COLOR • CONDUCTIVE • FILM/SHEET • FLAME RETARDANT
STRUCTURAL • THERMOPLASTIC ELASTOMERS • WEAR

New Abrasion Resistant Compound Technology

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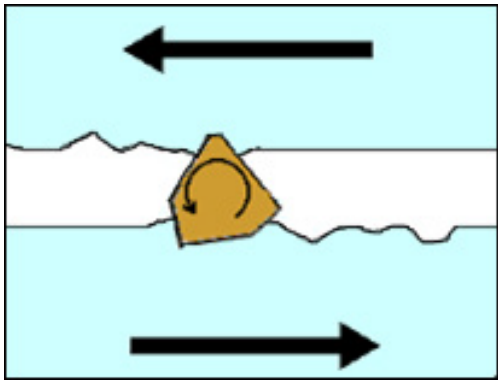
TODAY'S OBJECTIVES

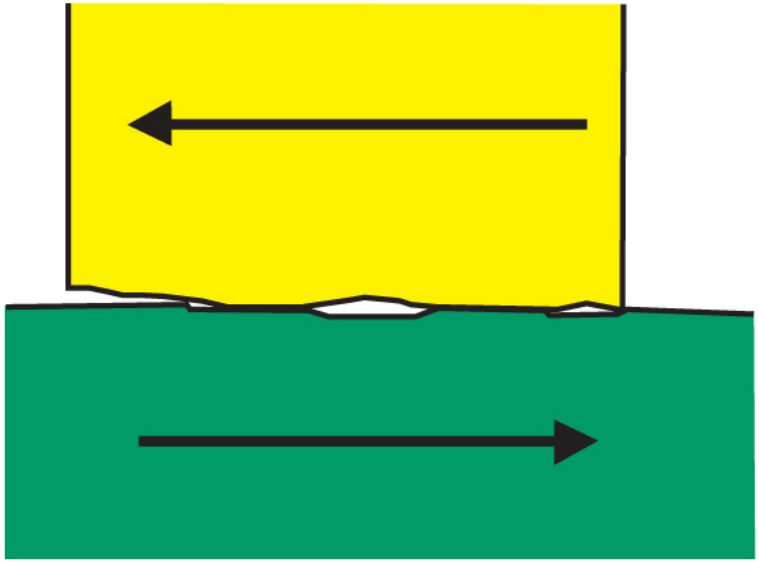
Agenda:

- What is abrasion?
- Abrasion resistant solutions
- Main industry-recognized test methods
- Test results
- Application examples
- Summary/conclusions
- Additional resources

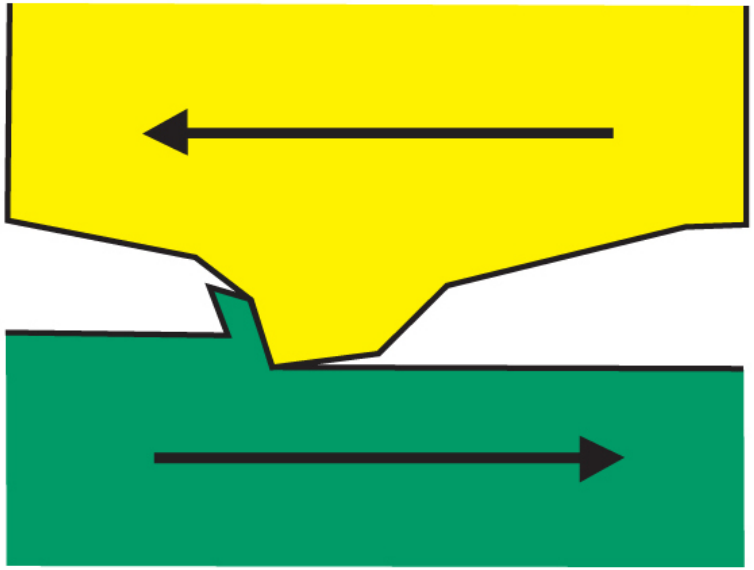


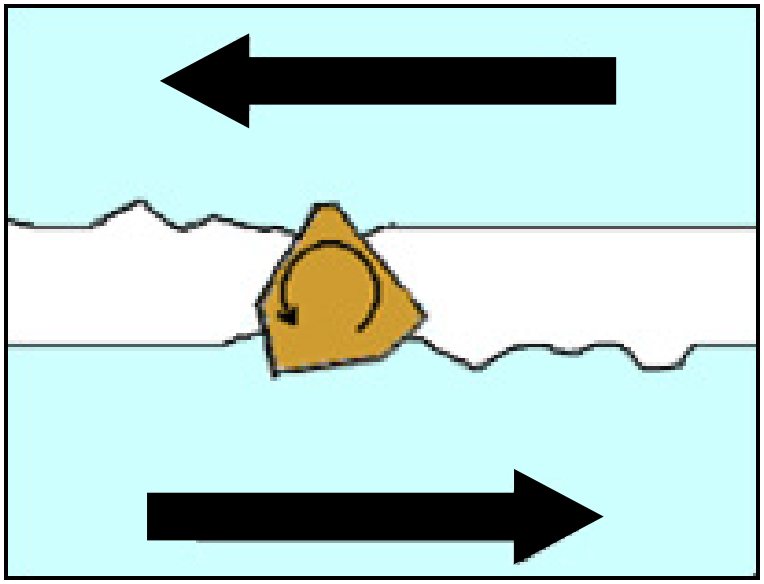
Adhesive Wear Mechanism

- The primary mechanism for thermoplastic wear
- Characterized by transfer of material from one part to the other caused by frictional heat



ABRASION IS DIFFERENT THAN SLIDING WEAR !



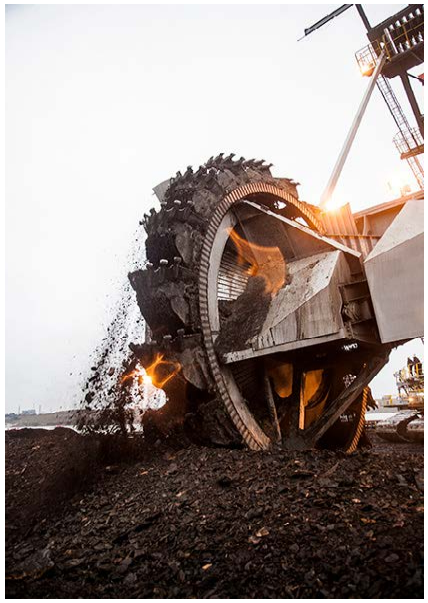


Abrasive wear occurs when a hard material scrapes or abrades away at a softer material or a 3rd party abrader is introduced.

Abrasive Wear = Loss of material over time

When are abrasion resistant material solutions needed?

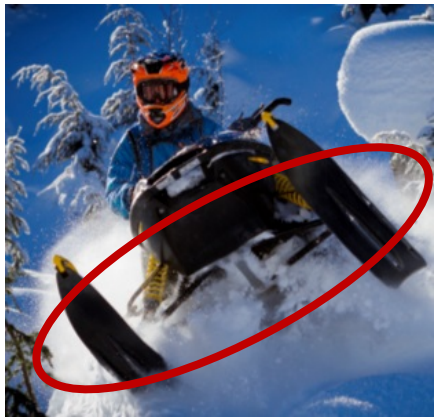
In environments where abrasion is difficult to control and predict, leading to significant or catastrophic failure and their related costs.



Abrasion Resistant Compounds (ABR)

RTP Company has developed its new ABR Series of compounds, which offer new advantages for the designer, including:

- Greater design freedom and performance properties, because they are offered in a number of resins
- Ability to injection mold or extrude the material, unlike other traditional materials that may be limited to compression, ram extrusion or machining
- Elimination of costly secondary operations
- Minimizing abrasive wear and providing excellent sliding wear and friction performance
- Competitive value pricing



ABRASION RESISTANT SOLUTIONS

COMPOUND	DESCRIPTION	POLYMER
RTP 700 ABR	Standard HDPE Abrasion Compound	PE
RTP 703 ABR	20% Glass Fiber Reinforced HDPE Abrasion Compound	PE
RTP 700 ABR GB 10	10% Glass Bead Filled HDPE Abrasion Compound	PE
RTP 700 ABR TFE 10	10% PTFE Lubricated HDPE Abrasion Compound	PE
RTP 200 ABR	Standard PA 6/6 Abrasion Compound	PA 6,6
RTP 205 ABR	30% Glass Fiber Reinforced PA 6/6 Abrasion Compound	PA 6,6
RTP 1200 S-90A	Ester-Based Thermoplastic Polyurethane Elastomer	TPUR/TPU
RTP 2300 A	Rigid Thermoplastic Polyurethane	RTPU
RTP 2305 A	30% Glass Fiber Rigid Thermoplastic Polyurethane	RTPU

COMPARATIVE MATERIALS TESTED

Our testing compares RTP Company Abrasion Compounds to industry recognized materials currently used in abrasion applications, including:

- UHMWPE
- Cast Nylons
- 304 Stainless Steel
- 6061 Aluminum Alloy

MECHANICAL PROPERTIES

	UHMWPE	RTP 700 (HDPE)	RTP 700 ABR	RTP 703 ABR
Tensile Strength, psi	5800	2900	4500	7500
Flexural Modulus, psi E^6	0.09	0.12	0.10	0.40
Notched Impact, ft lb/in	No Break	1.0	15.5(P)	5.0
Unnotched Impact, ft lb/in	No Break	No Break	No Break	15.0
Specific Gravity	0.93	0.95	0.95	1.10

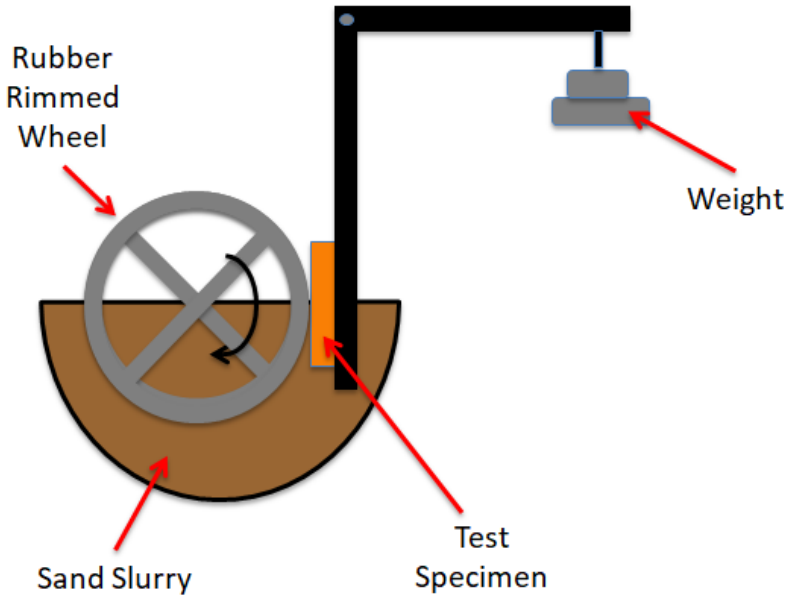
MECHANICAL PROPERTIES

	UHMWPE	RTP 200 (PA 6,6)	RTP 200 ABR	RTP 0205 (PA6,6 + 30% GF)	RTP 205 ABR
Tensile Strength, psi	5800	12000	7000	23000	17000
Flexural Modulus, psi E^6	0.09	0.40	0.28	1.25	1.02
Notched Impact, ft lb/in	No Break	1.0	1.2	1.5	2.3
Unnotched Impact, ft lb/in	No Break	20.0	No Break	15.0	14.0
Specific Gravity	0.93	1.17	1.07	1.36	1.27

ASTM G105
SAND SLURRY ABRASION TEST

Test Method:

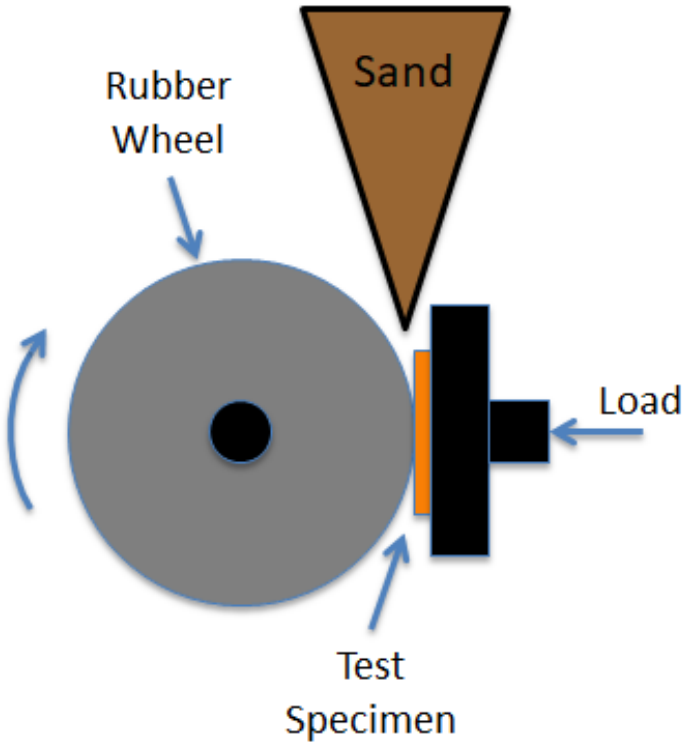
- Specimens tested against 60 Shore-D neoprene rubber wheel (1,000 cycles)
- Exposed to sand slurry
- Average Mass Loss is measured



ASTM G65
DRY SAND TEST

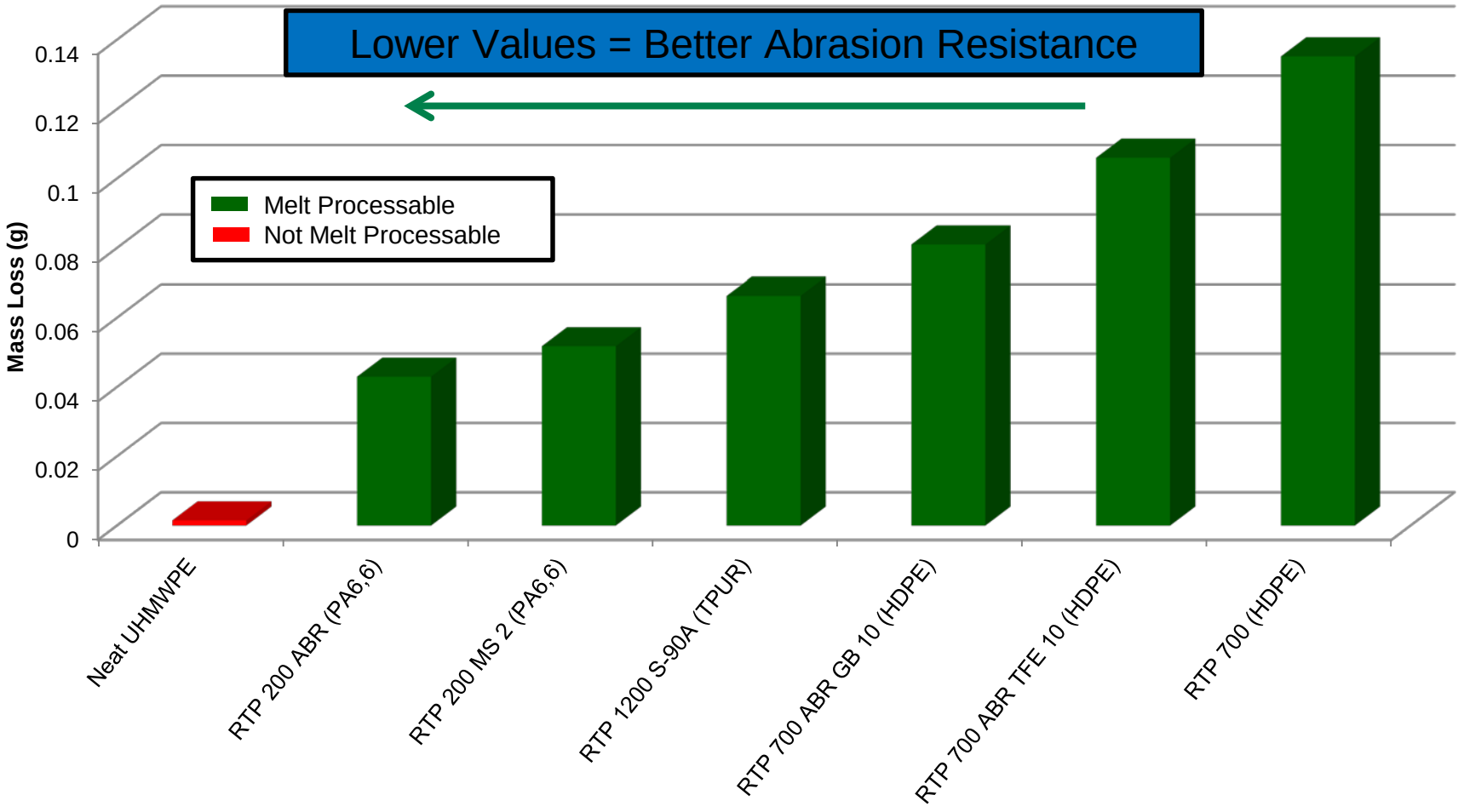
Test Method:

- Specimens tested against 60 Shore-D neoprene rubber wheel (1,000 cycles)
- Exposed to dry sand
- Average Mass Loss is measured



ABRASION TEST RESULTS

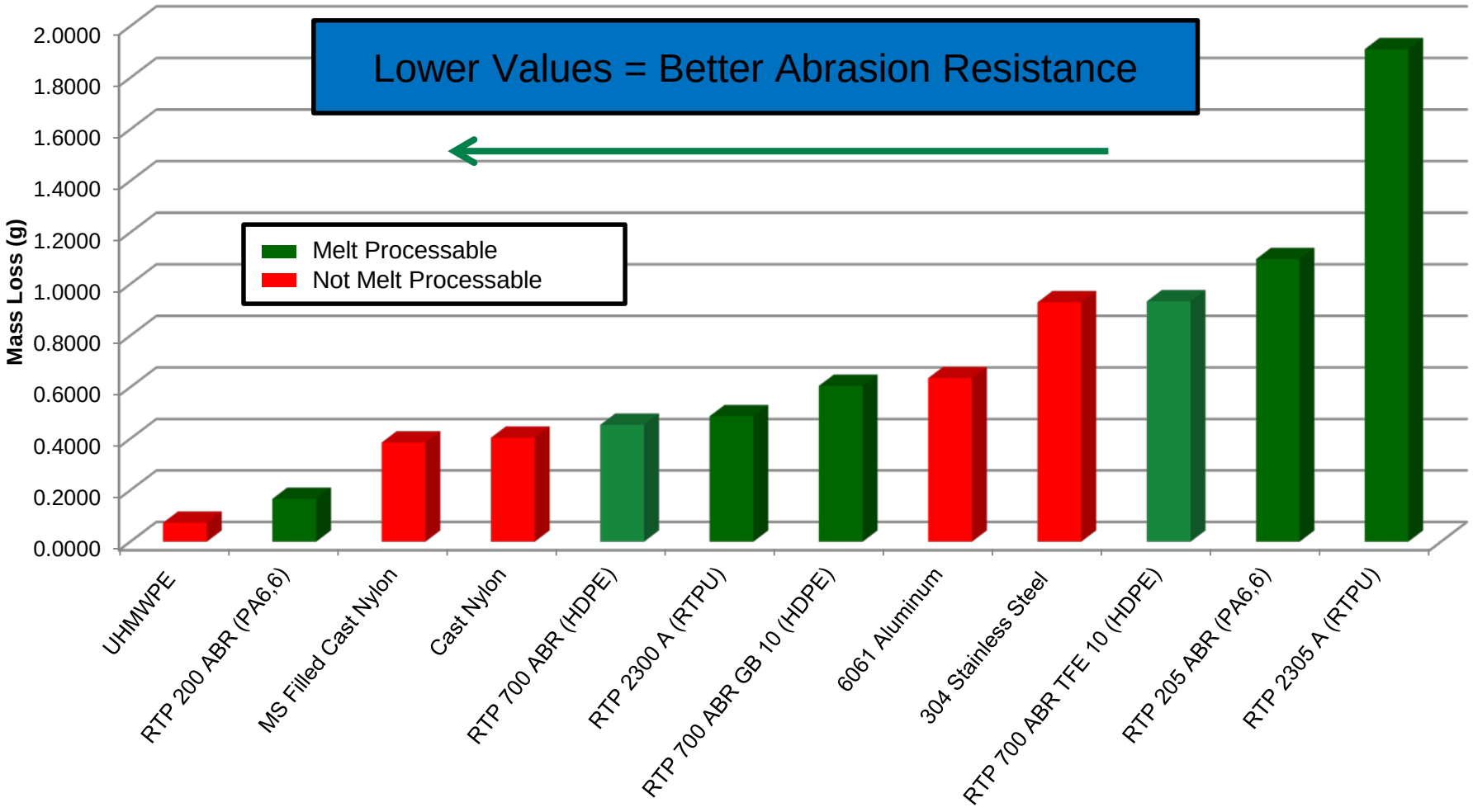
Modified ASTM G105 (Sand Slurry) Abrasion Results



Tested per ASTM G105 Sand Slurry/Rubber Wheel Abrasion Test

ABRASION TEST RESULTS

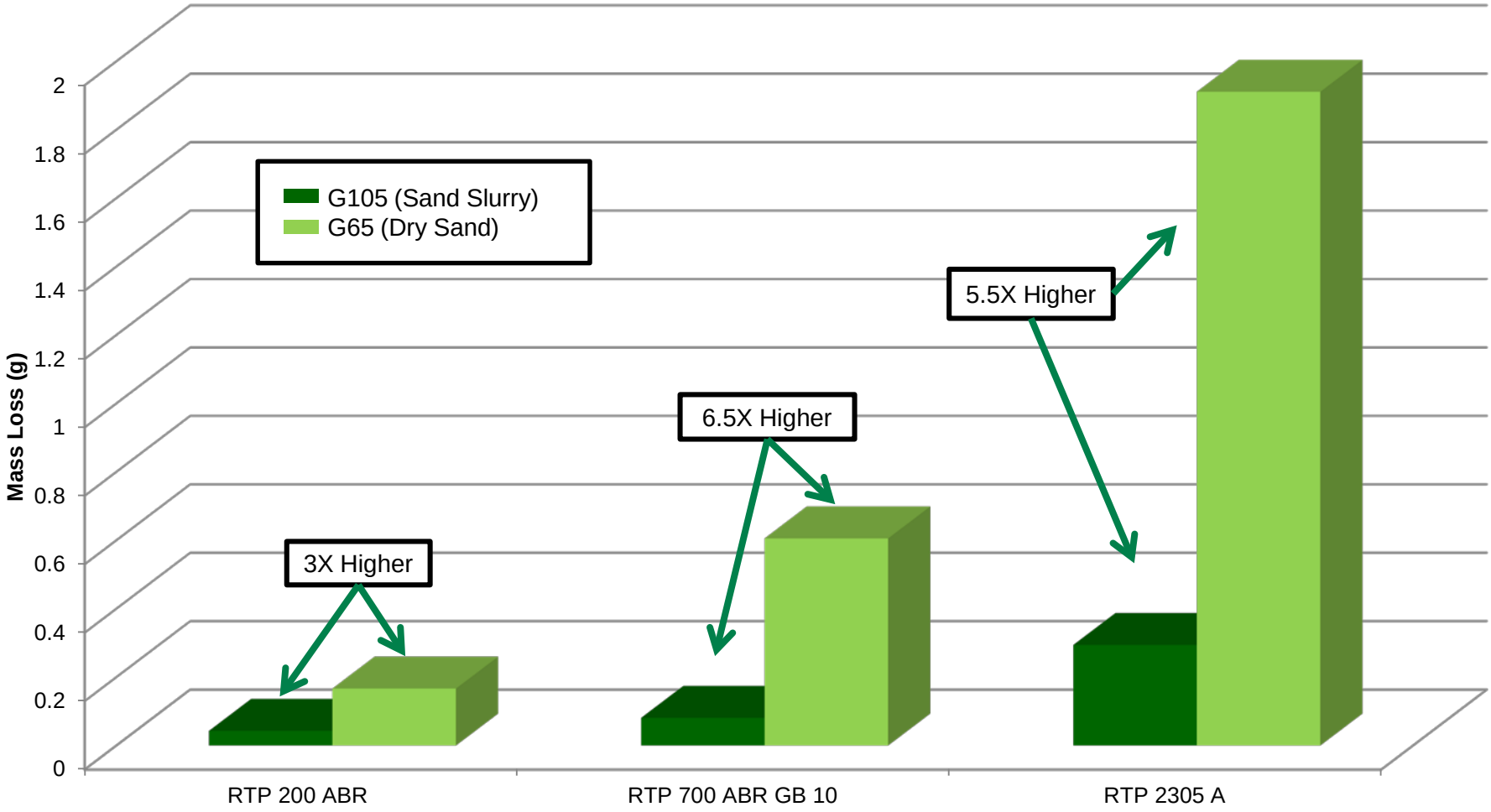
ASTM G65 (Dry Sand) Abrasion Results



Tested per ASTM G65 Dry Sand/Rubber Wheel Abrasion Test

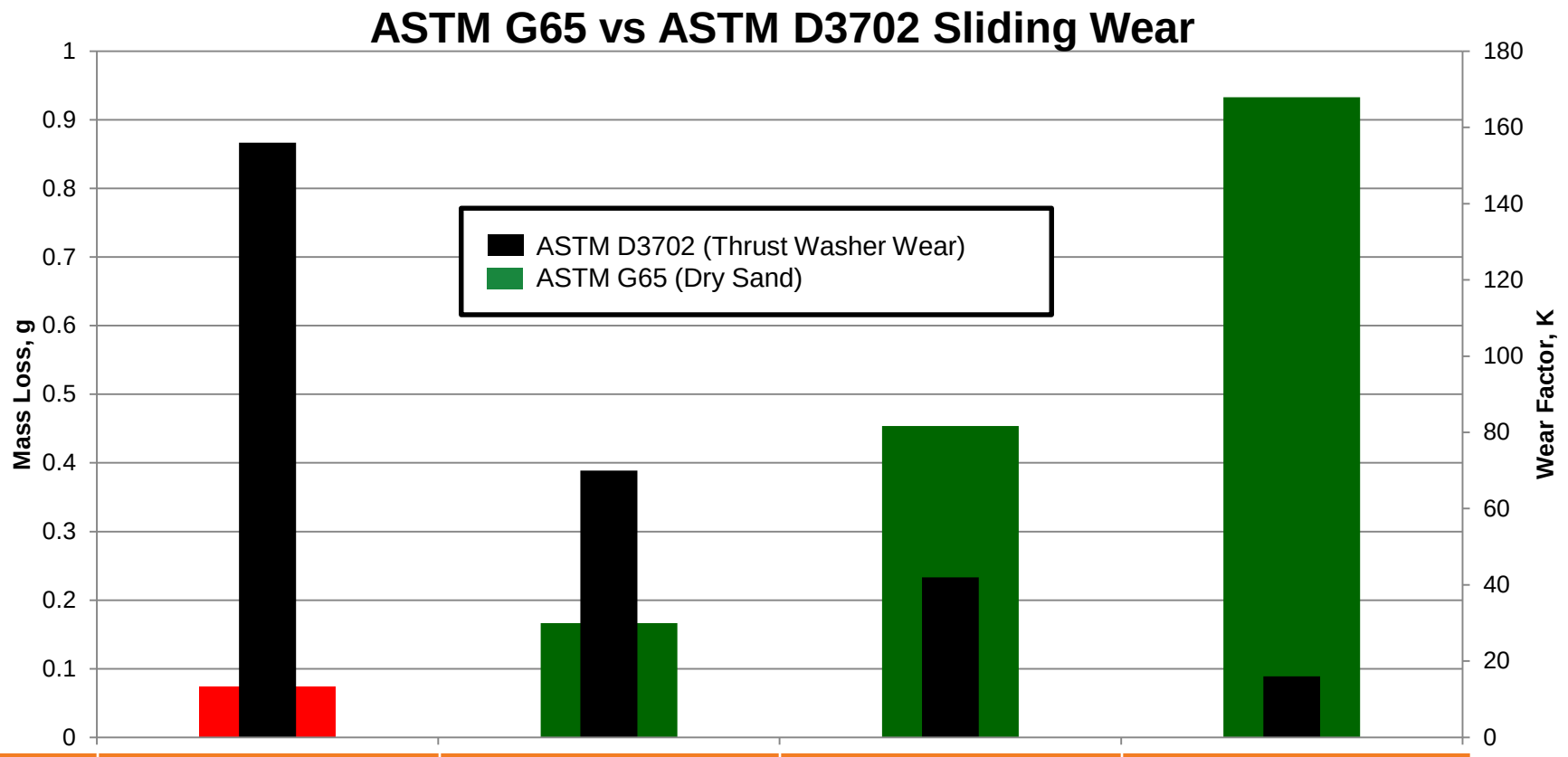
TEST METHOD COMPARISON

G65 (Dry Sand) vs G105 (Sand Slurry) Comparison



Tested per ASTM G65 and G105 Abrasion Tests

ABRASION VS SLIDING WEAR



	UHMWPE	RTP 200 ABR	RTP 700 ABR	RTP 700 ABR TFE 10
Wear Factor, K $(in^3\ min/ft\text{-}lb\text{-}hr)*E\text{-}10$	**156**	**70**	**42**	**16**
Dynamic CoF, μ_K	**0.73**	**0.24**	**0.24**	**0.18**

IMPACT PERFORMANCE

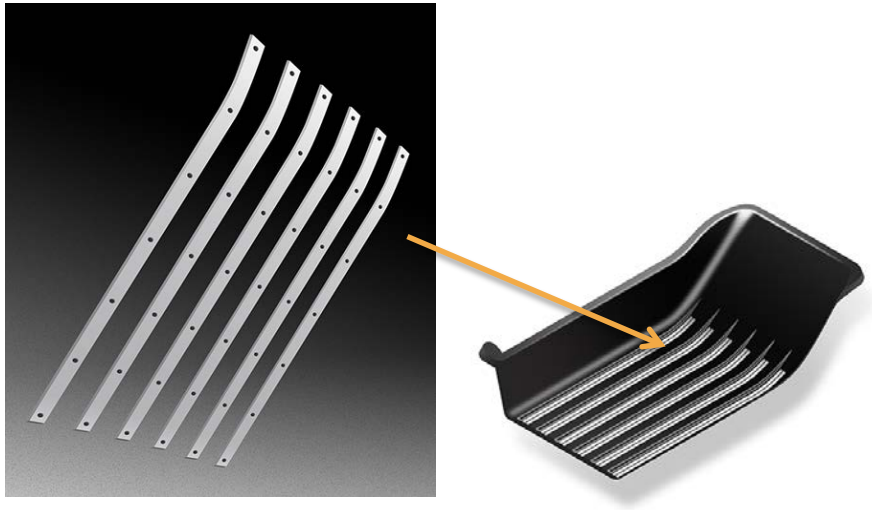
RTP 700 ABR products exhibit excellent impact performance at both room and cold temperatures.

	UHMWPE	RTP 100 HI (CoPP)	RTP 700 ABR
Notched Impact, ft lb/in, RT	No Break	14.0	15.5 (P)
Notched Impact, ft lb/in, -20° C	No Break	2.38	17.0

Tested per ASTM D256

SLED RUNNERS

CONSUMER PRODUCTS – WEAR RESISTANT (ABRASION), COLORED



Application Description

Add-on sled runner kit, which can increase the life of the equipment:

- Abrasion resistant runners to extend the life of the sled
- Comprised of machined strips of neat UHMWPE

RTP Company Solution

- Polyethylene (RTP 700 ABR)
  - Injection moldable abrasion resistant compound
  - Colorable

Benefits

- Standard, extrusion-capable, abrasion resistant material
- Material can be colored
- Increased production capacity and process control
- Reduced costs vs. fully machined parts

CHAIN GUIDES

CONSUMER PRODUCTS – WEAR RESISTANT (ABRASION), COLORED

Application Description

Chain guides are used to ensure smooth operation of the drive system (ATV, Agricultural, Auto, or Industrial equipment) and offer an abrasion and wear resistant component that:

- protects the chain from wear and binding
- is commonly made from materials such as Aluminum, Polyamide, or neat UHMPWE

RTP Company Solution

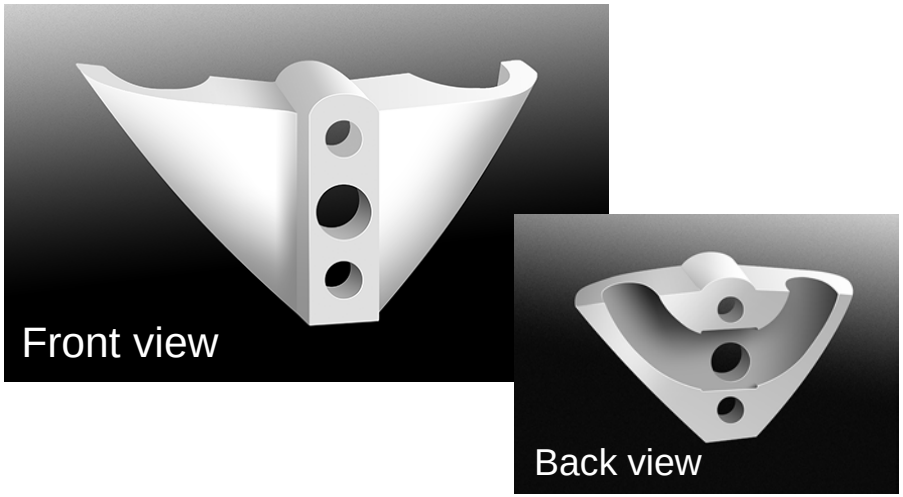
- Polyamide (RTP 200 ABR)
  - Injection moldable abrasion resistant compound
  - Colorable

Benefits

- Injection moldable abrasion resistant material solution
- Colorable
- Increased design flexibility
- Improved consistency vs. machined parts
- Increased production capacity
- Reduced costs vs. compression molded and machined parts

TWIN ROW SEED OPENER

AGRICULTURAL– WEAR RESISTANT (ABRASION), COLORED (UV)



Application Description

Twin row seed openers with design features that allow for perfect seed placement by:

- guiding seeds to the outermost part of the wing
- using machined neat UHMPWE for abrasion resistance and low soil buildup in wet conditions

RTP Company Solution

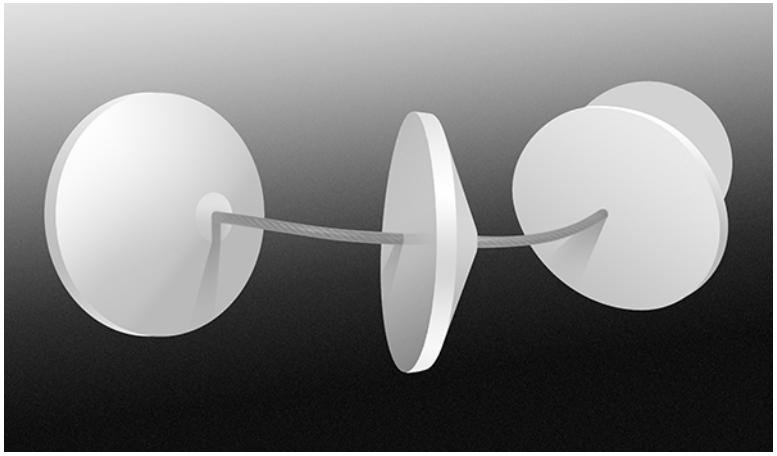
- Polyamide (RTP 200 ABR)
  - Injection moldable abrasion resistant compound
  - UV Stabilized

Benefits

- Injection moldable abrasion resistant material
- UV Stabilized
- Improved consistency vs. machined parts
- Reduced costs vs. compression molded or machined part
- Increased design flexibility

CABLE CONVEYOR

INDUSTRIAL - WEAR RESISTANT (ABRASION), FDA COMPLIANCE



Application Description

Cable conveyors can be customized to move just about anything, such as in-shell walnuts, peanuts, pet food, powders, and puffed rice breakfast cereal. These systems can operate on multiple planes, including feeding silos or moving materials from floor to mezzanine, with:

- Gentle material handling
- An enclosed, dust-free environment
- Easy maintenance

RTP Company Solution

- Polyamide or HDPE (RTP 200 ABR or 700 ABR)
  - Injection moldable abrasion resistant compound
  - FDA (Food Contact)

Benefits

- Injection moldable abrasion resistant material
- FDA compliant
- Increased design flexibility
- Improved consistency vs. machined parts
- Increased production capacity
- Reduced costs vs. compression molded or machined part

SUMMARY CONCLUSIONS

Conclusion: A new injection molding family of abrasion resistant compounds has been successfully developed.

- Because they are thermoplastics, they can be easily tailored to meet other engineering requirements in addition to abrasion/wear resistance; for example, higher mechanicals, custom colors, flame retardancy etc.
- Ease of processing via injection molding provides greater design freedom and lowers cost by eliminating secondary operations
- Offers effective abrasion resistance while providing dependable reduced wear and friction performance; unique to these ABR Compounds
- Significant abrasion performance differences were observed when comparing dry and wet sand-slurry testing of same materials
- Supported by RTP Company's extensive testing facilities, including both dry and wet sand abrasion along with traditional wear and friction testing, products can be specifically tailored to the tribological needs of the customer's total performance and cost requirements

ADDITIONAL RESOURCES

Abrasion Resistant Compounds Innovation Bulletin now available on www.rtpcompany.com website!

ABRASION RESISTANT COMPOUNDS

WEAR AND FRICTION RESISTANT PRODUCTS

FEATURES

- Can be injection molded or extruded
- Uniquely offered in a number of resin and additive combinations
- Suitable for both lower and higher volume applications

BENEFITS

- Can be injection molded, unlike other solutions that are limited to compression or ram extrusion
- Eliminates costly secondary processing, thereby reducing overall total cost
- Performance can be further enhanced by utilizing a wide range of resins and additives
- Global availability

Abrasion Resistant Compounds can be injection molded, offering design freedom and reduced costs for a variety of applications.

RTP Company formulates unique thermoplastic compounds that resist abrasion and are designed specifically for injection molding, offering a whole new way to solve abrasion issues!

Substances that cause abrasion are not easily predicted or managed; third party abraders can generate debris, resulting in system contamination and adverse effects on operations and quality. Typically, abrasion is catastrophic to a system, so minimizing the effects of abrasion is crucial.

Abrasion Resistant Compounds from RTP Company can reduce abrasion and provide additional properties to meet even the most challenging application requirements. They are available in multiple resin and additive combinations for extreme design flexibility. Additional functionality such as wear and friction resistance, flame retardancy, and conductivity can be included.

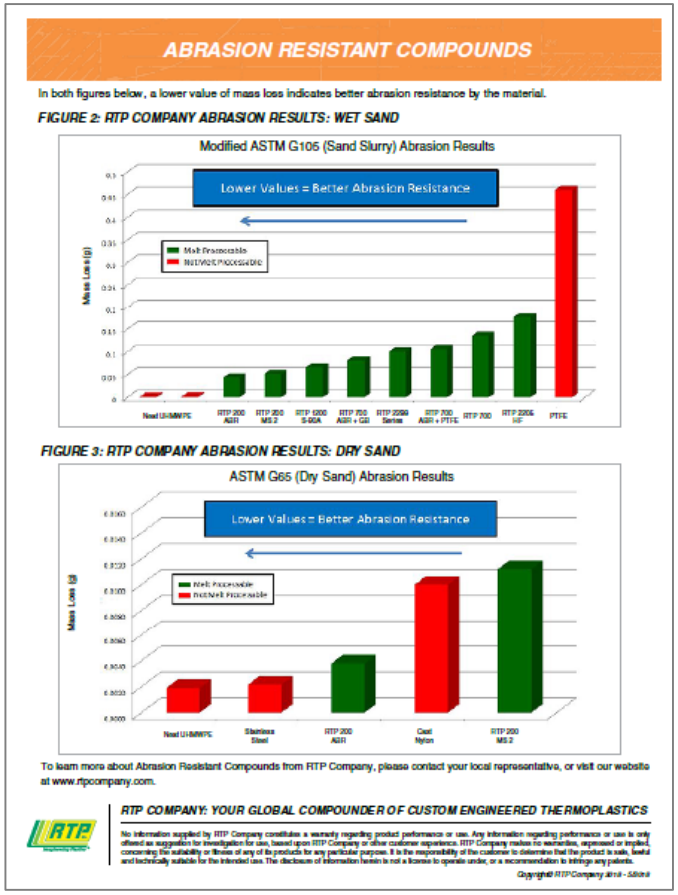
Data from multiple, industry-recognized test methods suggests that RTP Company's Abrasion Resistant Compounds demonstrate abrasion resistance comparable to UHMWPE (Ultra-High Molecular Weight Polyethylene). In addition, these compounds are superior to UHMWPE in wear and friction tests (see Figure 1).

FIGURE 1: ASTM D3702 WEAR AND FRICTION

Wear Factor (5000PV)

Abrasion is typically catastrophic to operating systems due to contamination by unpredictable debris.

With the added advantage of being injection moldable, our Abrasion Resistant Compounds are not limited to stock shapes that require costly secondary processing, making the design possibilities seemingly endless! Abrasion Resistant Compounds... available from RTP Company - your global compounder of custom engineered thermoplastics!



ABRASION RESISTANT COMPOUNDS

In both figures below, a lower value of mass loss indicates better abrasion resistance by the material.

FIGURE 2: RTP COMPANY ABRASION RESULTS: WET SAND

FIGURE 3: RTP COMPANY ABRASION RESULTS: DRY SAND

To learn more about Abrasion Resistant Compounds from RTP Company, please contact your local representative, or visit our website at www.rtpcompany.com.

RTP COMPANY: YOUR GLOBAL COMPOUNDER OF CUSTOM ENGINEERED THERMOPLASTICS

Q & A

Questions?

Thank You!

- The Wear and Friction Team

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