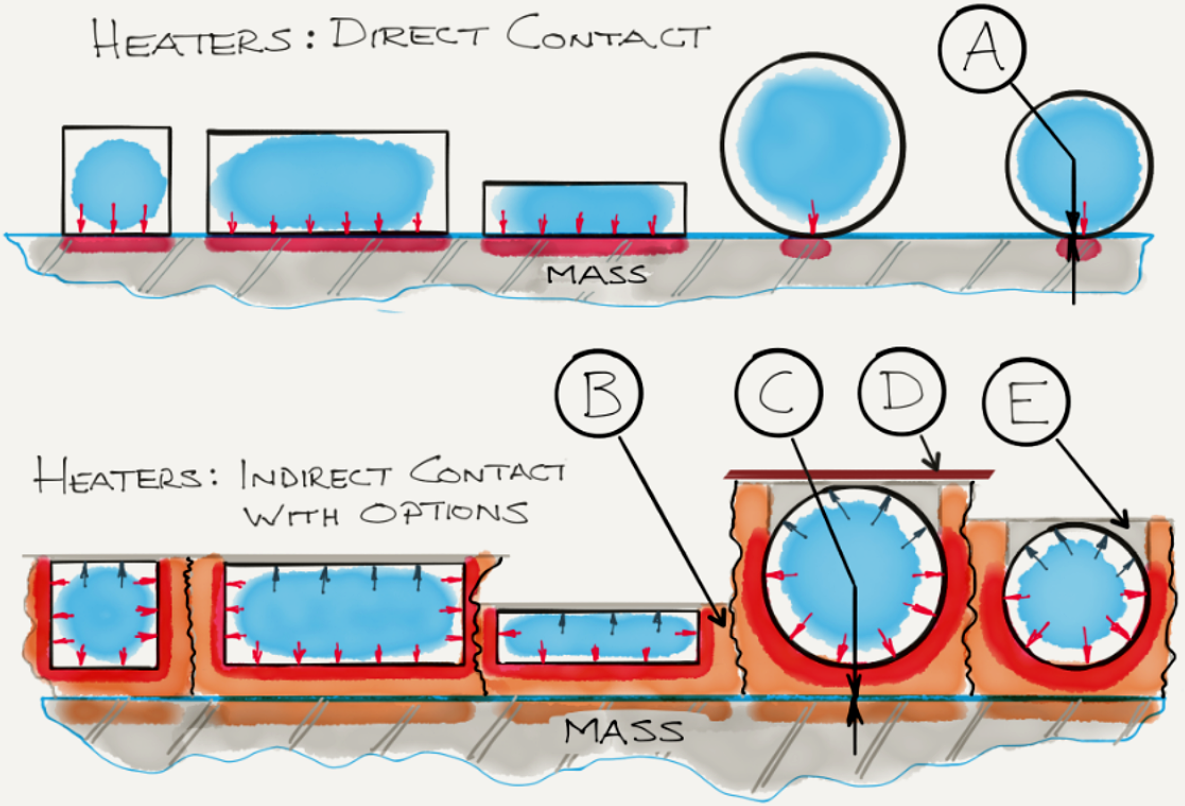
Heater Configuration 101

- Heater Type greatly influences performance
- Direct contact to body (A)
- Indirect contact through sleeve (B)
- Fit is important (C)
- Surface area improves transfer (C)
- Reflection tube increases performance (D)
- Sintering or casting (E)



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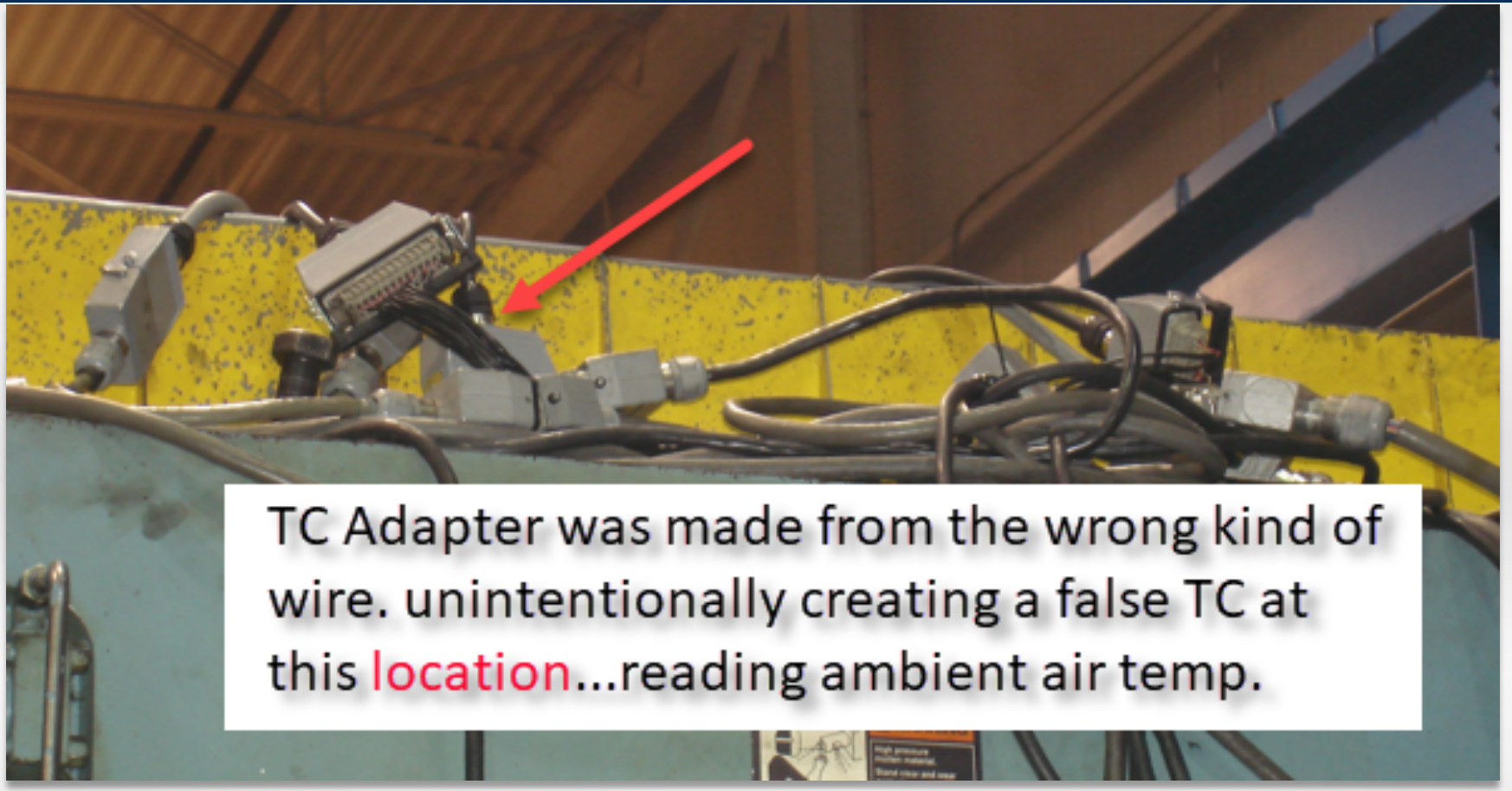
TC Standards

- Thermocouple:
  - Temperature sensor consisting of two dissimilar electrical conductors forming electrical junctions at different temperatures
  - Thermoelectric effect; direct conversion of temperature differences to electric voltage via a thermocouple
- Type J TC: Positive lead is ferrous material (magnetic)
  - Common to Hot runner nozzle and manifold applications
- Type K TC: Negative lead is ferrous material (magnetic)
  - Common to heat injection unit heater applications.
- Use Ferrules for Multi-strand wires
- TC wire, adaptors, extensions and pinched wires:
  - Make sure they are made from the same materials or false TC junction can be created

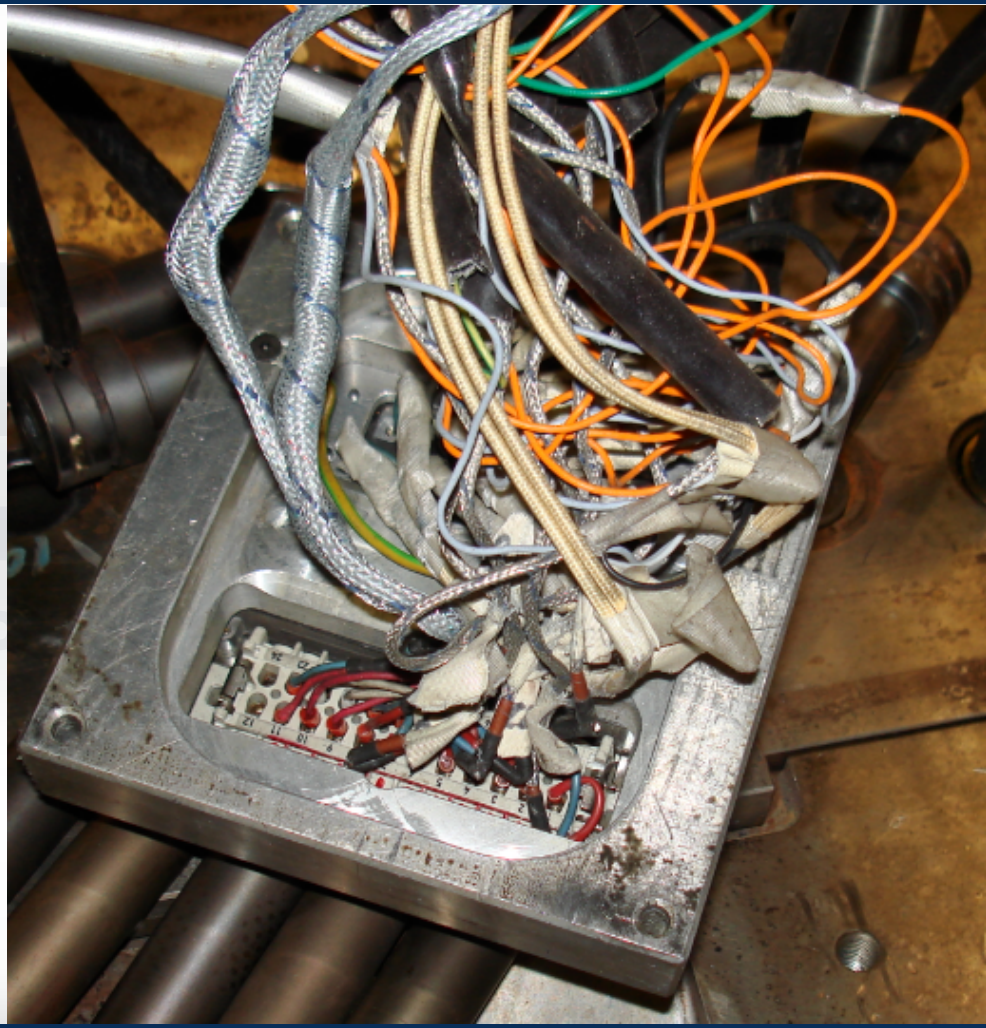
False TC



False TC: Results video

Wiring

- Verify the TC and heat zone are paired correctly
- Do not splice TC wires as a practice
- Use Ferrules (correct type)
- Use correct crimping & wire-stripping tools



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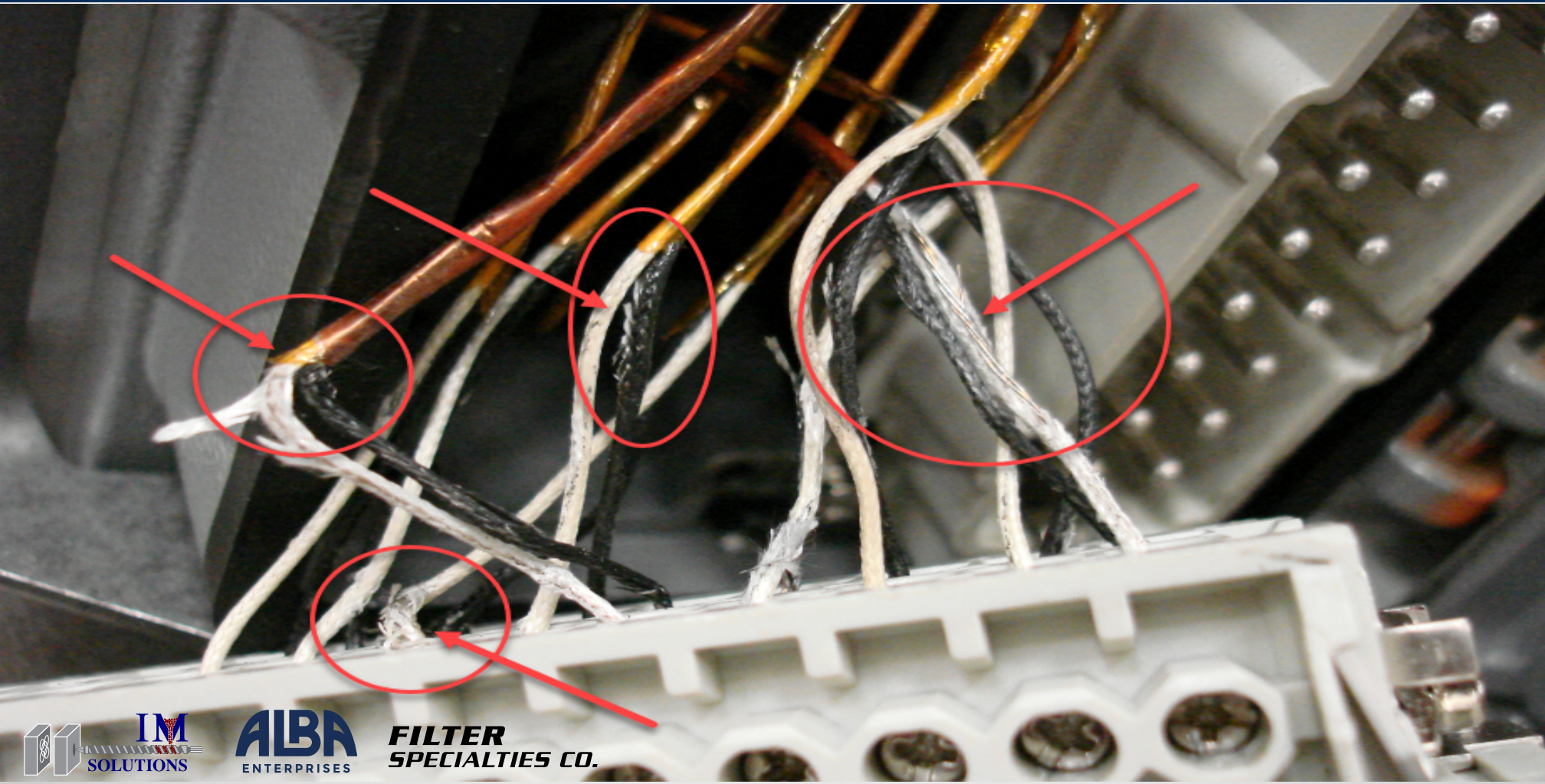
Wiring



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False TC Reading

- Pinched TC lead can act as a TC
- Organize your wiring
- Use Hellerman-Tyton or equivalent High temp zip ties to manage wiring
- They don't become brittle with high temp applications

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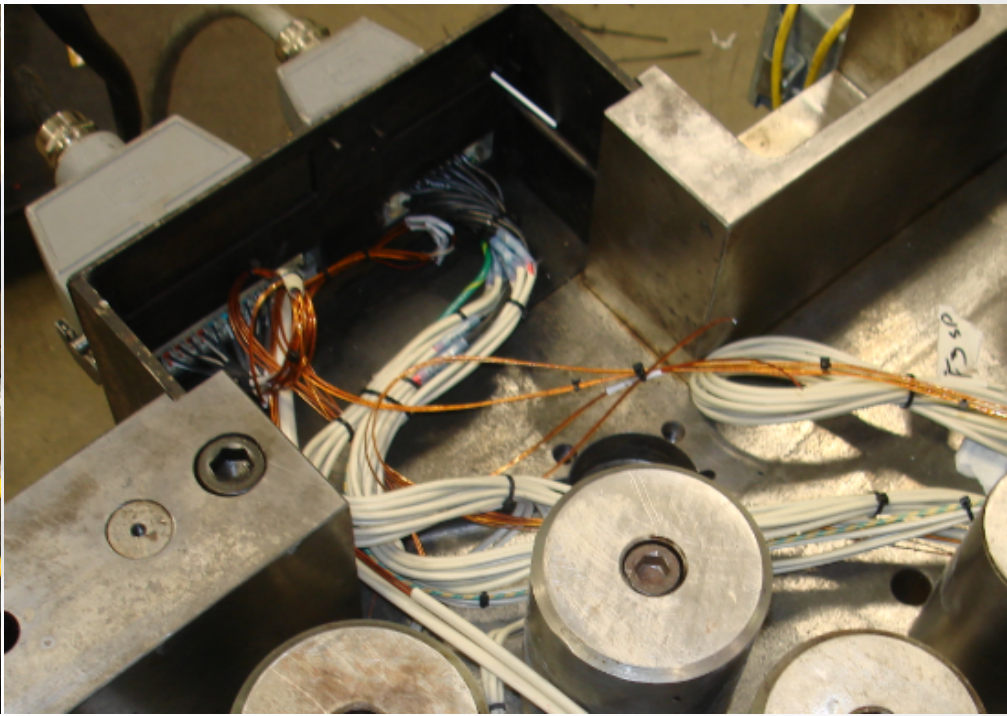
Over Injection: Proper Wiring



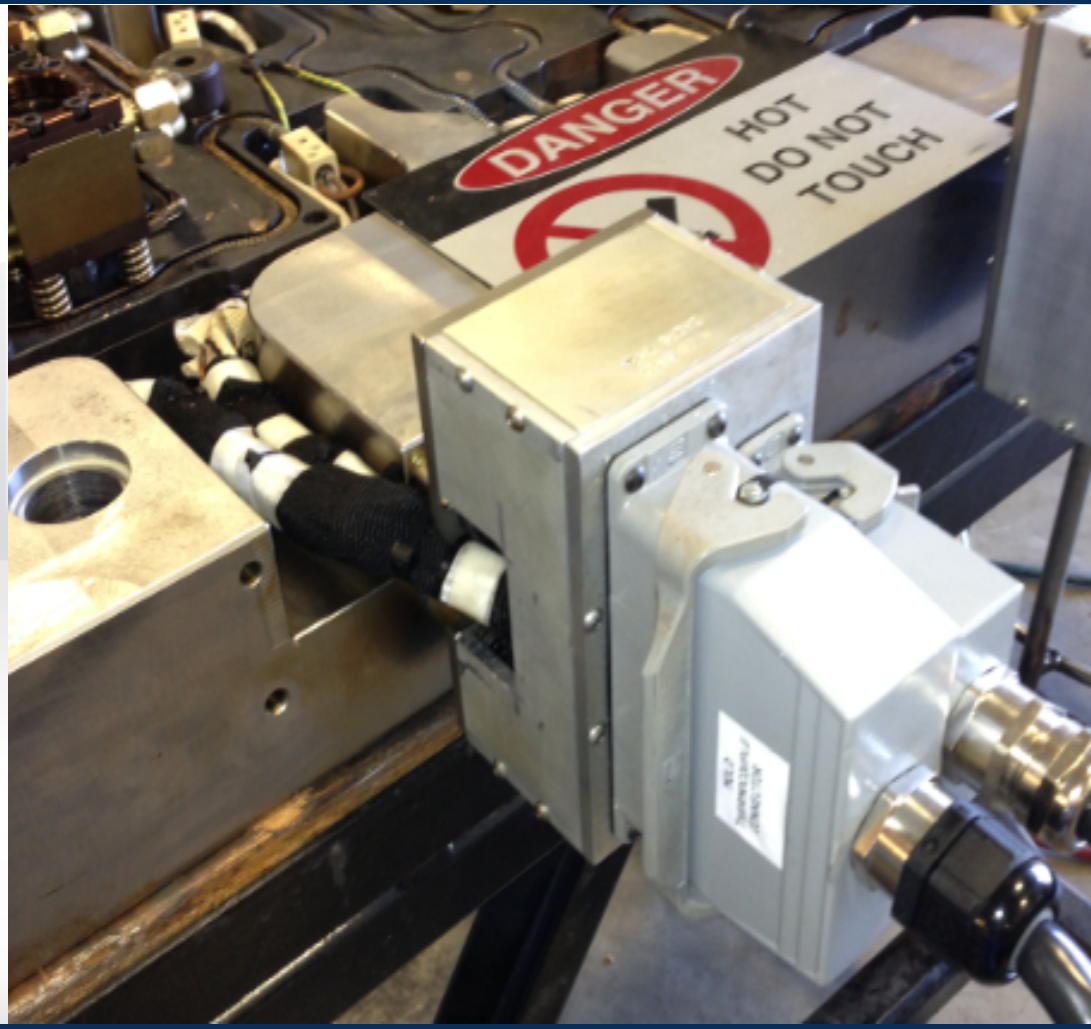
Results of False TC

The "Chimney"

- Premature plug failures
- Erratic performance as a result

Solution:

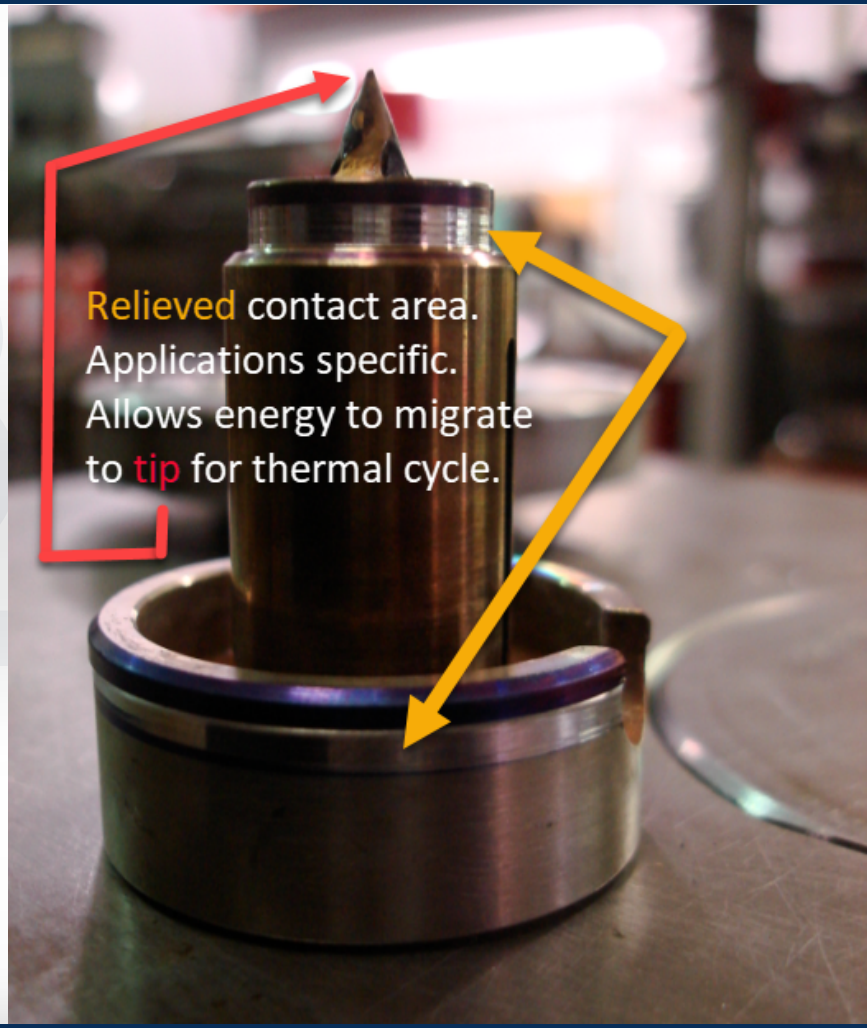
- Move electrical box to allow heat to escape but not **THROUGH** the box.



Surface Area of Contact: Heat Highway

Heat Sink:

- Poor nozzle performance
- Stock nozzle did not work with engineered resins
- Modified nozzle surface area contact to mold
- Managed nozzle temp through overall assessment
- Modified (50) molds like this at one client.
- Purchase the right product the first time…



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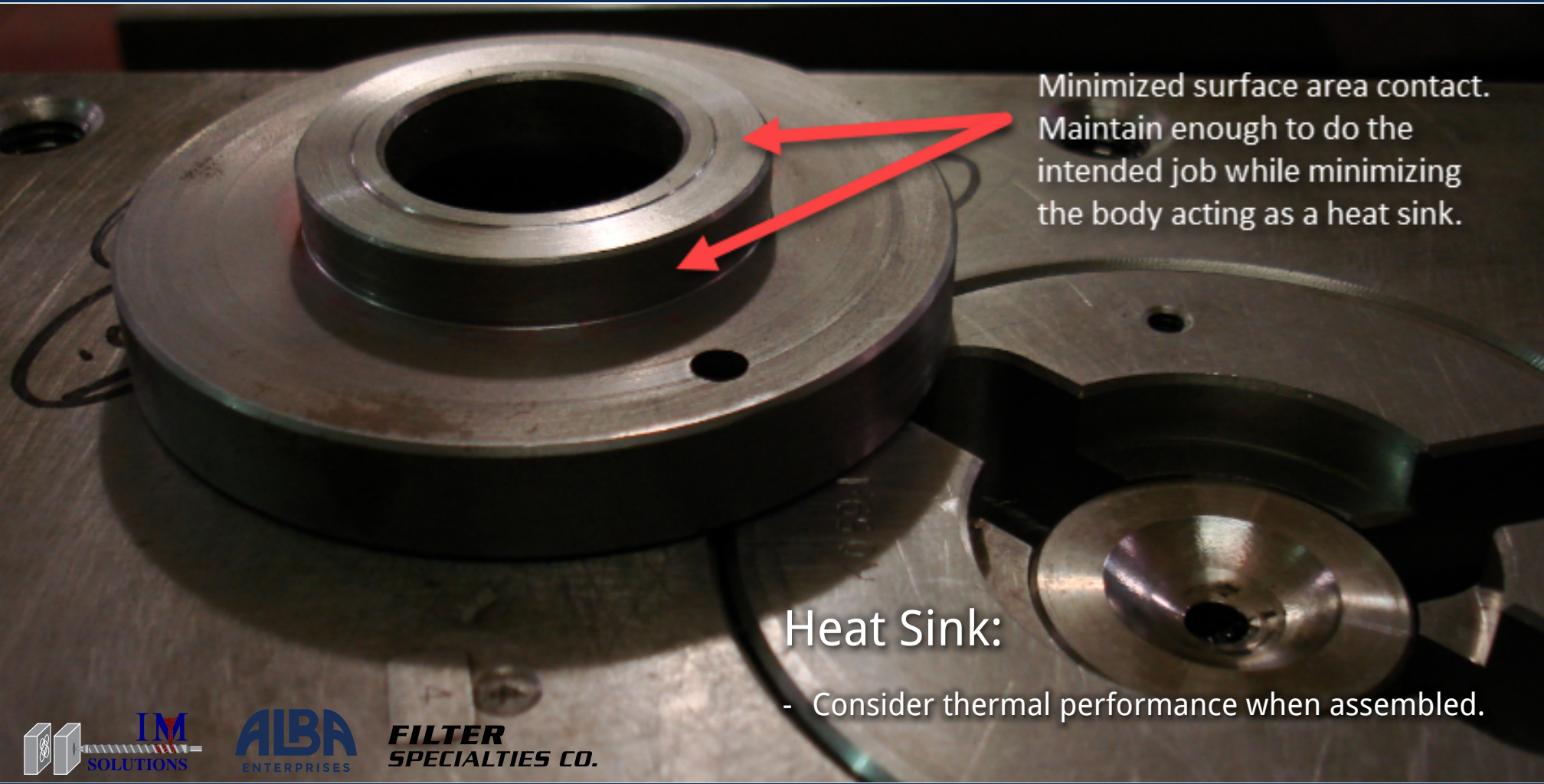
Surface Area of Contact: Heat Highway



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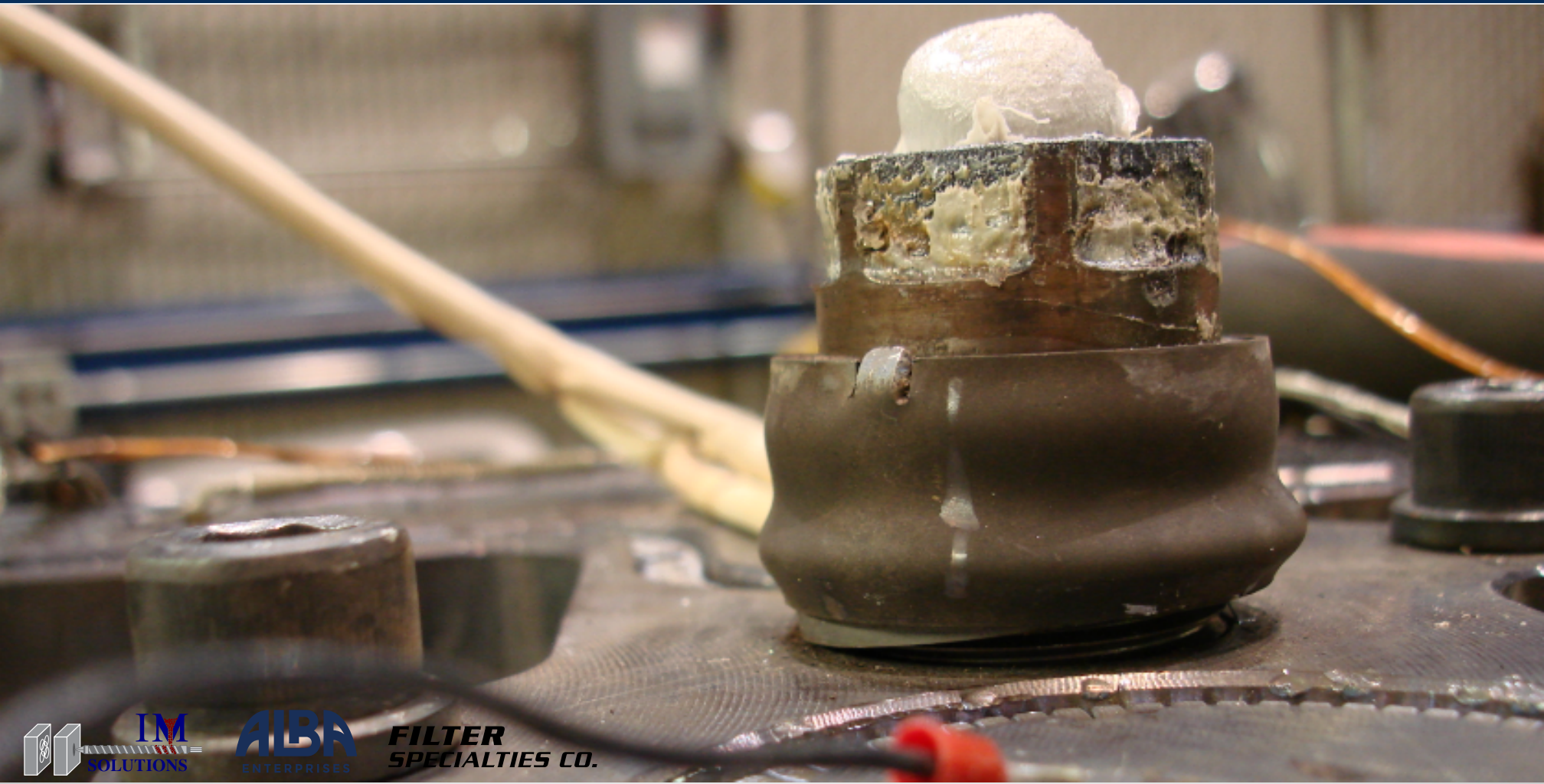
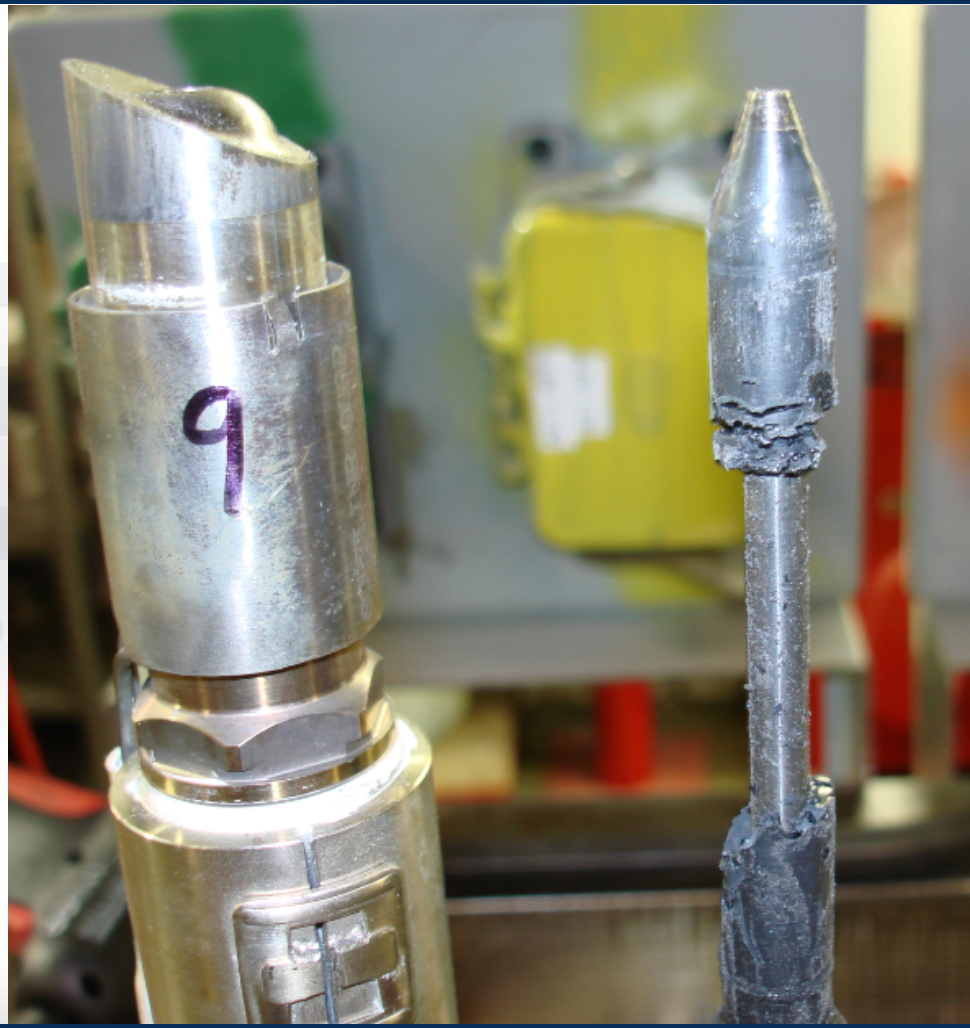
Unplanned Heat Sink



Wattage Issues

Wattage Issues:

- Watt to mass ratio way to high related to mass.
- Issue is magnified due to large heat sink at tip to mold contact.
- Resin degraded to powder when molding cycle was interrupted.
- Process engineer **"Turn it up to flow better"** mentality.



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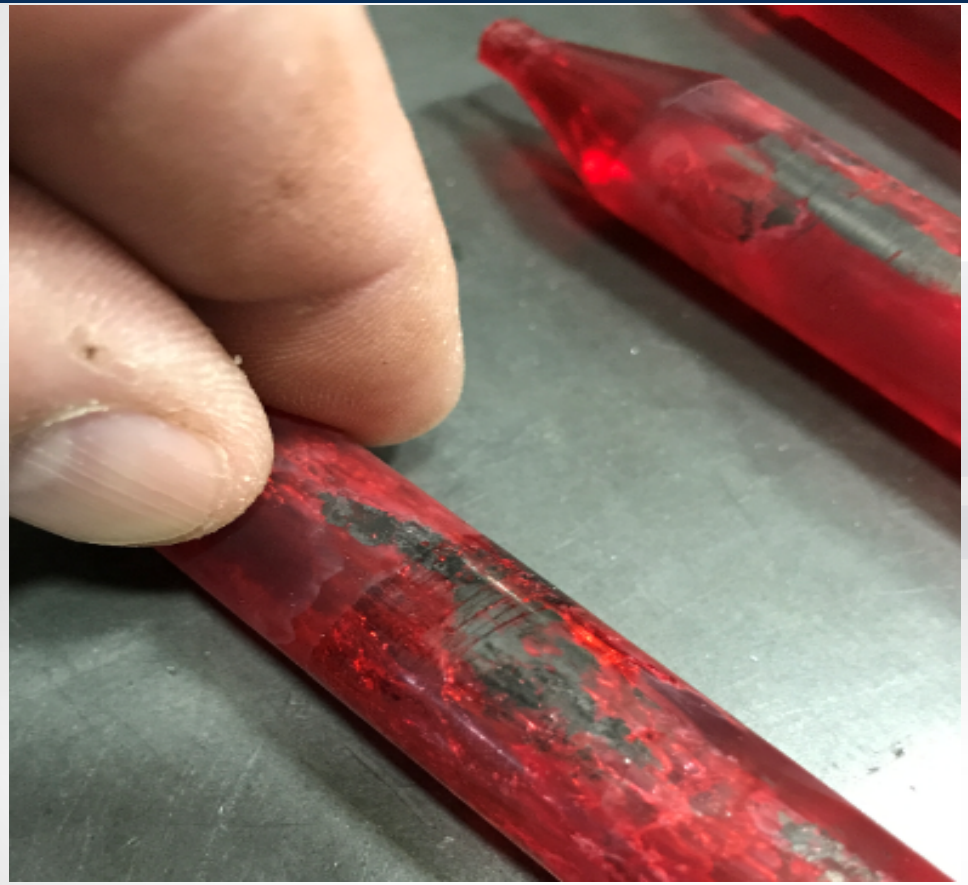
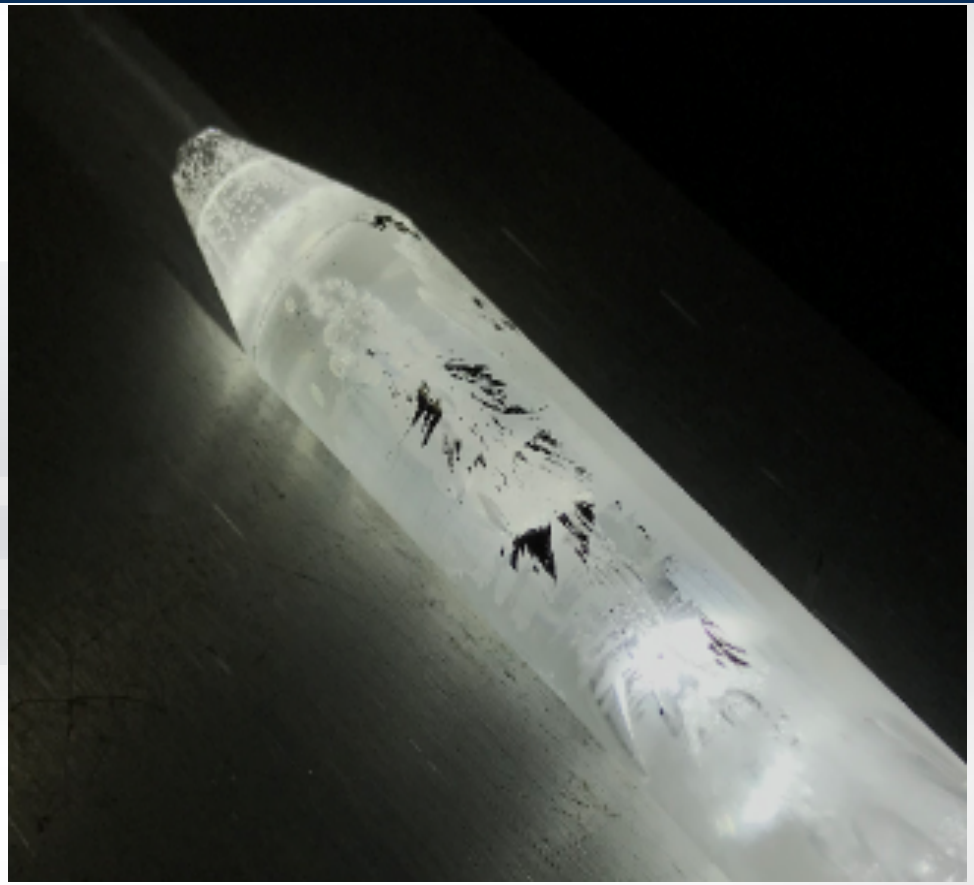
Flow Path Degraded Skin





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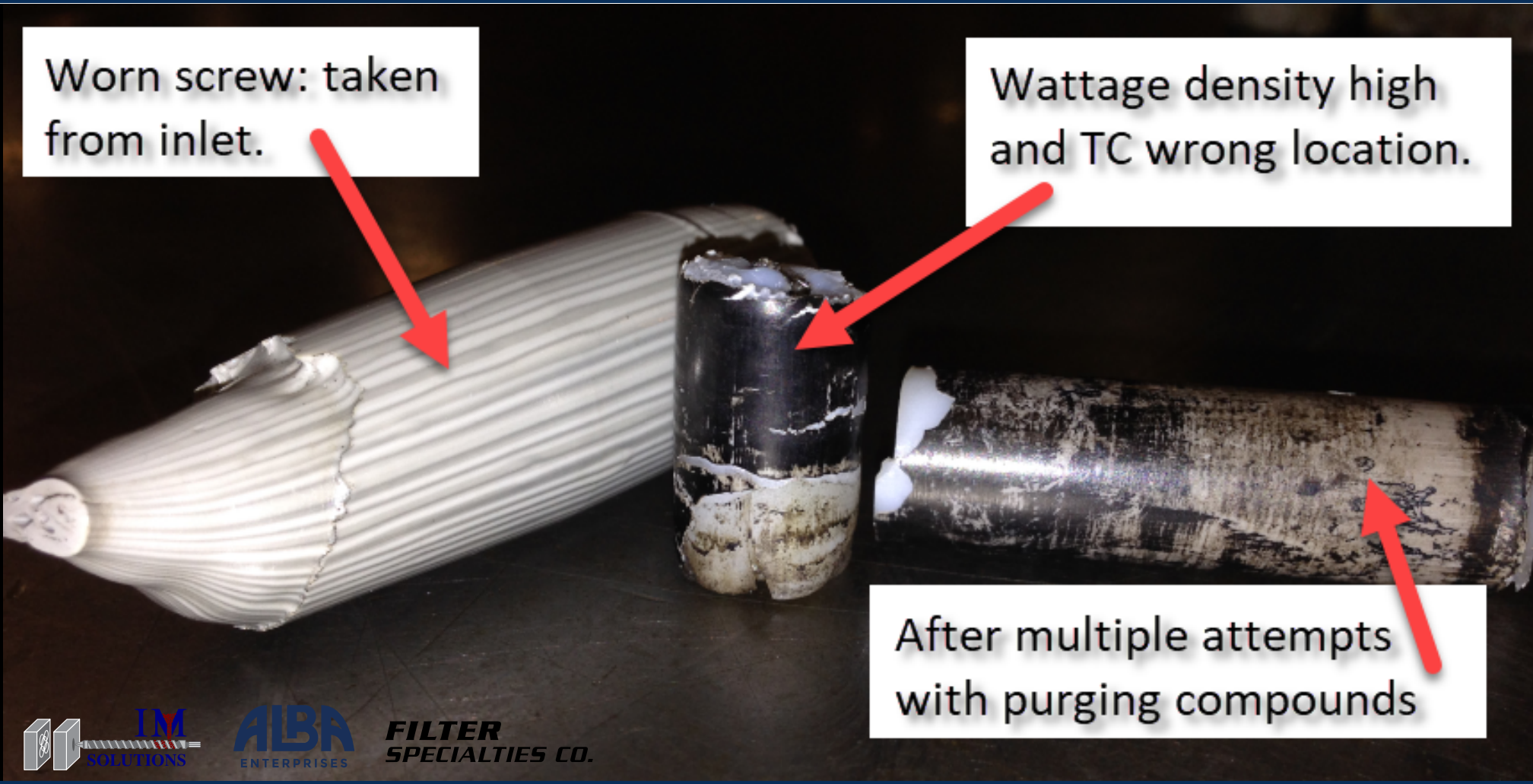
Flow Path Degraded Skin

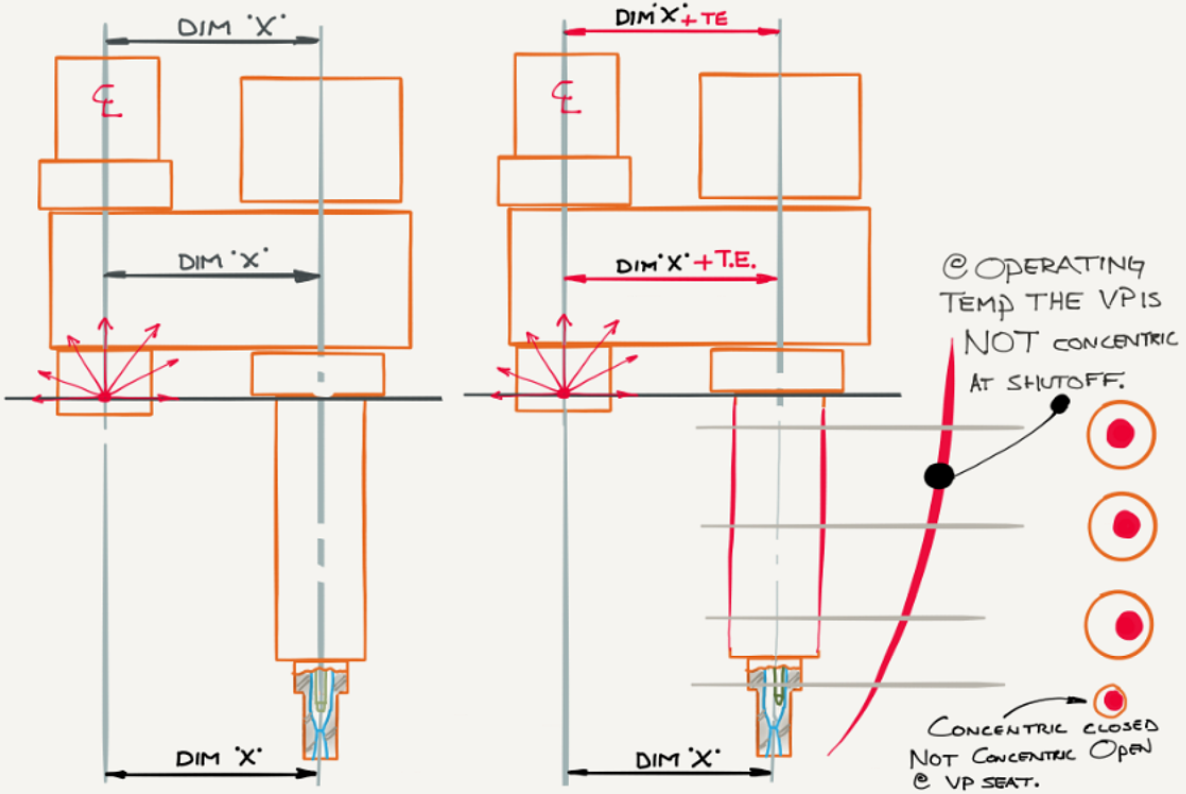


Thermal Expansion

- The result that happened when a change in temperature takes place is thermal expansion or contraction.
- You cannot stop it.
- It can result in mismatch, heat sink and damaged components.
- Common issue is nozzle pocket clearances are not correct.

Valve Pin Concentricity

- Screw in nozzle example
- Length of nozzle + distance from TE point determine amount of deflection.



Valve Pin Concentricity

- Sliding seal nozzle example
- OEM decided how they deal with thermal expansion.
- ASK.....

Nozzles

Hot Runner Nozzles - Key Performance Issues:

a) Assembled concentricity

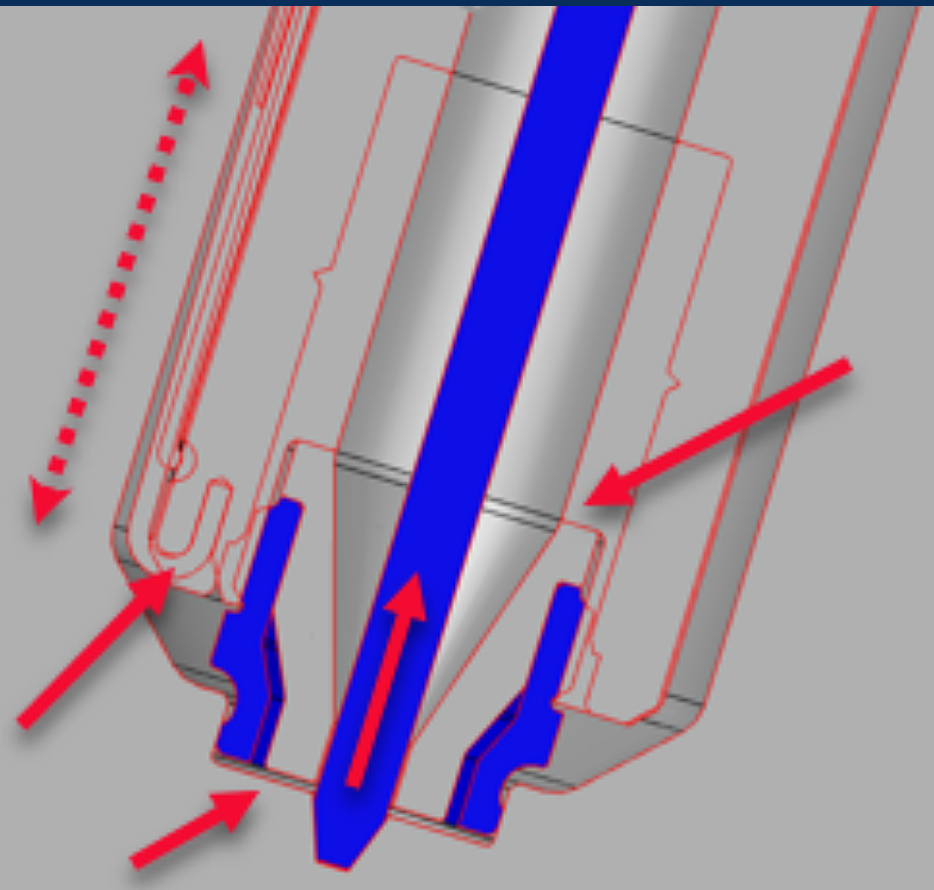
b) TC position - contact

c) Heat sink: possible contact

d) Isolation gap: degrading?

e) VP position:

- variable shear rate during opening



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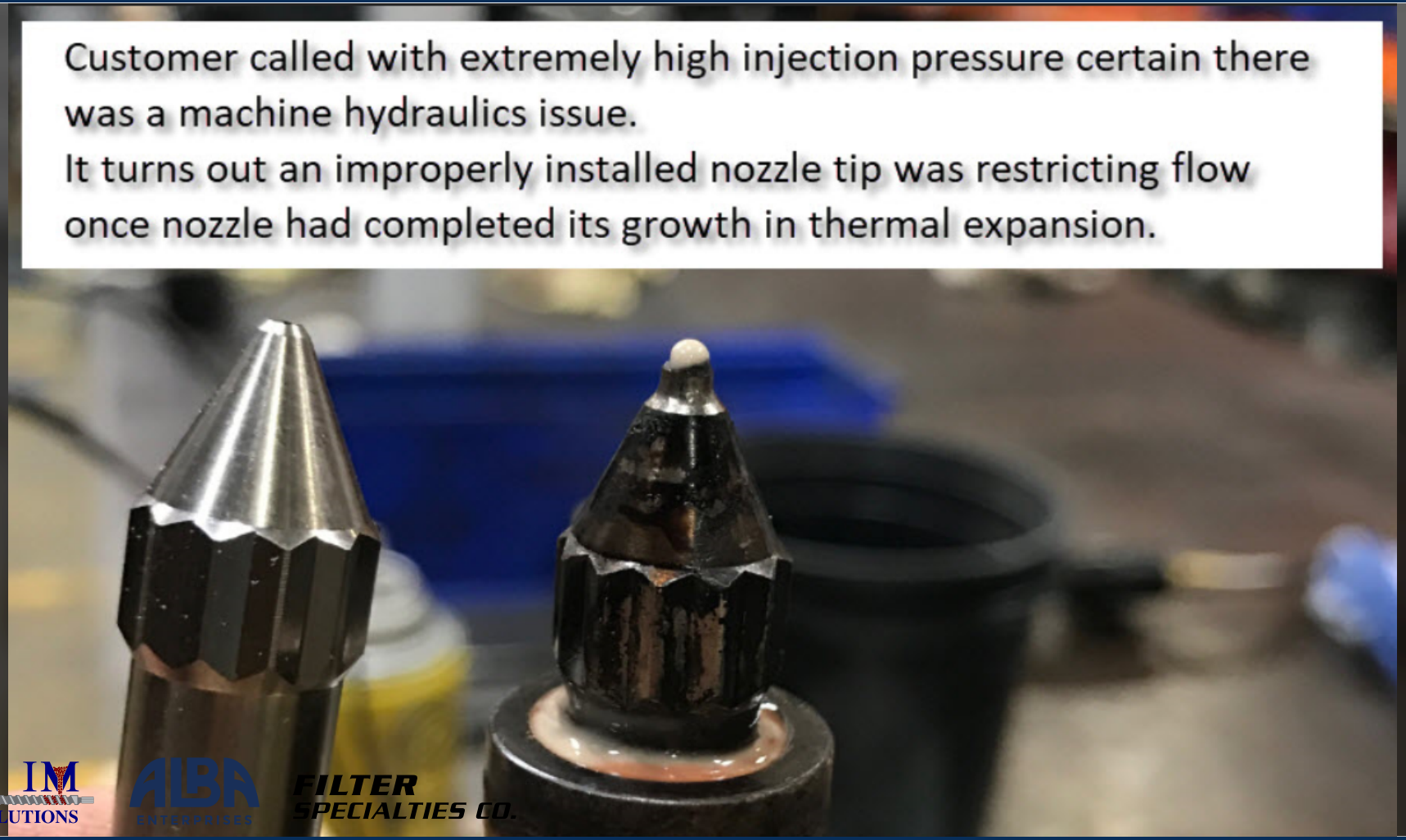
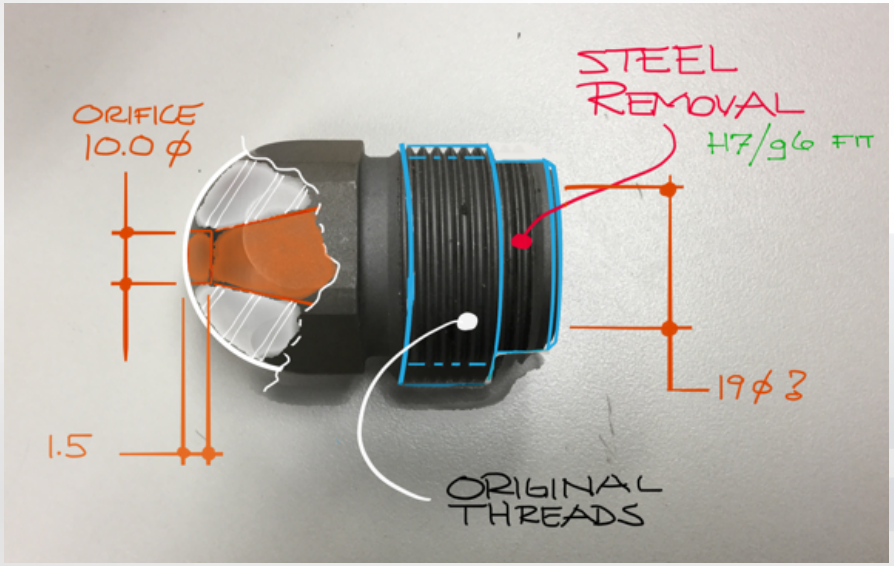
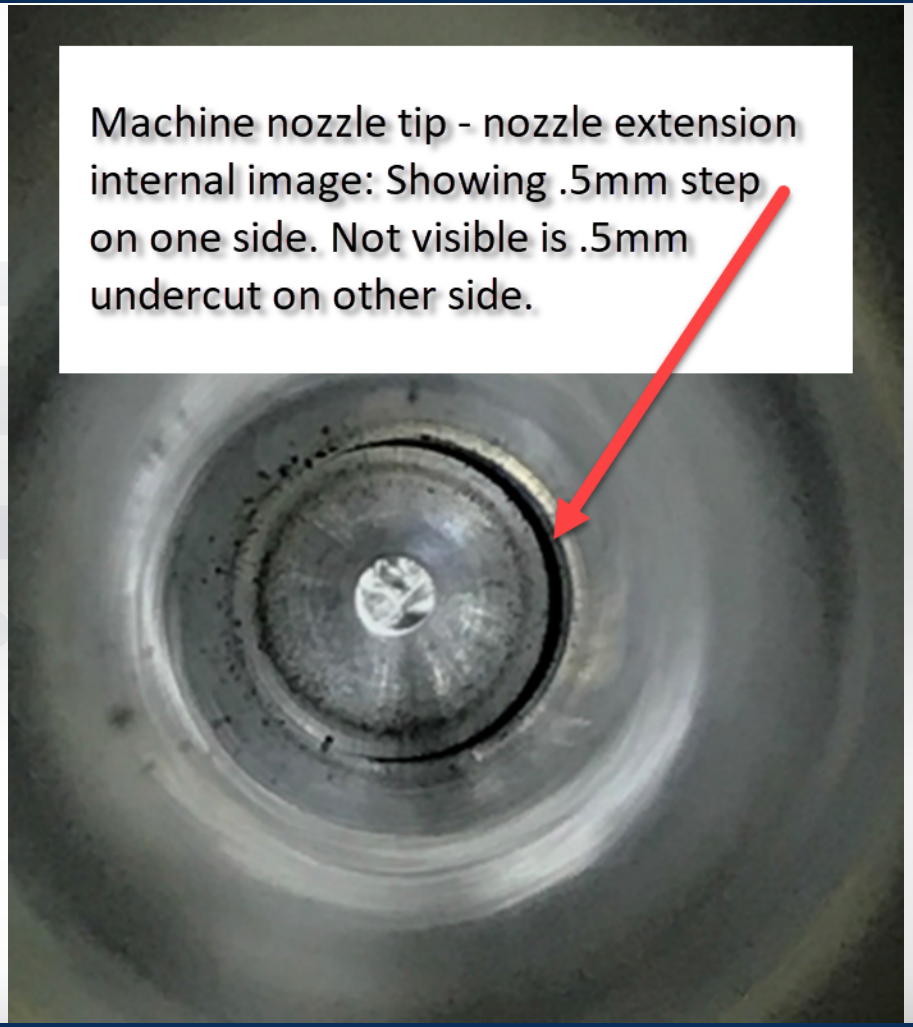
Just the Facts Please



Concentricity



- Shear Point
- Undercut: poor color change/degrading resin over time
- Unplanned residence time



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Concentricity

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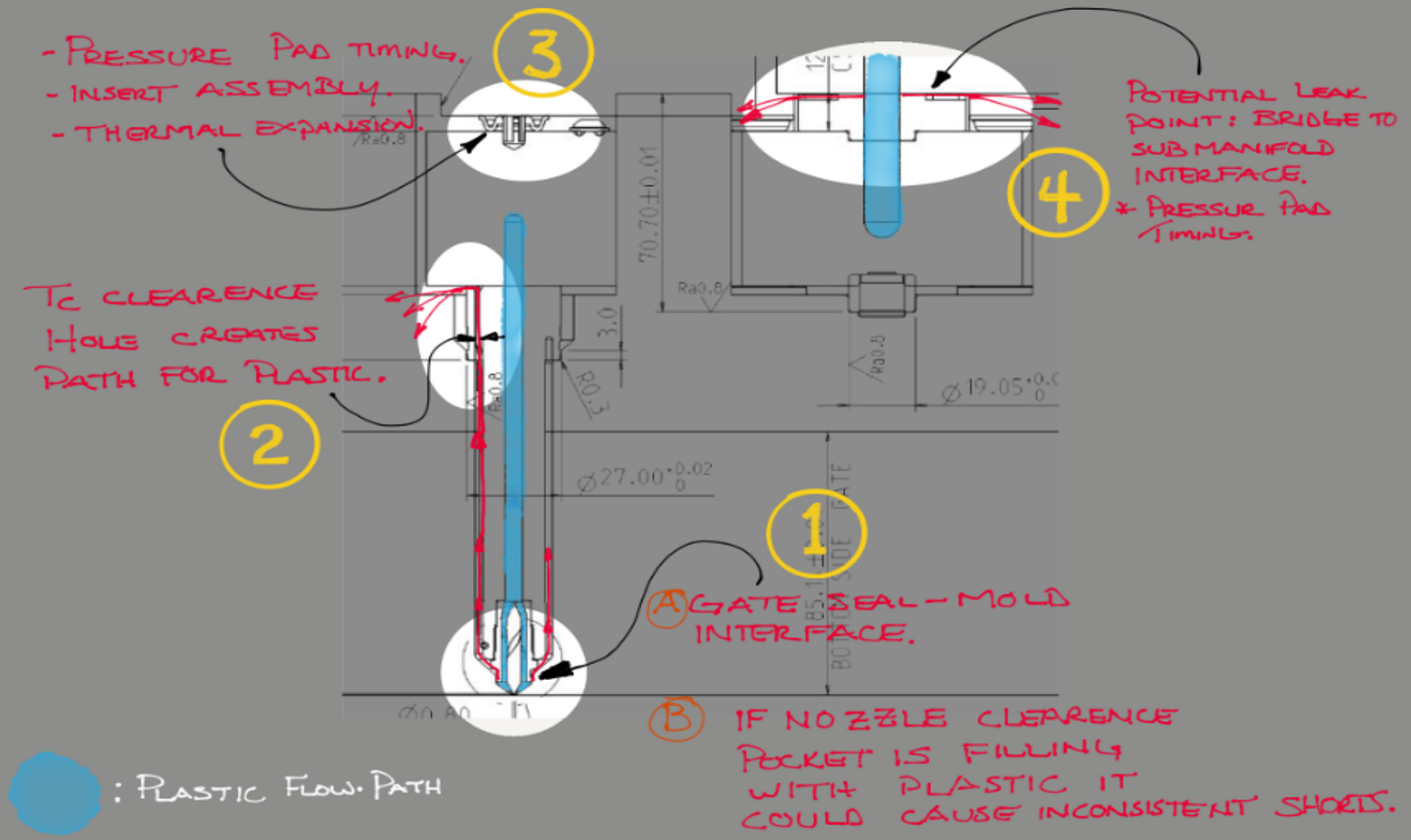
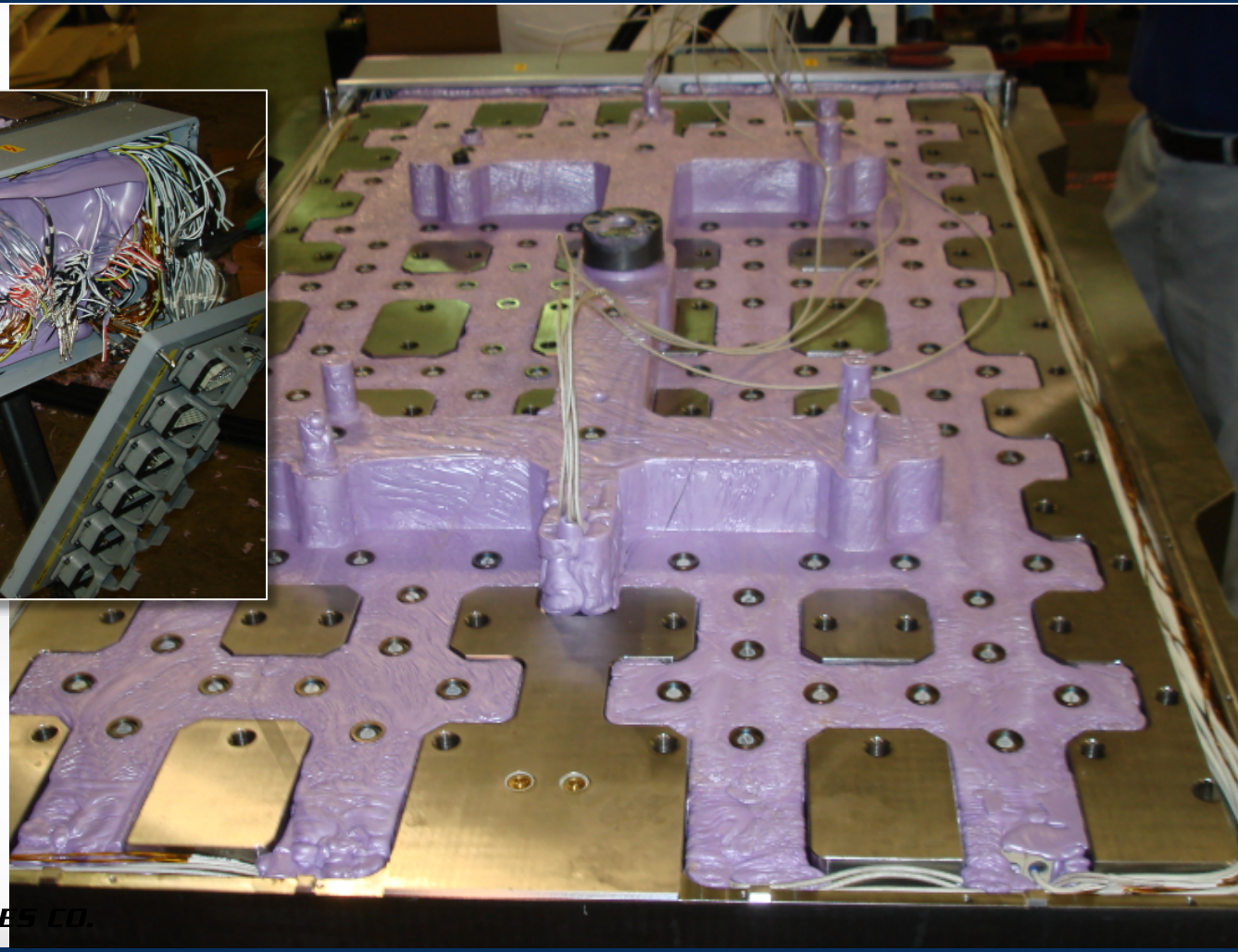
Where Did It Leak From?



Troubleshooting: Melt Delivery Systems Required for Scientific Molding

When You Don't Pay Attention to the Details...



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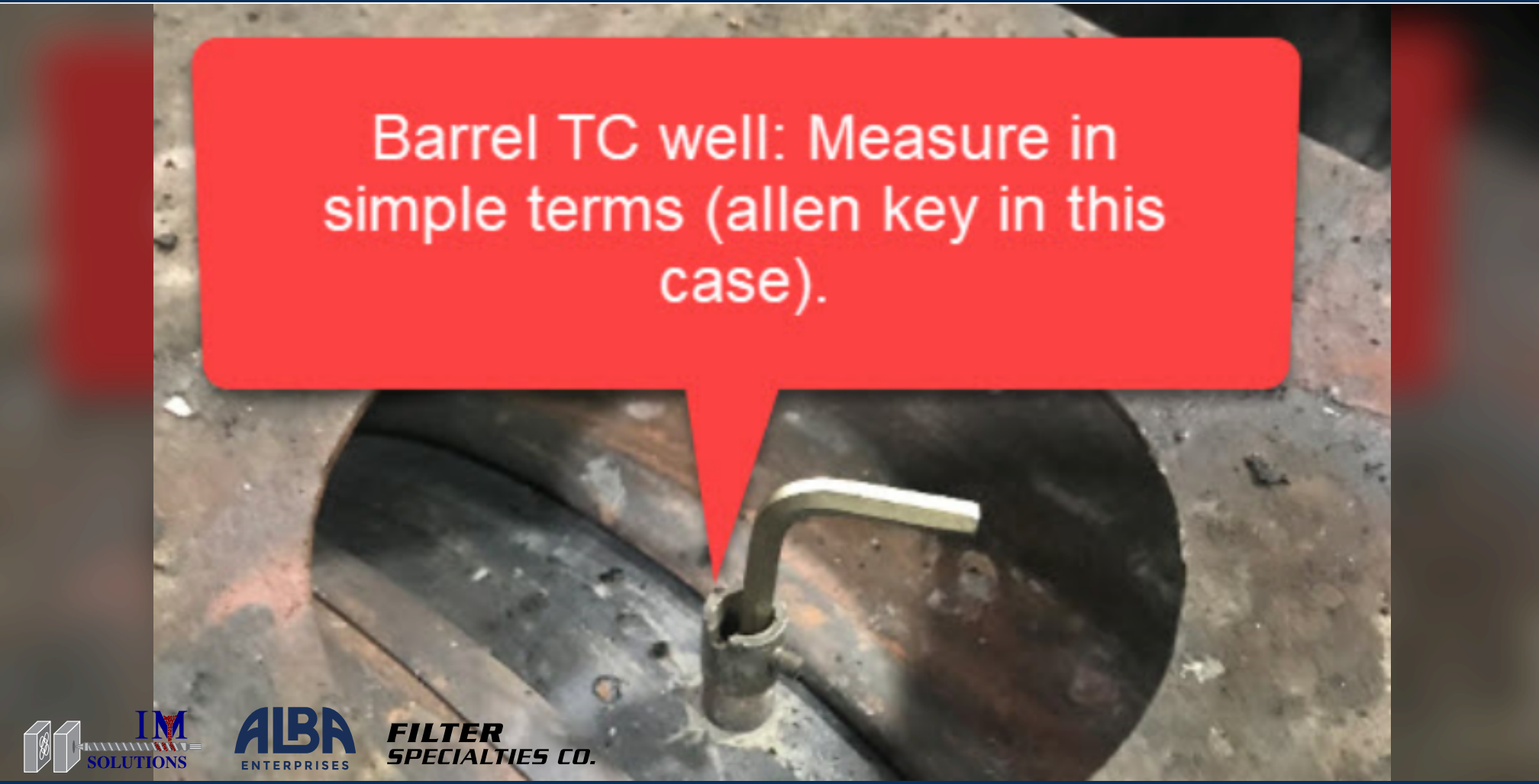
Best Practice for Success

- Make no Assumptions about heater band function.
- Test Amp Draw on heaters and record for PM
- Confirm Wattage and the location of the band.
- Confirm TC type and proper installation
- Must have a clean TC well
- TC must touch bottom and have spring force holding down
- Use Anti-seize (correct temperature type) on threads and TC for future removal

Best Practice for Success

- Test TC response of each TC to ensure it is controlling the correct heat zone.
- Mark all zones to match the graphic screen display. *This makes troubleshooting easier.
- Move heater/TC wires at the nozzle area to the **TOP SIDE** of the injection unit so plastic drool does not pull the wires!
- Remove nozzle extension tip when possible.
- Ensure nozzle tip orifice and Radius is correct to the mold running.
- Verify nozzle tip to sprue bushing seat alignment is correct, with an imprint.

Best Practice for TC Installation



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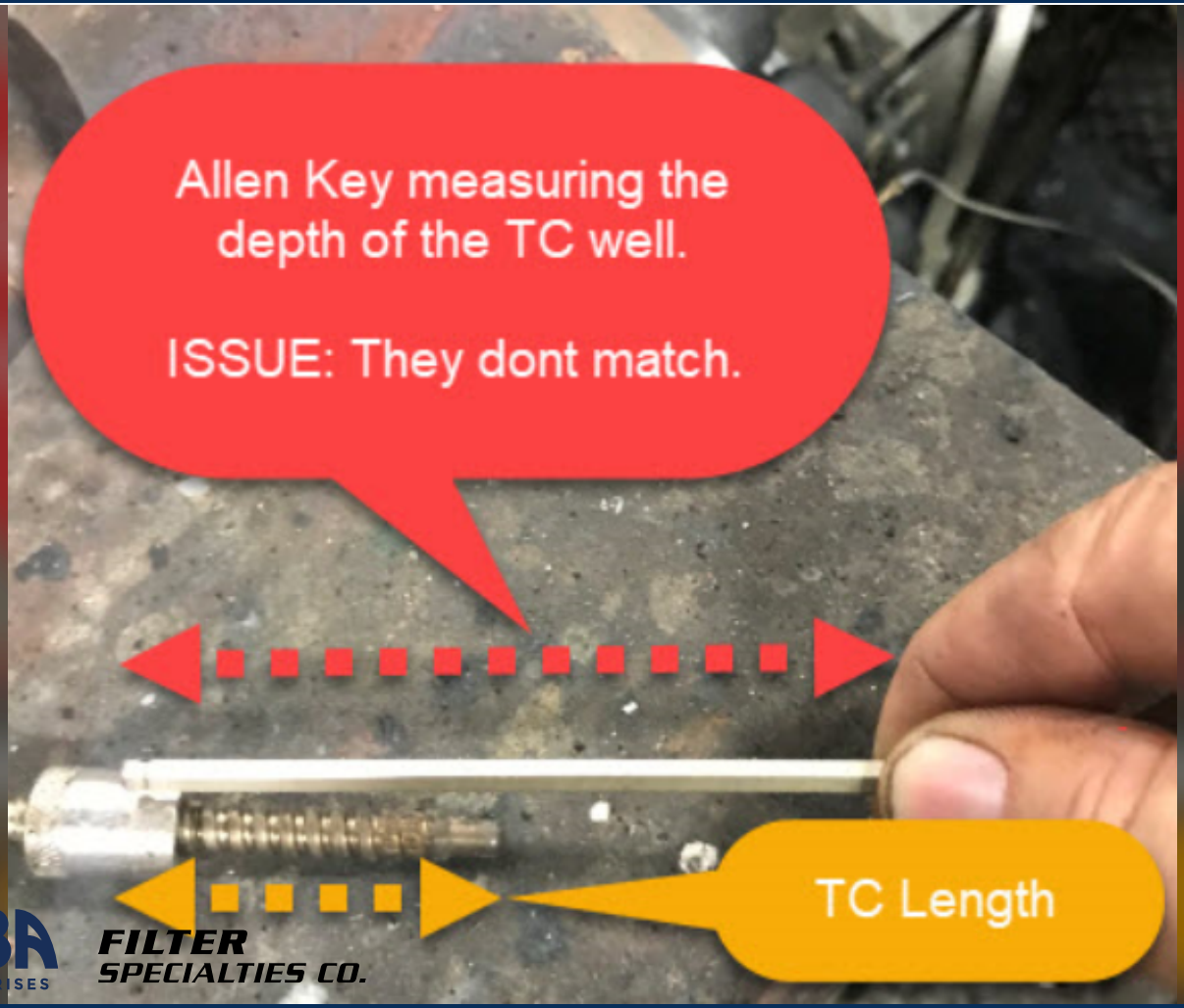
Best Practice for TC Installation



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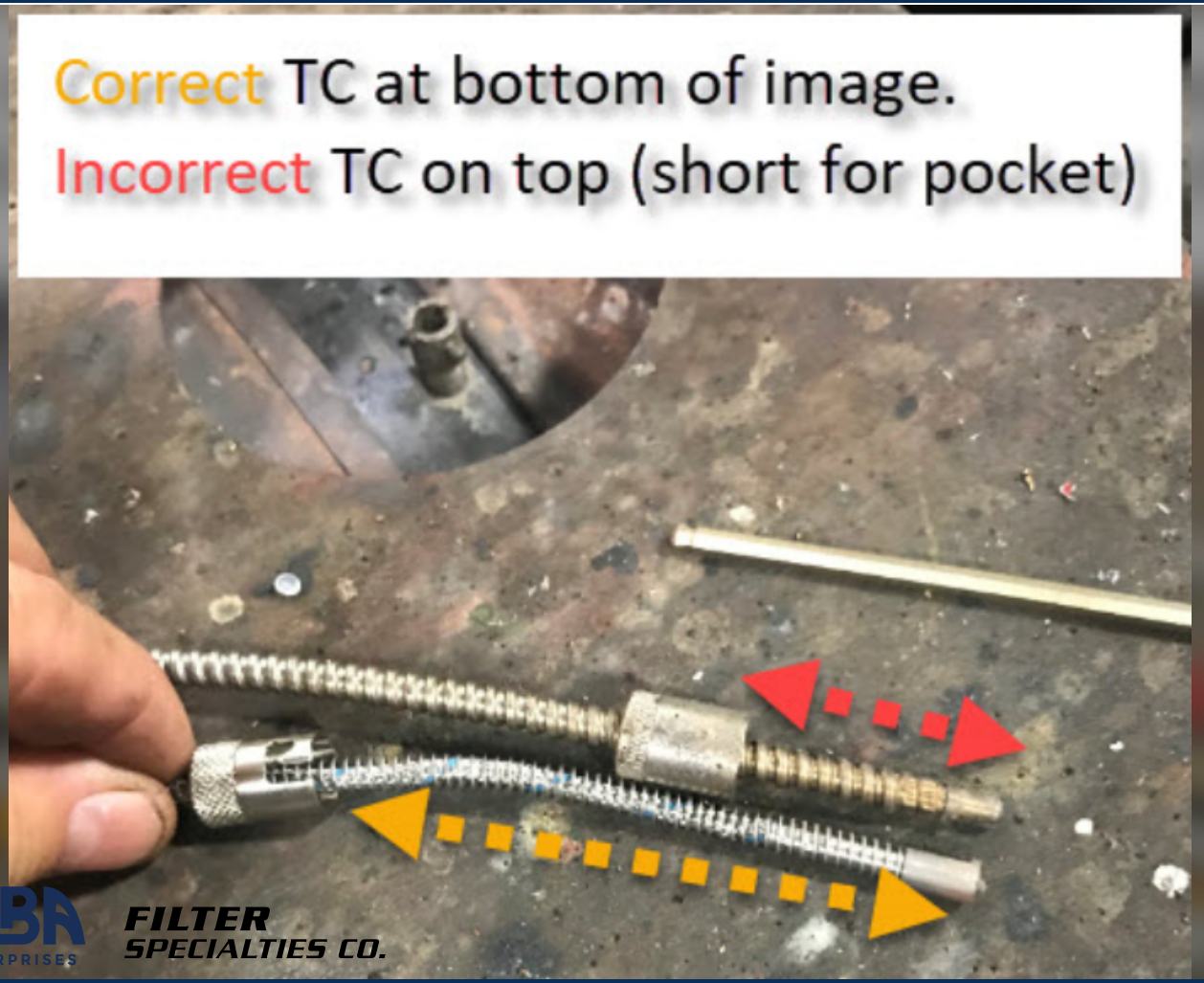
Best Practice for TC Installation

Best Practice for Machine Evaluation and Repair



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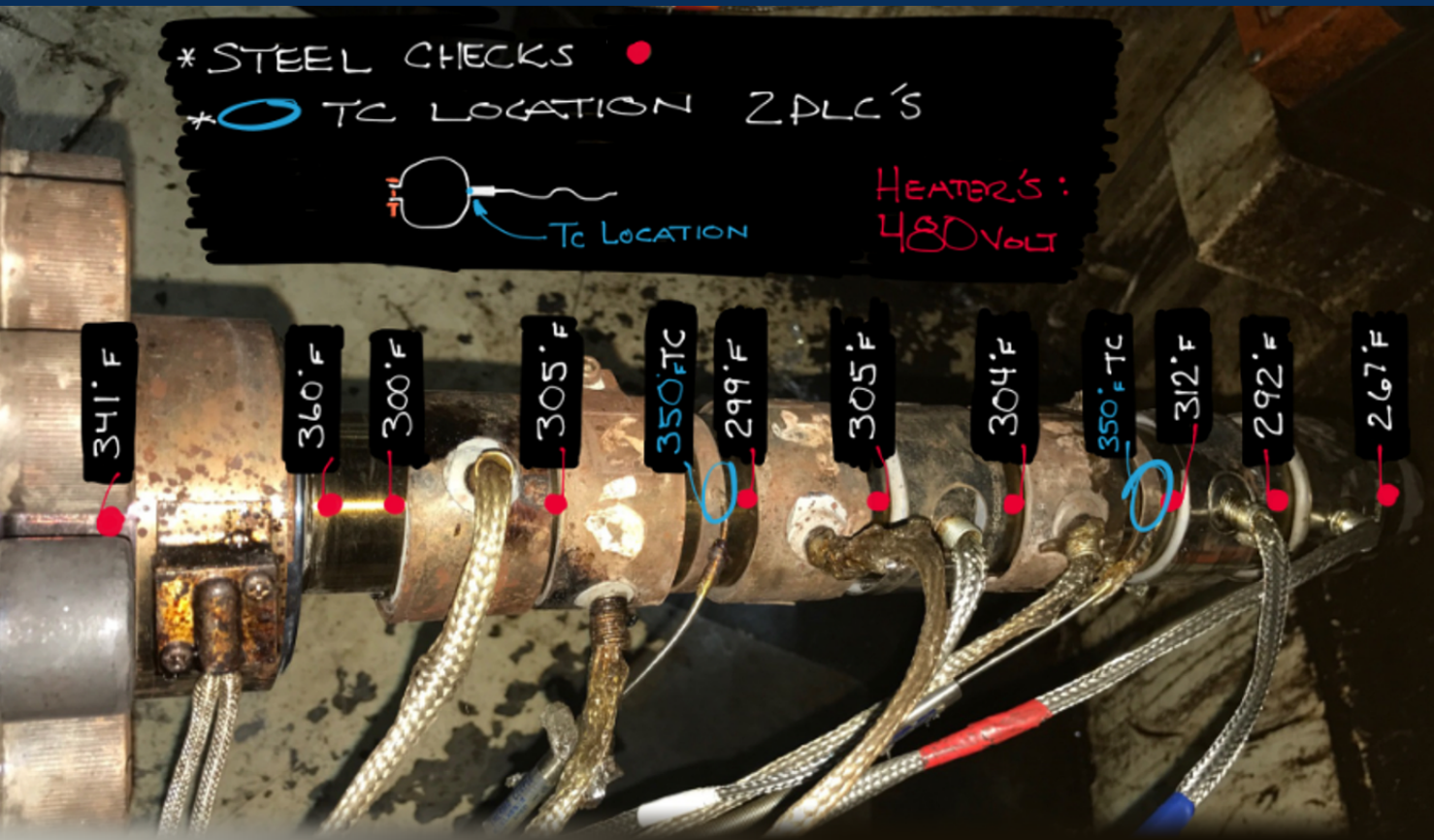
Typical Nozzle Extension



- Multiple heaters
- Some paired heaters (into a single heat zone) are of different wattages and controlled by a common TC.
- Delta-T: 60F HZ-1
- Delta-T: 83F HZ-2

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Presenter: John Bozzelli

John is a graduate of Marietta College (BS) and Ohio University (MS). His studies were interrupted for a stint in Vietnam (Army First Air Cavalry, Purple Heart and Silver Star). Twenty years in Dow Plastics provided extensive experience in polymer synthesis, development, production, and processing. John has been a seminar leader with RJG Associates, *Injection Molding Magazine,* University of Wisconsin, General Polymers, PolyOne, Glenn Beall, and John Klees. Competent in resin characterization and analysis, his specialty is practical, hands-on injection molding training in plastics, rubber, LIM/LSR, metals, wax, ceramics, medical validations, and Infrared Thermography.

National recognition has come through ten patents, over 200 papers and industry articles covering plastics and processing. He has over 25 years on the seminar circuit and has several feature articles such as the "Productivity Challenge" and "Scientific Molding." In 2005, he was named as processor of the year by Modern Plastics.

John teaches **Scientific Molding** (SIM) technology from the plastics point of view for design and processing with a passion that provides a significant emotional experience that you will remember. He presents *practical* techniques that improve your profits today while elevating your production to international standards. On-site seminars are a specialty, electric or hydraulic machines. He is the originator of "Scientific Molding."

Presenter: Rich Oles

- 34 years in the injection molding industry
- Plastic injection mold and die cast mold making: 1985-1999
  - Journeyman mold maker.
  - Engineering manager,
  - IT manager.
- European Hot runner manifold OEM's NA expansion : 1999-2012
  - Engineering manager
  - General Manager
  - CEO/President
- Production Plastic Injection molding 2012-2015
  - Director of molding.
- Consulting 2015 –2018 at ROI Rich Oles Industries, LLC
- Serving all industries: Automotive, medical, consumer, electronics, housewares, micro and miniature injections molding.
- Specializing in the thermal dynamics of plastic injection molding and thermal imaging.
- President/CEO 2018-Current at **ALBA Enterprises, LLC**

Presenter: Bill Hartwick

38 years in the injection molding industry

- Engel Canada Service 1980-1997
  -Machine Installations
  -Troubleshooting and Repairs
  -Training
- Major Automotive Molder 1997-2002
  - Project Management Setting up Greenfield facility in Toledo, Ohio area.
  - Maintenance Mgmt. Set up maintenance department and implemented PM program
- Hydraulics Repair House (Toronto, Canada) 2002-2008
  - In house repair service
  - Set up customer service & repair department
- Opened **Filter Specialties Co**. 2008- Present
  - Providing machine troubleshooting to all makes of machines
  - Hydraulic repairs
  - Electrical/ electronic troubleshooting
  - All molding machine Mechanical including service on;
    - Screws, barrels
    - Toggles & tie bars
    - Control system retrofits and servo- hydraulic pump installs
    - Hydraulic filters and oil analysis programs for predictive maintenance.

Thank you.

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The Home of Scientific Molding

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ALBA ENTERPRISES

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FILTER SPECIALTIES CO.

Bill Hartwick

Cell: 416-709-4454
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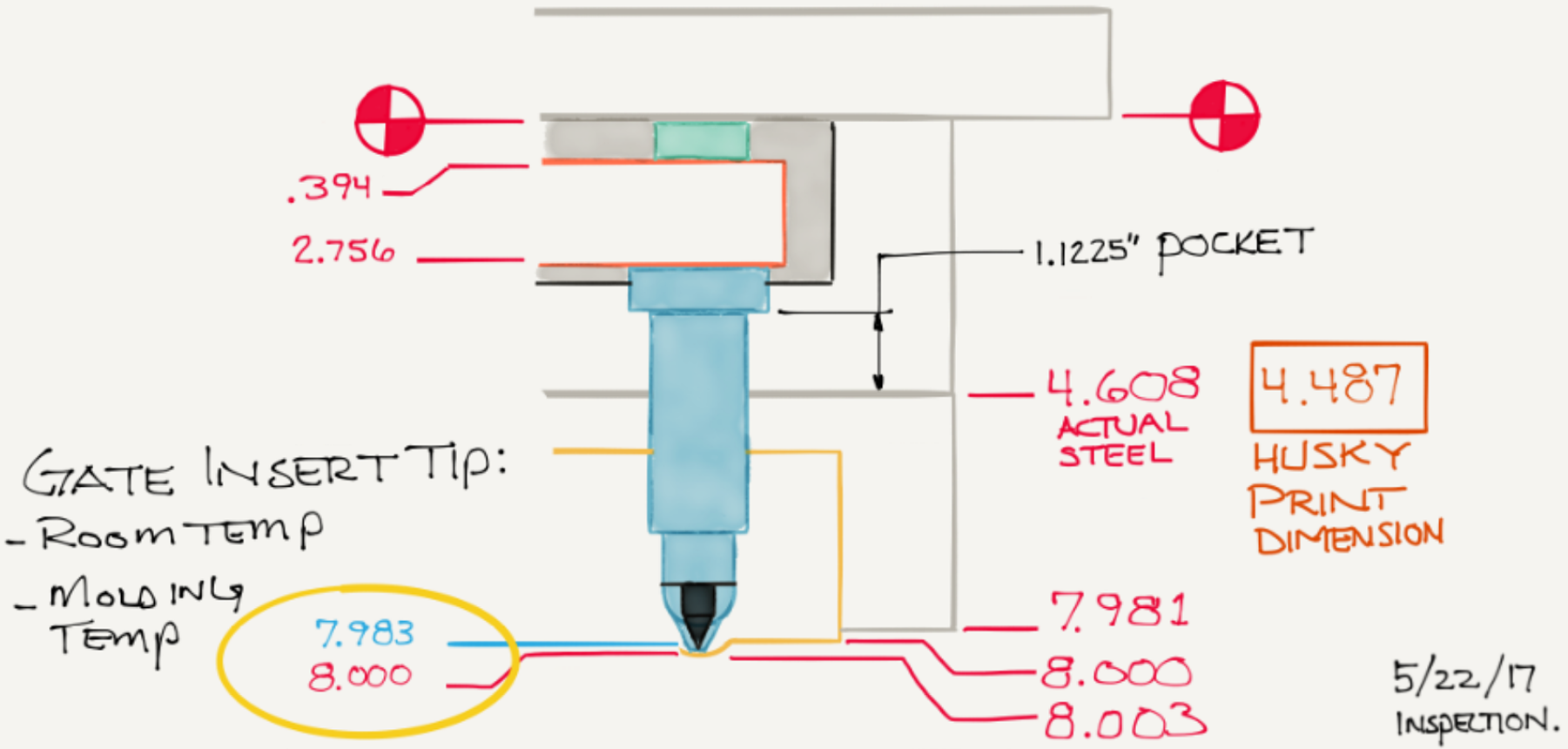
www.FilterSpecialties.com

Just the Facts Please



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