RTP Co.
Imagineering Plastics®

THERMOPLASTIC ELASTOMERS • STRUCTURAL • WEAR
CONDUCTIVE • COLOR • FLAME RETARDANT

High Performance Plastics for Pumps and Fluid Handling Applications

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ISO 9001

Agenda

- **Overview of RTP Company**
- **Pump Types/Applications**
- **High Performance Pump Compounds**
- **Key Technologies**
  - Very Long Fiber Reinforcement
  - Wear & Friction Resistance
  - Static & ESD Control
  - Flame Retardant
- **Case Studies**
- **Additional Information**
- **Questions**

RTP Company Profile

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- RTP Company is an independent, privately owned custom compounder
- Global manufacturing and engineering support
- Worldwide sales representation/distribution
- Established in 1982
- 1000+ employees
- $400+ million annual sales

Custom Solutions

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **High-Tech Specialty Compounder**
  - 60+ engineering resins
  - 100+ modifiers
- **Annual Production**
  - 6000+ commercial products
  - 1750+ new products each year

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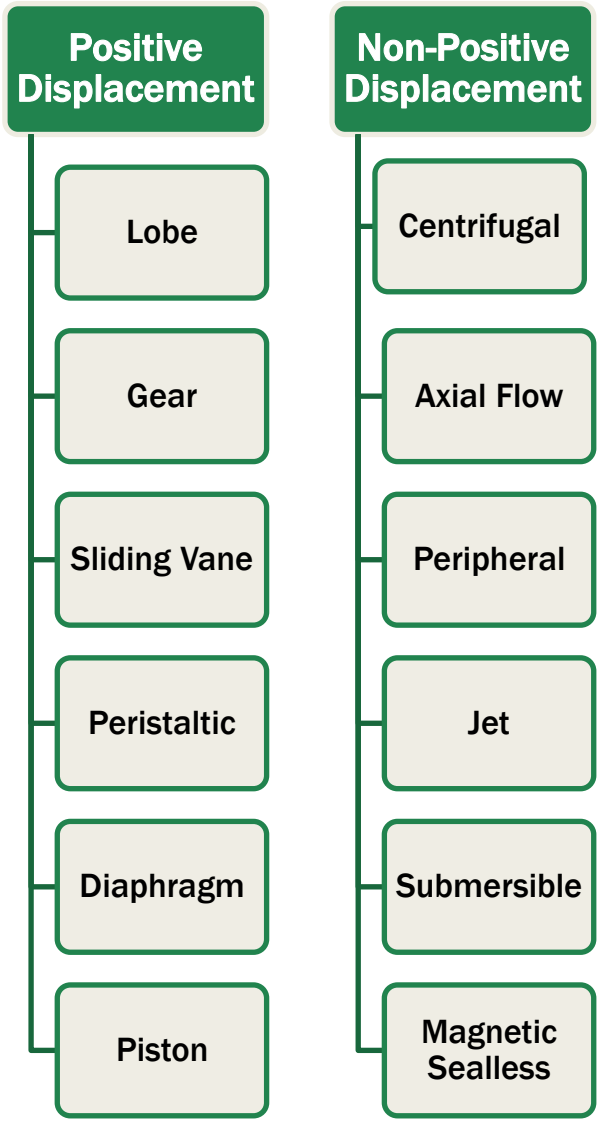
- **Are you currently utilizing plastics in your pump products or plan to in the next 12 months?**
  - Yes
  - No

Pumps Types

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Products pumped**
  - Water
  - Chemicals
  - Fertilizers
  - Fuels
  - Petroleum products
  - Paints and Inks
  - Medicine



Pump Applications

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

- **Engineered plastic compounds**
  - Pump Housings
  - Propellers
  - Impellers
  - Diffusers
  - Rotors and Vanes
  - Housing Liners
  - Gears and Lobes
  - Seals
  - Containment Shells
  - Bushings
  - Valves

- **What is your main motivation for using or considering plastics?**
  - Cost benefits vs metal
  - Manufacturability
  - Chemical/corrosion resistance
  - Lightweight

Plastics in Pumps

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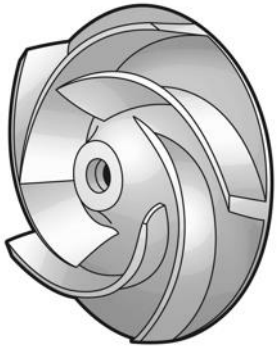
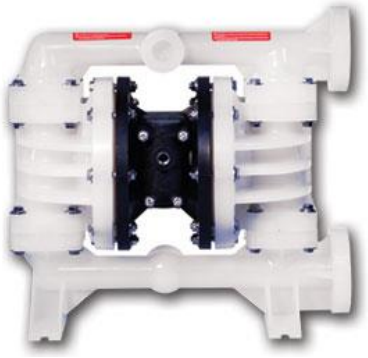
Advantages	Limitations	Considerations
• Chemical Resistance • Light Weight • Manufacturability • Cost	• Flammability • Wear • Strength/Impact • Conductivity • Continuous Use Temp.	• Products Pumped • Operating Temp. • Conditions of Use • Regulatory Constraints • Economics





- **What is your biggest challenge to implementing plastics in your pump designs?**
  - Flammability
  - Strength/Impact
  - Wear resistance
  - Conductivity
  - Temperature requirements
  - Chemical resistance

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Pump Compound Formulation

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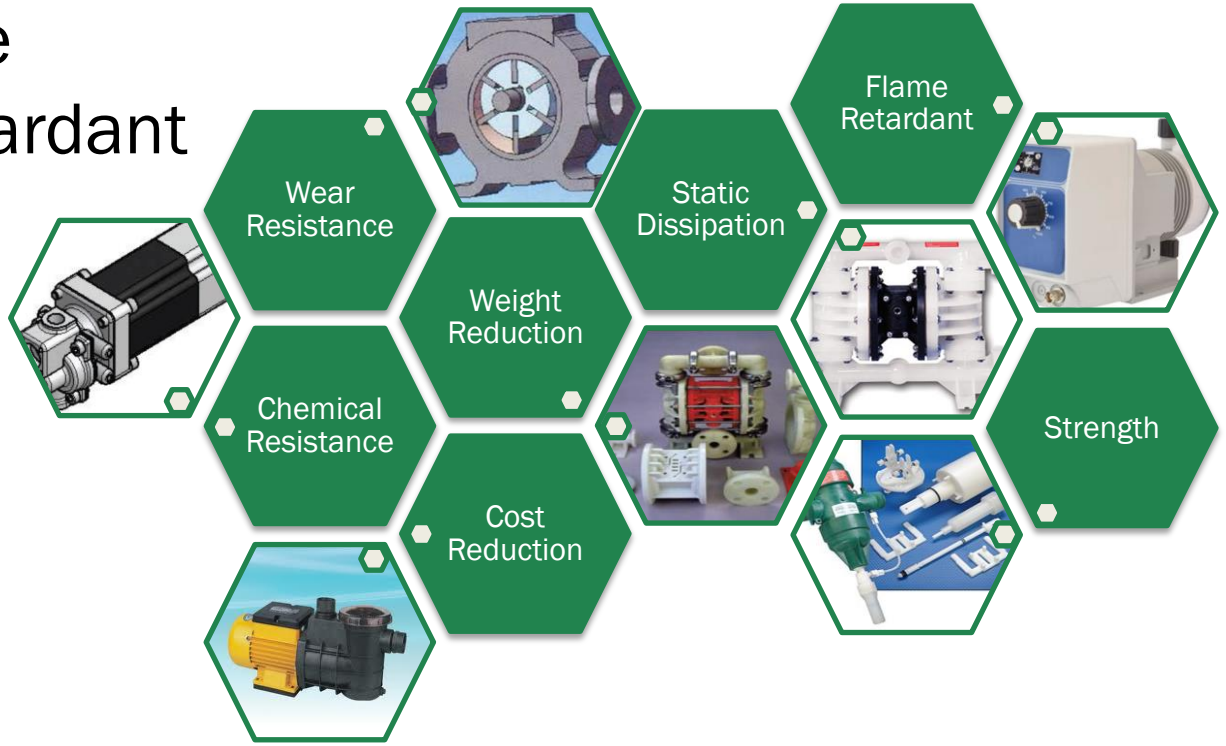
Resin	Reinforcement	Additive
• PP • Nylons • PBT • PPS • Fluoropolymers • PEEK • Urethane • Acetal • PPA	• Short Glass • Long Glass • Carbon Fiber	• Graphite • PTFE • Silicone • PFPE • Aramid Fiber • Ceramic • Flame Retardant • Carbon Black

- **Key Technologies**
  - Structural
  - Wear
  - Conductive
  - Flame Retardant
  - Elastomer
  - Color



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Structural Products

FILLED • REINFORCED • DENSITY MODIFIED

- **Filled**
  - Talc
  - Minerals
  - Ceramics
  - Nanoclay
- **Fiber Reinforced**
  - Glass fiber
  - Carbon fiber
  - Natural fibers
- **Density Modified**
  - Lightweight
  - High gravity
- **Impact Modification**

Ultra Performance Structural Products?

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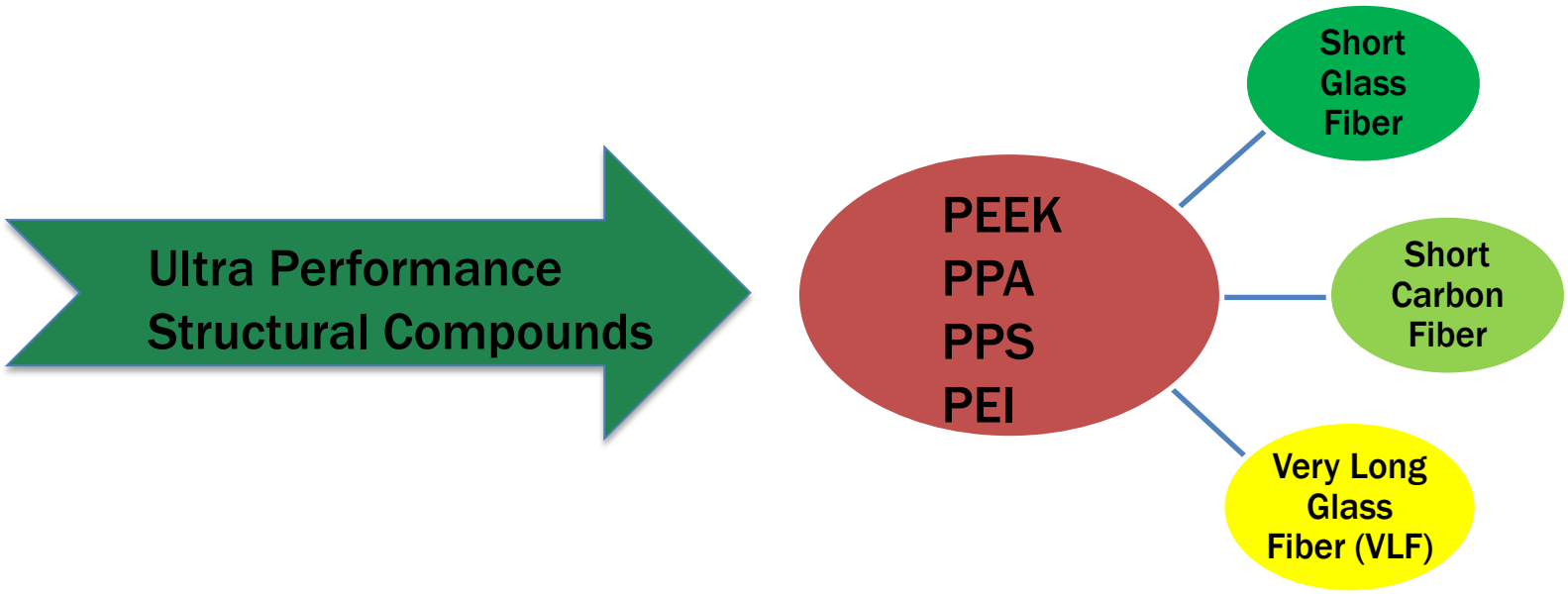

1. 10-35% improvement to the High Temperature product portfolio that is already the highest performing in the industry!
2. PPA and PPS w/CF products that exceed the tensile and flexural properties of competitive products by 30-40%
3. 40%CF PEEK product that competes with Victrex 90 HMF 40
4. VLF products have 3-4 times the impact of short glass products

Very Long Fiber

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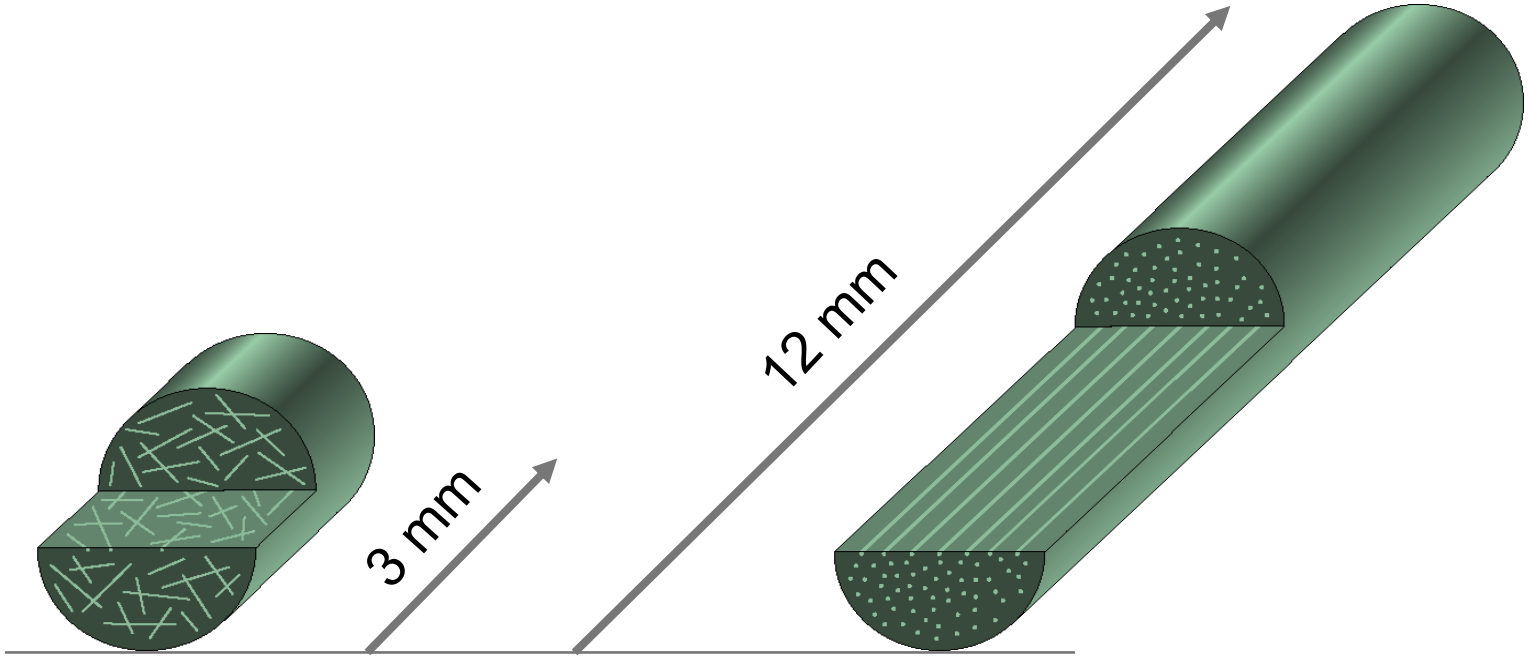

Fiber length

~1 mm **12 mm**

Very Long Fiber

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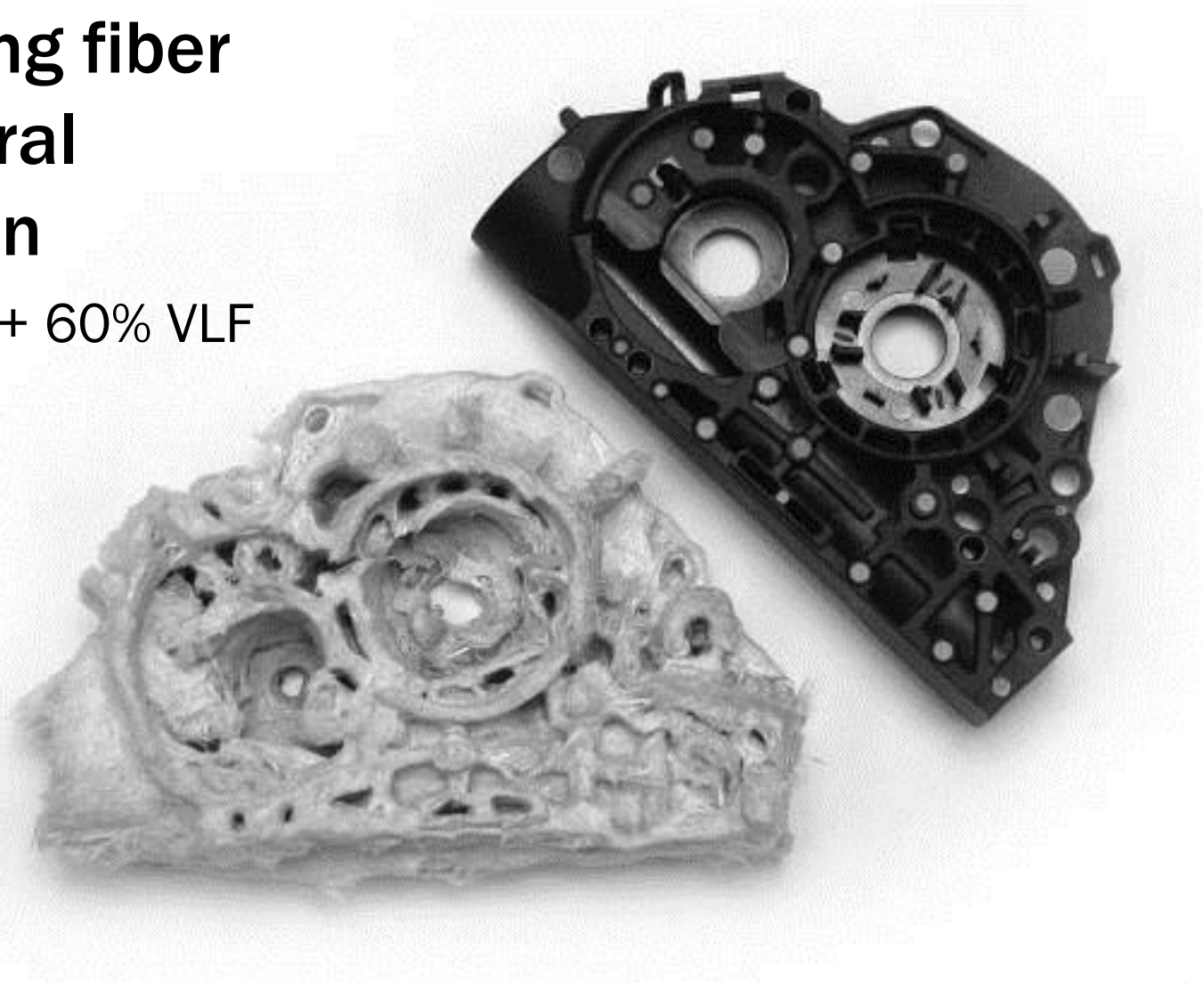
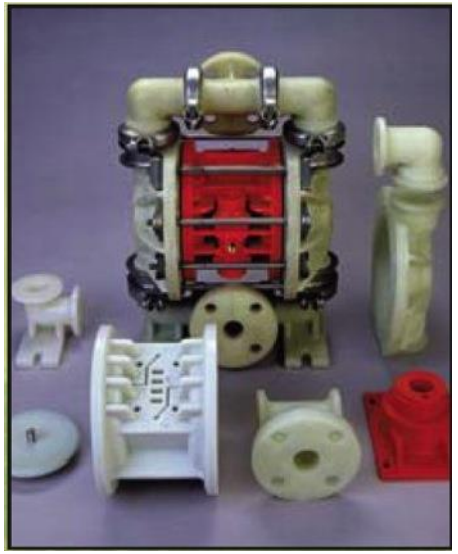
- **Very long fiber structural skeleton**
  - PA 66 + 60% VLF



- **In both hot and cold environments**
  - Stiff and tough!
  - Extremely high impact resistance
  - Dimensional stability and warp resistance
  - Retain stiffness as temperature increases
  - Excellent creep resistance
  - Lightweight vs metal



Very Long Fiber

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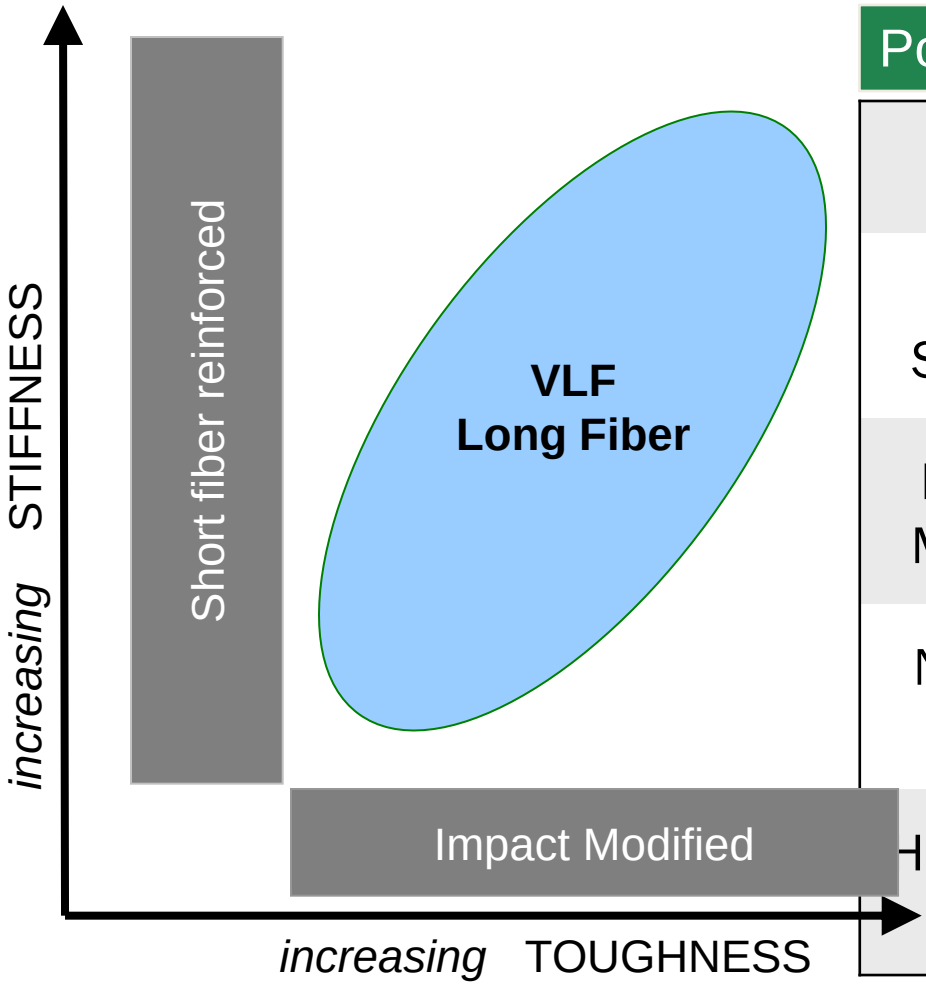
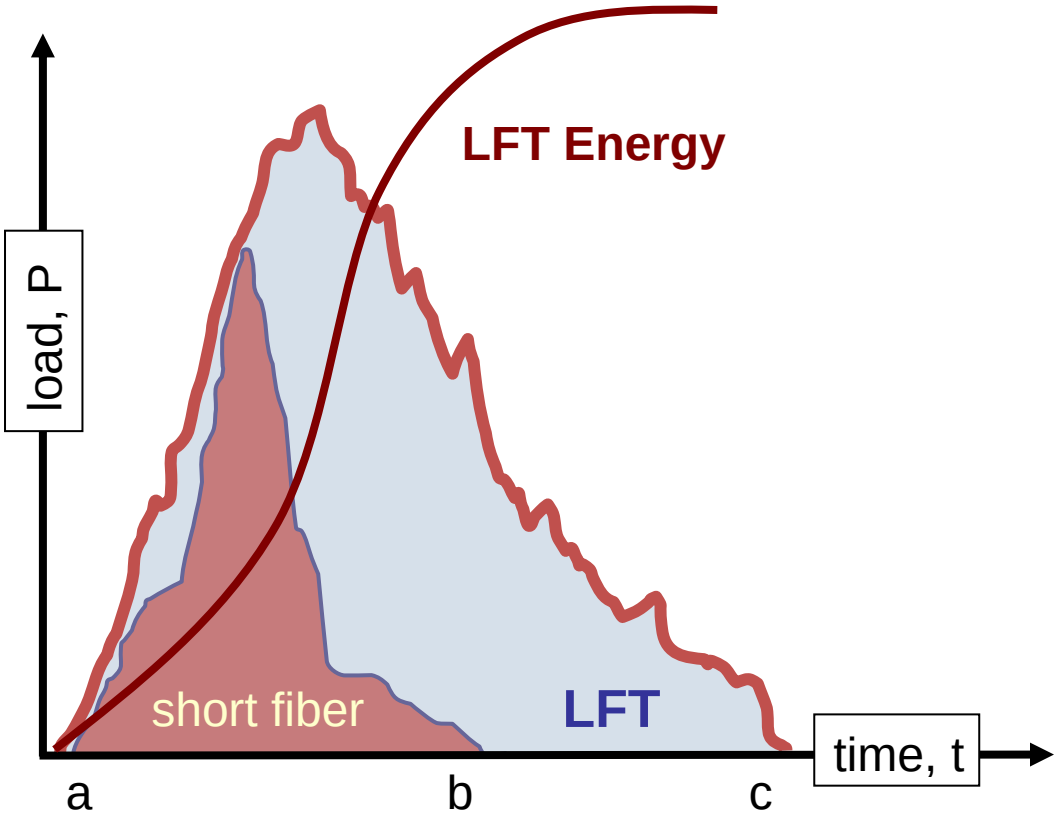
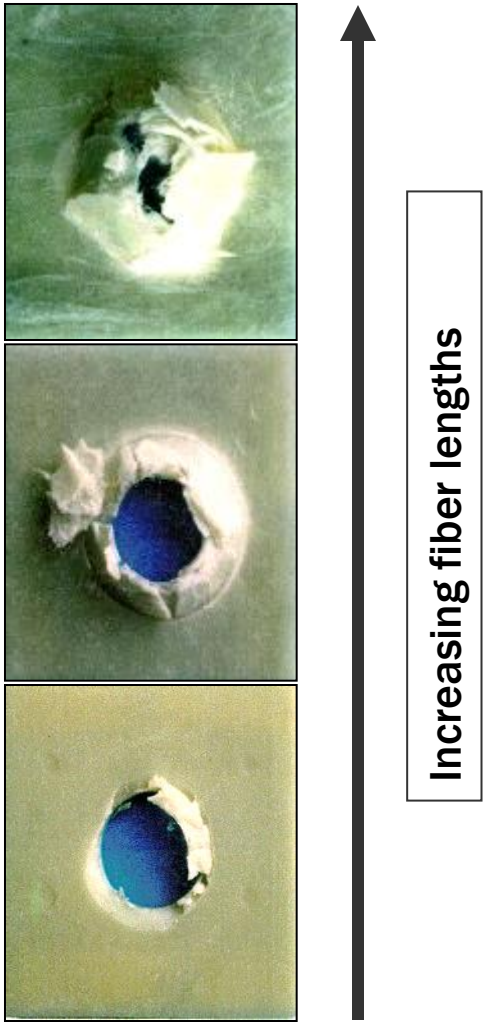


Polypropylene with 40% glass fiber	short	LONG
Tensile Strength	90 MPa	120 MPa
Flexural Modulus	6.90 GPa	8.25 GPa
Notched Izod	100 J/m	270 J/m
HDT @ 1.8 MPa	140 °C	155 °C

Impact energy absorption

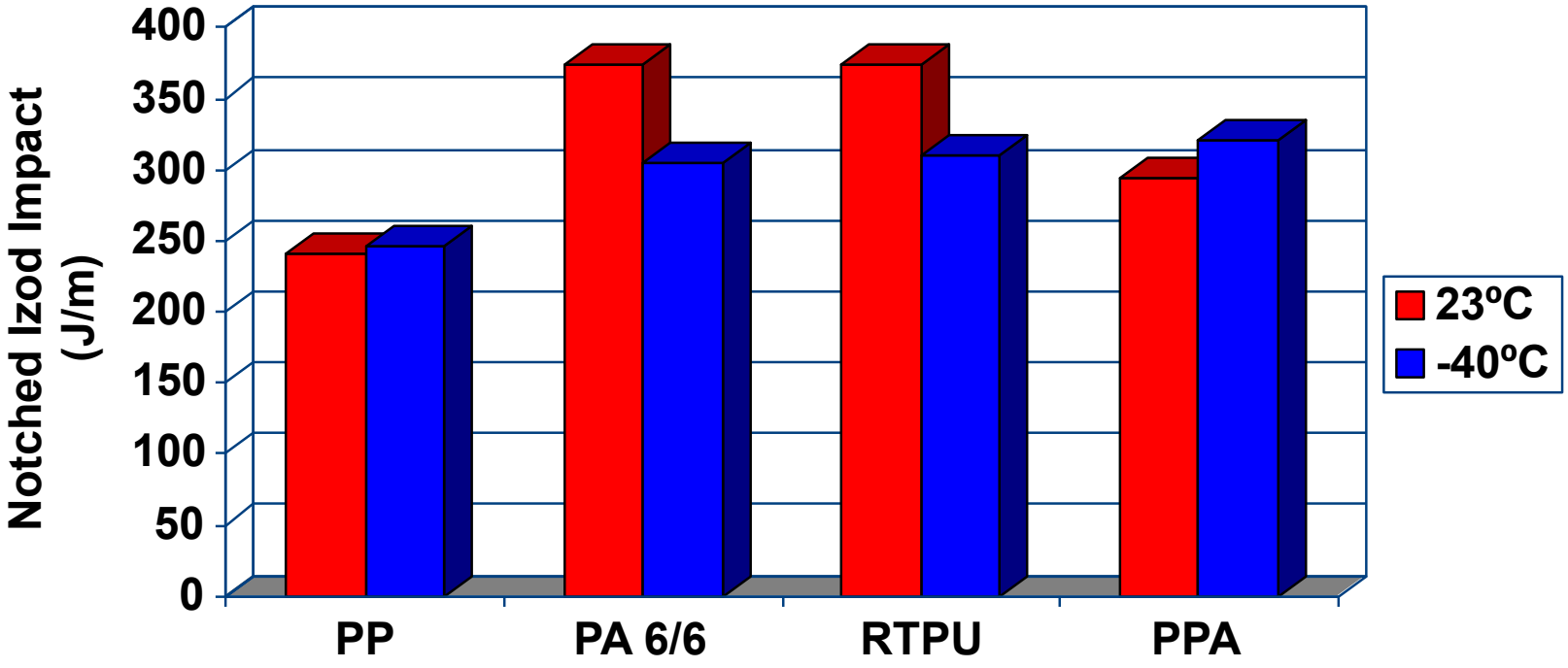


$$\text{LFT Energy} = \int_c^a Pv\,dt$$



VLF Parts Maintain Durability at Low Temp

50% VLF



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Wear & Friction Resistance

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Additive technologies

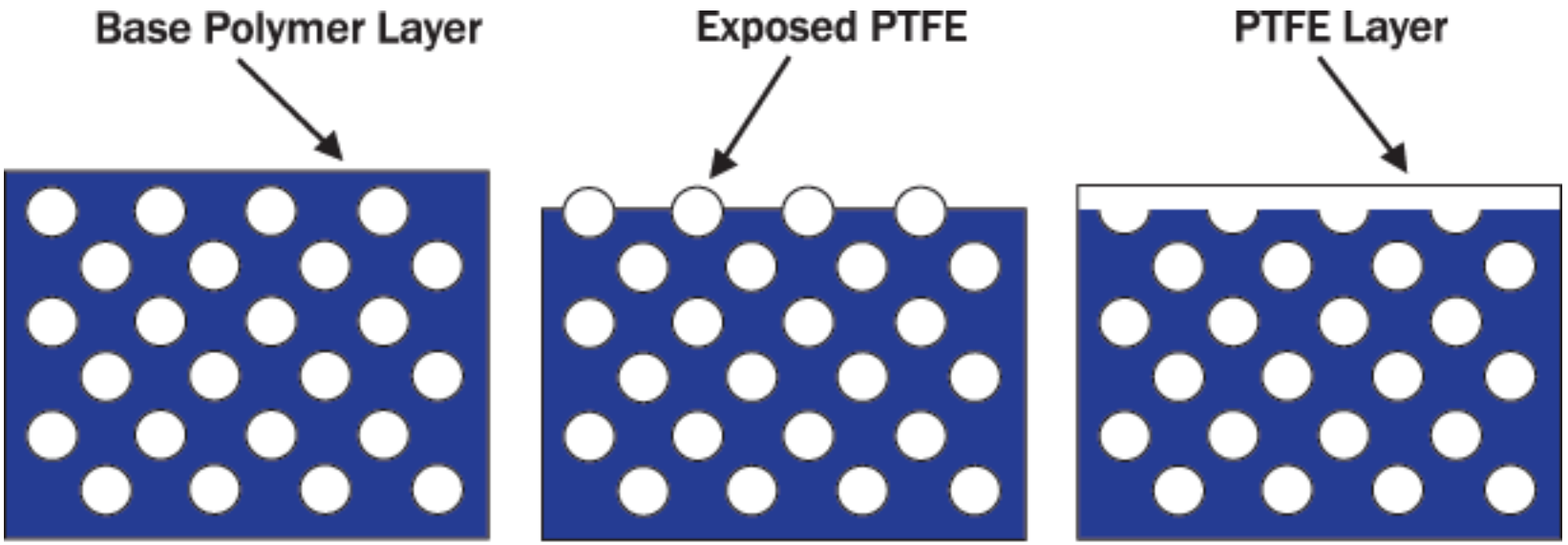
PTFE – Polytetrafluoroethylene (5-20%)

- Workhorse additive – solid white powder
- Homogeneously distributed throughout the polymer matrix
- Forms a lubricious layer at polymer surface – requires a "Break-in" period
- Compatible with nearly all thermoplastic resins

Limitations

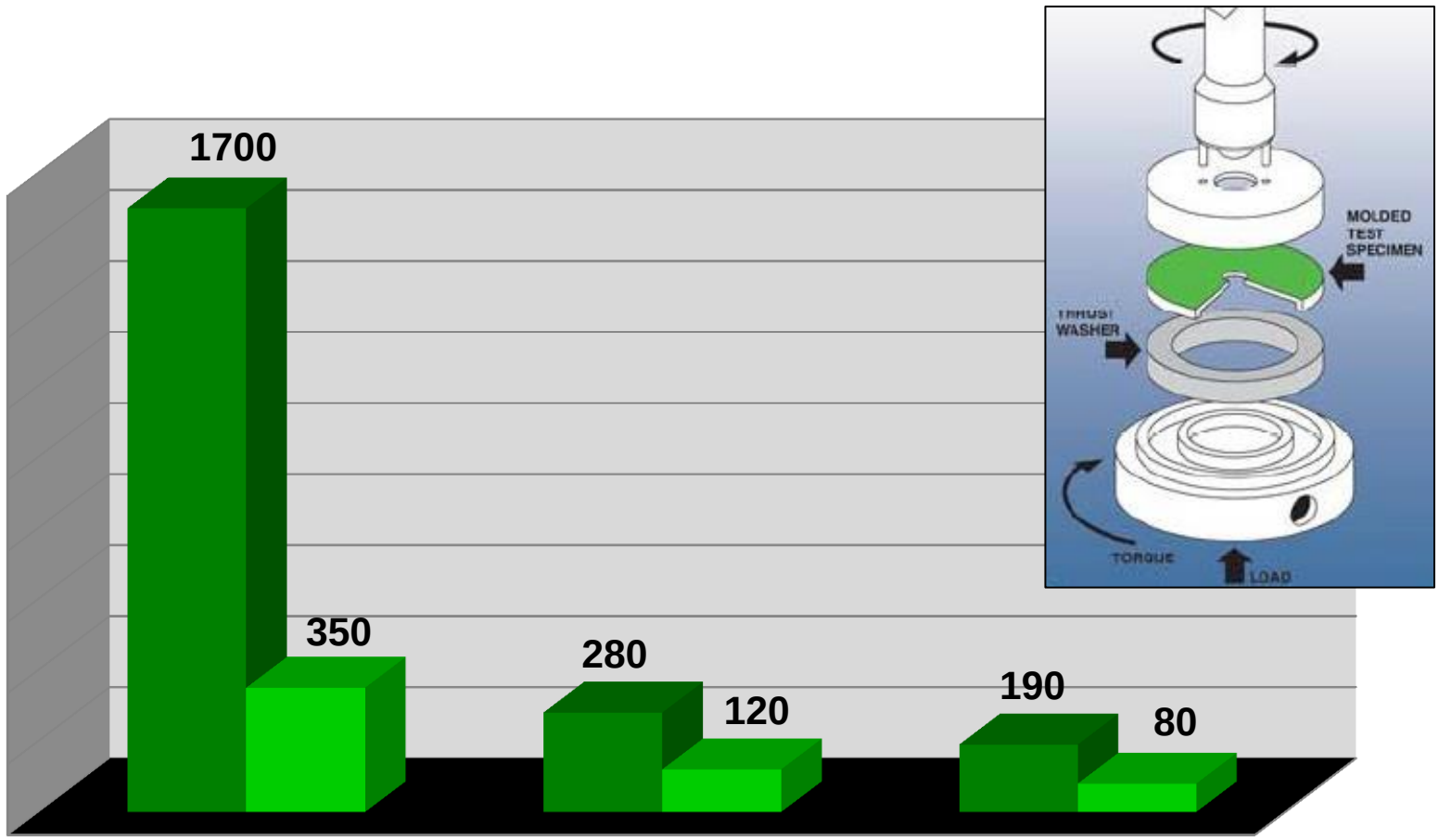
- Fluorine content
- Die plate-out
- Relatively high loadings
- Becoming very expensive

PTFE Wear Mechanism



Wear & Friction Resistance

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



Wear Factor per ASTM D3702 against steel; PV=70 (kPa m/sec)

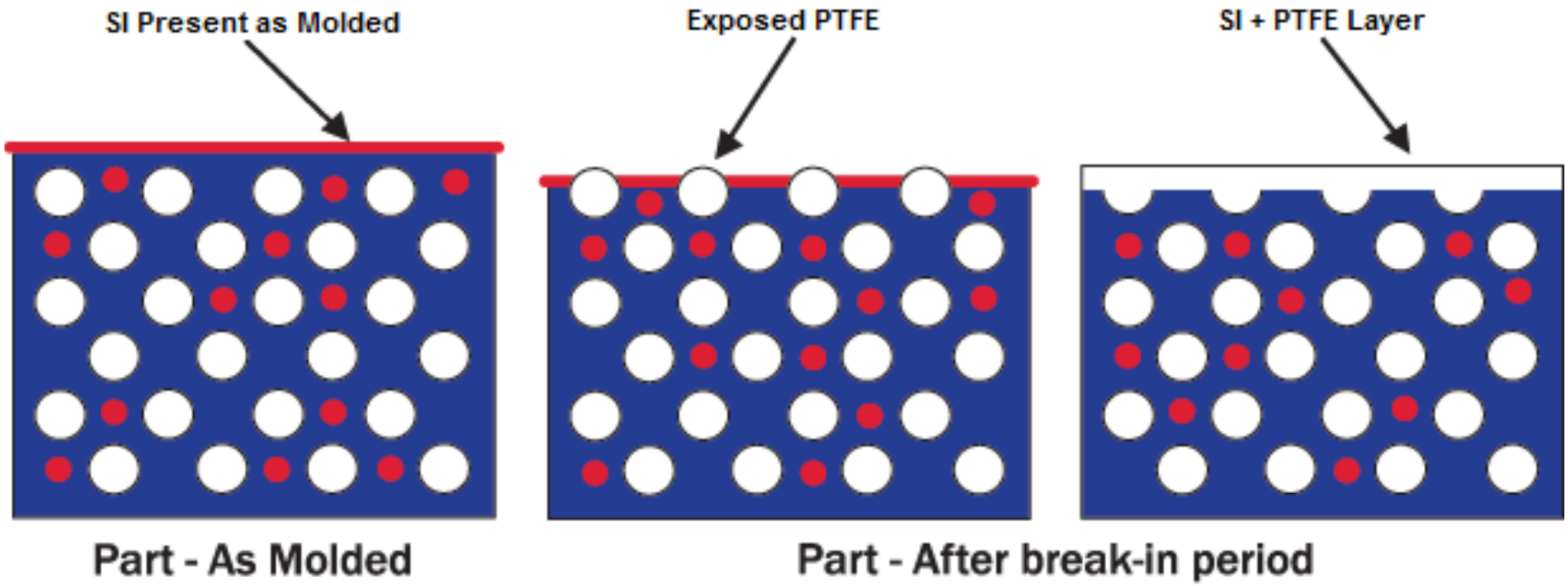
Silicone – Polydimethylsiloxane (1-3%)

- Boundary lubricant which migrates to the surface over time
- Migration rate is viscosity dependent
- Excellent friction reducer
- Best in high speed/low load applications
- Used with PTFE to eliminate "Break-in" period

Limitations

- **Limited use in decorated parts**
  - Poor adhesion of paint or print inks
- **Bad for electrical applications**
  - Can foul contacts

Silicone Wear Mechanism



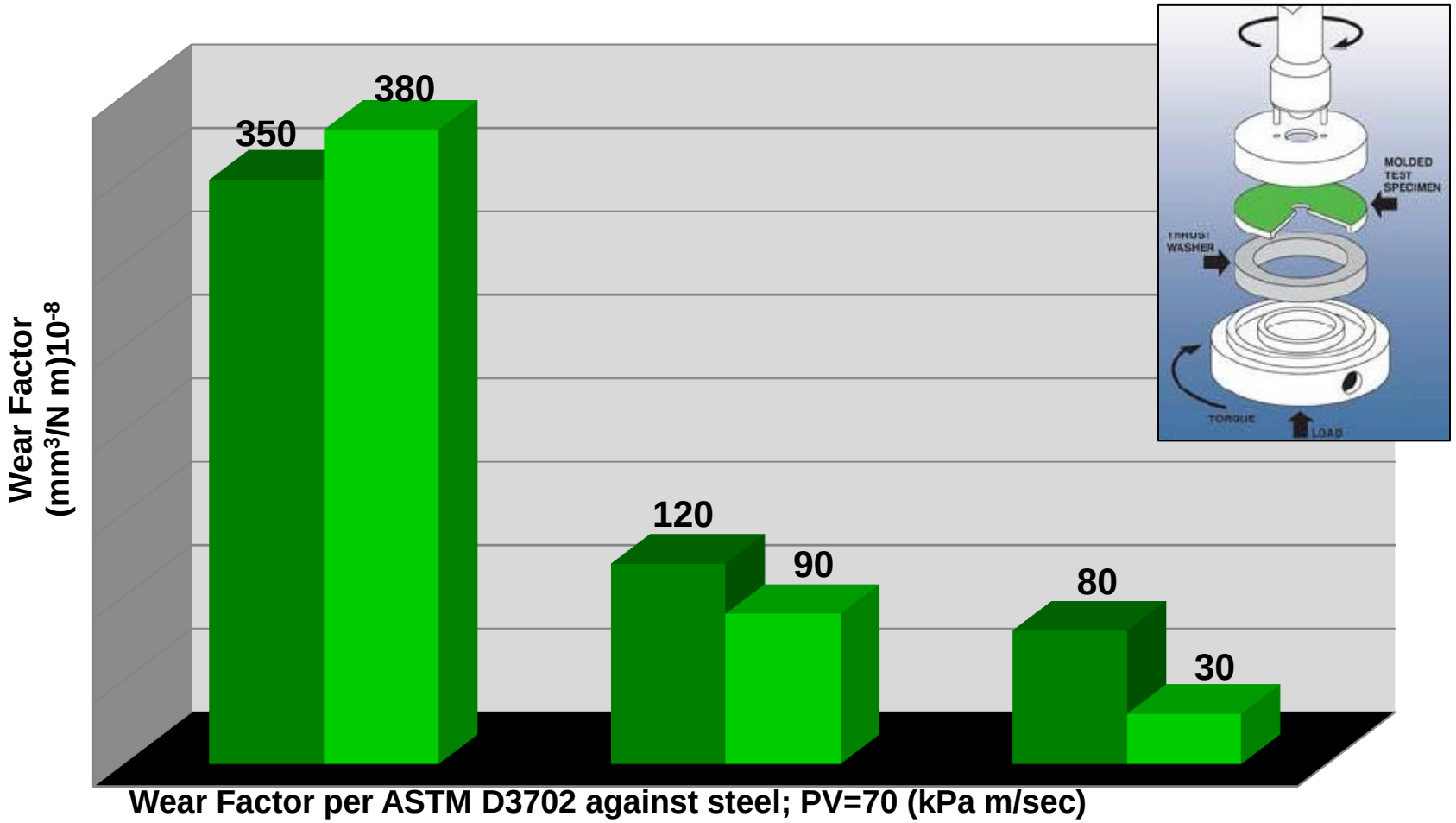
PFPE – Perfluoropolyether Oil (< 1%)

- Thermally stable up to PEEK processing temps
- Differentiates RTP Company from others
- Physical properties maintained
- Minimized die plate-out
- Synergy with PTFE
- Specific gravity benefits
- Improved fatigue resistance

Limitations

- Limited effectiveness in amorphous resins
- Needs PTFE “kick” to deliver optimum friction reduction

PFPE Allows For A Reduction In PTFE Loadings



Wear & Friction Resistance

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Graphite Powder (5-30%)

- Aqueous environments
- Excellent temperature resistance
- Black color

Molybdenum Disulfide - MoS_2 (1-5%)

- Nucleating agent in nylons: creates harder surface
- High affinity to metal
  - Smoother mating surface = lower wear

Limitations

- Limited use
- Dark color limits colorability
- Sloughing type additives

Reinforcing Fibers

Glass Fiber

- Improved bearing capabilities/wear resistance
- Very abrasive

Carbon Fiber

- Higher bearing capabilities
- Excellent thermal resistance
- Conductive
- Less abrasive

Aramid Fiber

- Little strength improvement
- Very gentle to mating surface

Wear & Friction Resistance

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Fibers protect the polymer, but may be abrasive against the mating material

Glass

Carbon

Aramid

Aluminum Contact Surface

"Ultra" Wear Compounds

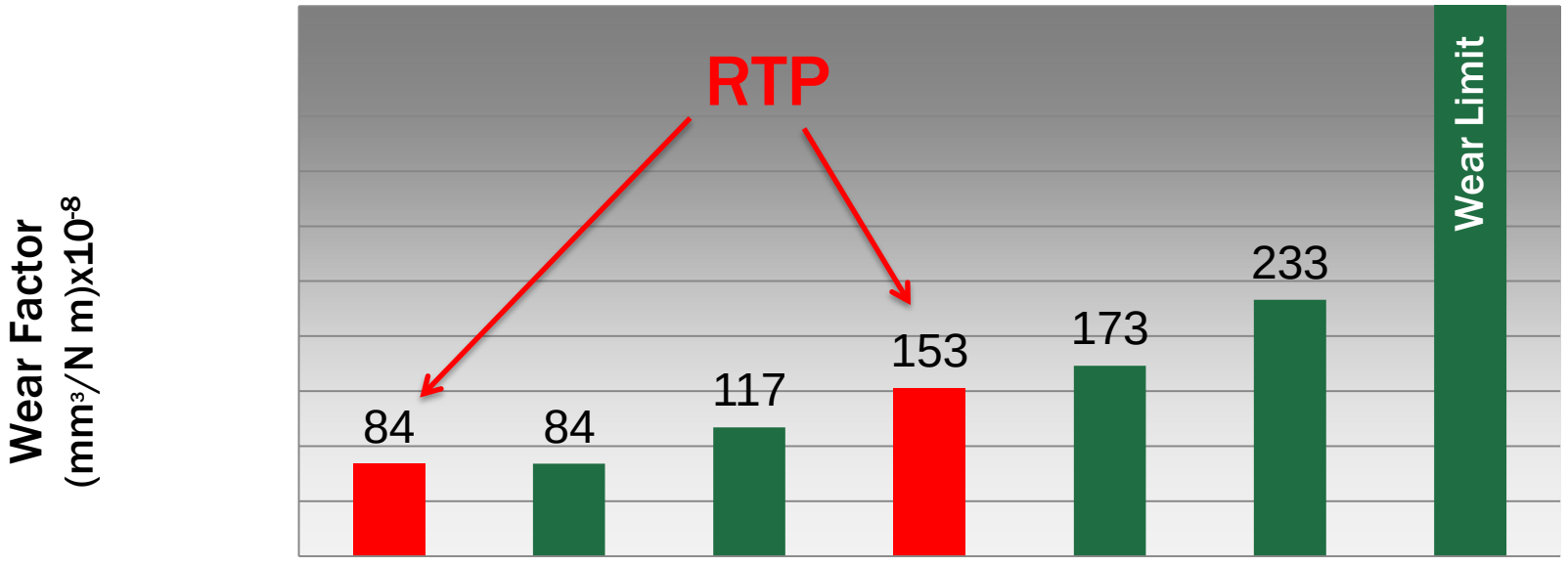
- **Demand for materials to withstand extreme conditions**
  - Typical PV = 70 to 350 (kPa m/sec)
  - What about 350+
  - High temperature
  - Chemical environments

- **RTP Company has investigated high temperature resins and wear additive combinations to compete in these environments**

Ultra Wear Advantages

Injection Moldable	• Vespel® (TPI) and Rulon® (PTFE) available in stock shapes only • Torlon® (PAI) requires extensive post curing
Outstanding Wear	• At high PV combinations of 1750 + (kPa m/s) • At room and elevated temps (204°C)
High Strength	• Stiffer and stronger than Rulon® (PTFE) • Similar strength and notched izod impact vs Torlon® (PAI) and Vespel® (TPI)

"Ultra" Wear Data (Elevated Temperature)



Wear per ASTM D-3702 against Steel at **204° C (400°F) ; PV = 1750 kPa m/sec**

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Static & ESD Control

ANTI-STATIC • STATIC DISSIPATIVE • CONDUCTIVE • EMI/RFI SHIELDING

Anti-Static Compounds

- All-polymeric
- PermaStat®
- Prevents accumulation of static charge

Static Dissipative Compounds

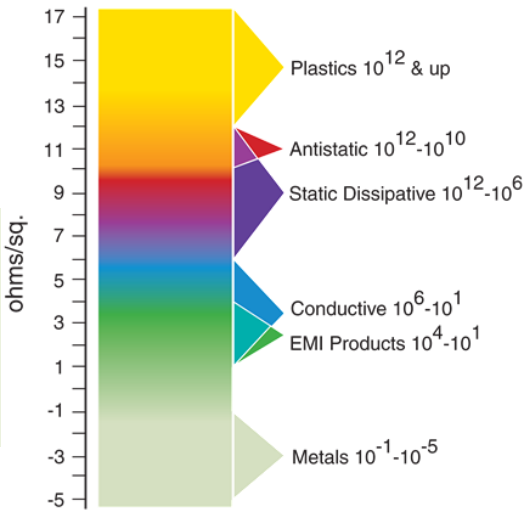
- PermaStat® Plus
- Fully colorable
- Controlled dissipation of static charge

Conductive Compounds

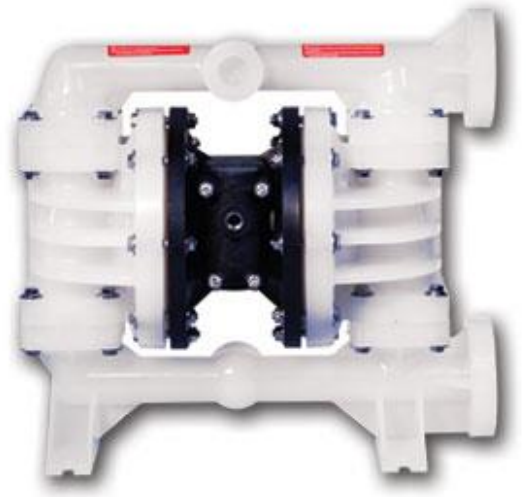
- Carbon fiber
- Carbon powders (ESD-C)
- Carbon nanotubes
- Near instantaneous charge decay

EMI/RFI Shielding Compounds

- Stainless steel fibers
- Nickel coated carbon fibers
- Absorb /reflect electromagnetic energy



What is ATEX?



- **ATmosphere EXplosive**
  - Potentially explosive environments
- **Began as a European Union directive**
  - Now seen in in Americas and Asia
- **Standards**
  - Several depending on the type of equipment
    - EN 50014
    - IEC 60079
    - UL 60079
    - FM 3610

ATEX Testing

- **Actual requirements dictated by operating environment**
- **All tests are on actual parts**
- **Tests could include**
  - Surface resistance (almost always included)
  - RTI (Relative Thermal Index)
  - Chemical resistance
  - Impact (low temperature)
  - UV
  - High humidity aging testing
  - Flame Retardance
- **Need to fully identify all requirements for proper material selection**

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Flame Retardant

HALOGEN & NON-HALOGENATED

- **Broad Technology Platform**
  - Halogen-free technology
  - Halogenated technology
- **Technology for over 30+ thermoplastic systems**
- **Meet flammability performance specifications**
- **Obtain regulatory compliance**
  - UL
  - RoHS/REACH Compliant
- **Global support**

Key Technologies-Flame Retardant

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Flammable	Inherently Flame Resistant
• Polyolefins • Nylons • Polycarbonate • Polyesters • Styrenics • TPE's	• Polysulfones • Polyphenylene Sulfide • Polyetheretherketone • Polyetherimide • Fluoropolymers

Flammable resins can be tailored with additives to impart the needed UL ratings…

UL94 V-0, V-2, 5VA

UL746 RTI, f1, electrical ratings (CTI, HWI, etc.)

Multi-Functional Flame Retardant Products

- **FR Solution to meet compliance… PLUS**
  - Reinforced options
    - Increase Modulus/Strength
    - Thinning of wall sections or carry additional loads
  - Additional functionalized stabilization
    - Increase resistance to UV, Heat, Chemical Resistance, Hydrolytic Stability
  - Increased durability and safety
    - Impact modification, added lubricity, ESD protection
  - Added Aesthetics
    - Color, transparency/diffusion

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Application Case Study

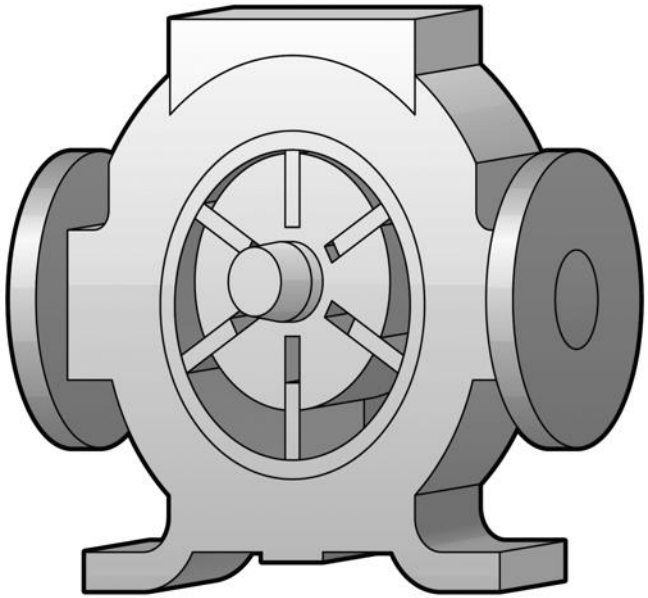
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Application: Positive displacement transfer pump

Problem: Pump must be light weight and capable of moving hydrocarbons and other chemicals.

Solution: Impeller: RTP 1300 Series PPS with carbon fiber, PTFE, and PFPE; Wiper Blade: RTP 2200 Series PEEK compound with PTFE

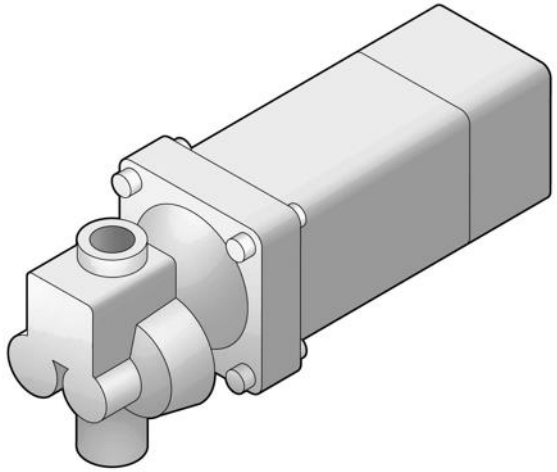
Benefit: High strength, excellent chemical and fuel resistance, superior wear and abrasion



Application Case Study

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Application: Gears in a micro pump for use in food and industrial applications. Used to transfer clean liquids at pressures up to 250 psi and flows up to 11 gallons/minute



Problem: Pump requires chemically resistant materials capable of moving a wide variety of fluids. Need high wear materials but can not utilize glass fiber

Solution: RTP 2200 Series PEEK with carbon fiber, aramid fiber, and PTFE

Benefit: Excellent chemical resistance, high strength, wear resistant, lower abrasion than glass versus mating materials

Application Case Study

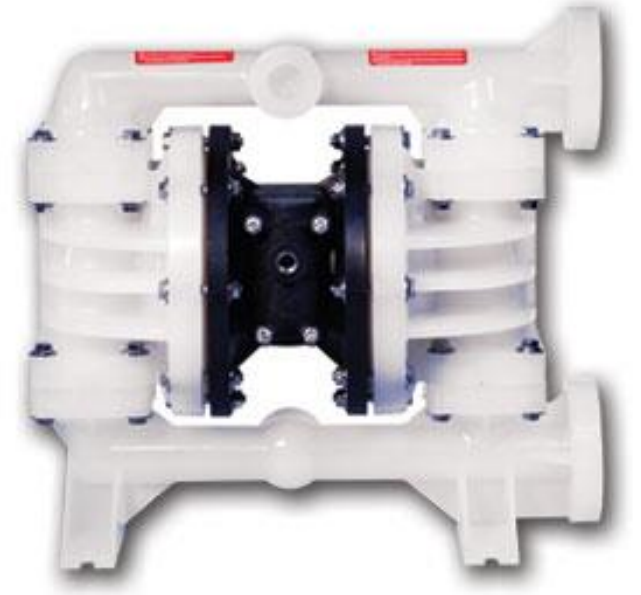
YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Application: Housing for an air operated diaphragm pump used to move a variety of liquids in mining operations

Problem: Pump must be lightweight, chemically resistant, and ATEX compliant for use in explosive atmospheres

Solution: RTP 100 Series glass reinforced PP with conductive carbon powder

Benefit: High strength, low weight versus metal, good chemical resistance, static dissipative



Application Case Study

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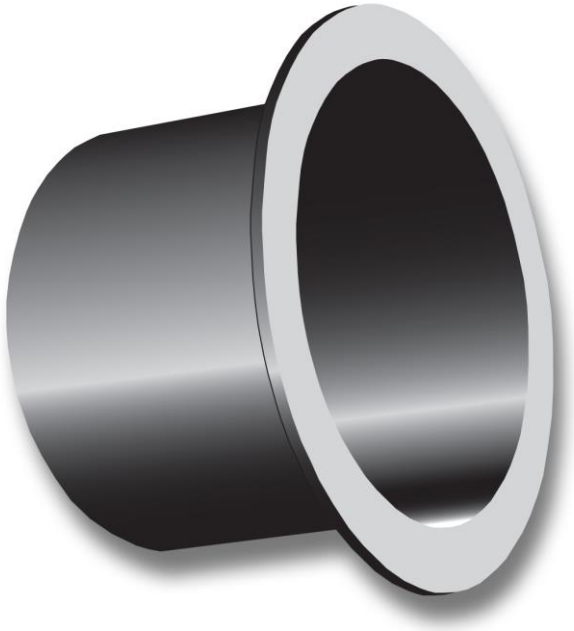

Application: Containment shell for seal less centrifugal pump

Problem: Pump must be capable of pumping a wide range of chemicals and fuels. Containments shell must have outstanding chemical resistance with high strength and impact properties

Solution: RTP 3200 Series carbon fiber reinforced ETFE

Benefit: High strength, high impact, low weight versus metal, outstanding chemical resistance versus a wide range of chemicals and fuels

Application Case Study

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Application: Control housing for metering pump

Problem: Housing must be durable and flame retardant (non-hal)

Solution: RTP 100 Series flame retardant glass reinforced PP

Benefit: Non halogenated flame retardant, good durability and chemical resistance, excellent colorability, moldability, cost effective, overmoldable

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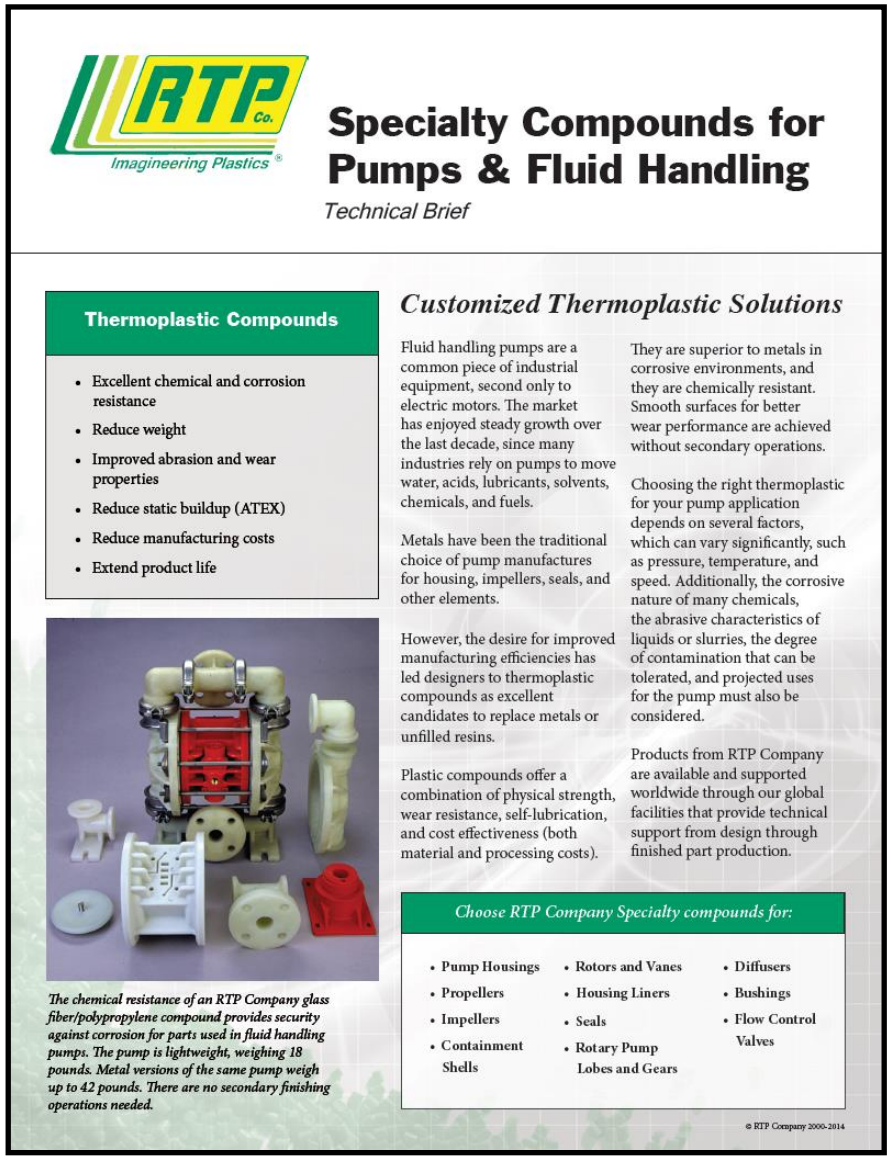

RTP Co. Imagineering Plastics

Specialty Compounds for Pumps & Fluid Handling

Technical Brief

Thermoplastic Compounds

- Excellent chemical and corrosion resistance
- Reduce weight
- Improved abrasion and wear properties
- Reduce static buildup (ATEX)
- Reduce manufacturing costs
- Extend product life

Customized Thermoplastic Solutions

Fluid handling pumps are a common piece of industrial equipment, second only to electric motors. The market has enjoyed steady growth over the last decade, since many industries rely on pumps to move water, acids, lubricants, solvents, chemicals, and fuels.

Metals have been the traditional choice of pump manufactures for housing, impellers, seals, and other elements.

However, the desire for improved manufacturing efficiencies has led designers to thermoplastic compounds as excellent candidates to replace metals or unfilled resins.

Plastic compounds offer a combination of physical strength, wear resistance, self-lubrication, and cost effectiveness (both material and processing costs).

They are superior to metals in corrosive environments, and they are chemically resistant. Smooth surfaces for better wear performance are achieved without secondary operations.

Choosing the right thermoplastic for your pump application depends on several factors, which can vary significantly, such as pressure, temperature, and speed. Additionally, the corrosive nature of many chemicals, the abrasive characteristics of liquids or slurries, the degree of contamination that can be tolerated, and projected uses for the pump must also be considered.

Products from RTP Company are available and supported worldwide through our global facilities that provide technical support from design through finished part production.

The chemical resistance of an RTP Company glass fiber/polypropylene compound provides security against corrosion for parts used in fluid handling pumps. The pump is lightweight, weighing 18 pounds. Metal versions of the same pump weigh up to 42 pounds. There are no secondary finishing operations needed.

Choose RTP Company Specialty compounds for:

- Pump Housings
- Propellers
- Impellers
- Containment Shells
- Rotors and Vanes
- Housing Liners
- Seals
- Rotary Pump Lobes and Gears
- Diffusers
- Bushings
- Flow Control Valves

- **Specialty Compounds for Pumps Tech Brief**
- **Download from RTP website**
  - www.rtpcompany.com
- **Request email copy at end of webinar**
- **Available Translations**
  - English
  - German
  - Japanese
  - Chinese

Additional Information

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- **In-depth recorded webinars on RTP Company product technologies featured in this presentation**
  - Very Long Fiber Reinforcement
  - Wear & Friction Resistance
  - Static & ESD Control
  - Flame Retardant
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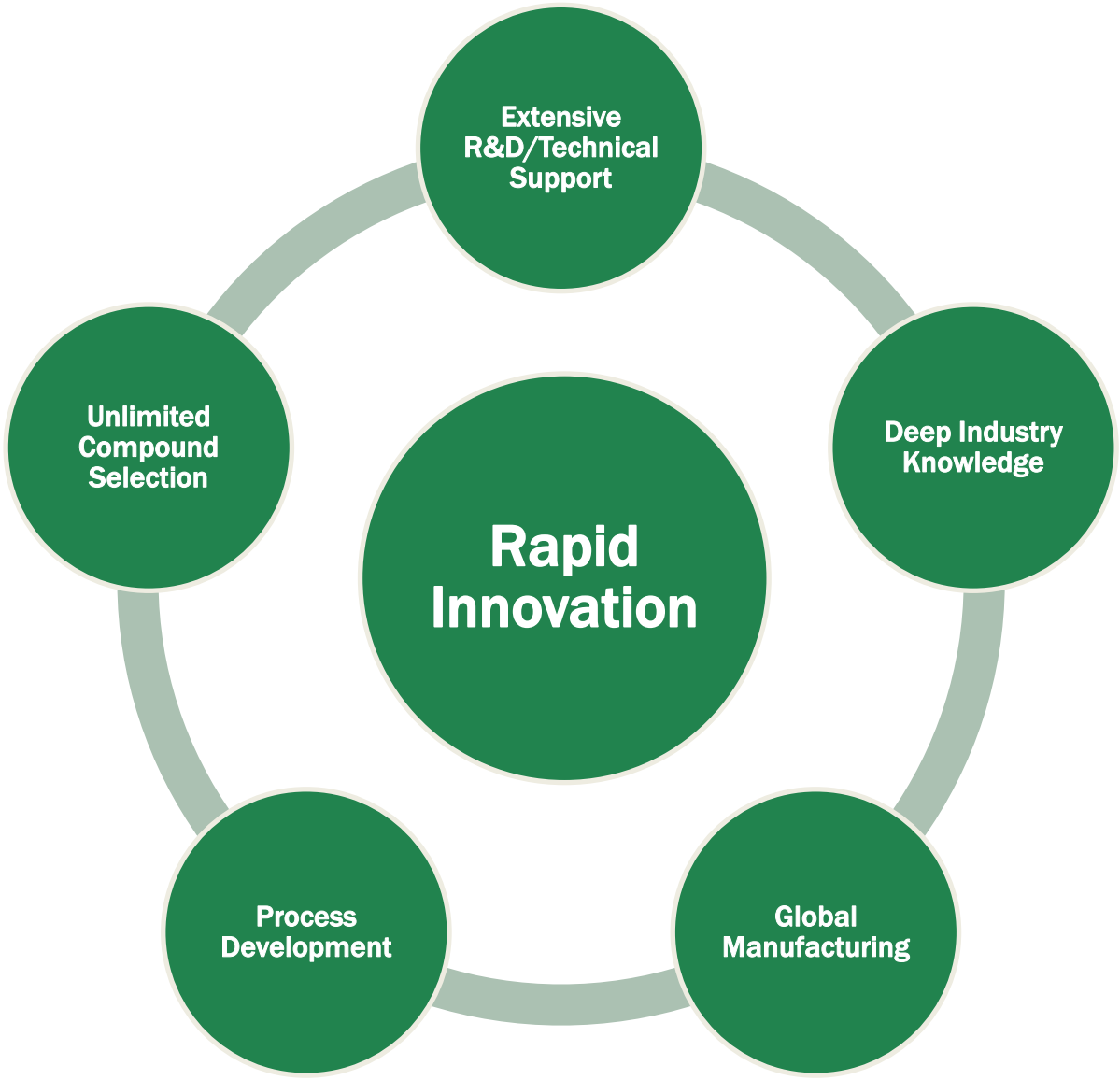
Conclusion

YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS



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