Avoiding Failure By Testing Low Temperature Performances in Elastomers

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RUBBER IN ENGINEERING GROUP

Elastomers at Low Temperatures Virtual Event

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ACE Products & Consulting LLC

Physical Testing

Does your product comply with regulations and match consumer expectations? ACE's physical testing capabilities will assure that your final product meets the demands of government regulations, industry standards, and customer-specific protocols.

PHYSICAL TESTING

Analytical Testing

ACE's many analytical test capabilities include specialized equipment and an array of wet chemistry solutions. Looking to outshine competitors but there is no established ASTM standard? ACE offers custom test solutions by creating methods that meet customer-defined applications.

ANALYTICAL TESTING

Expert Consulting

A team of agile, highly trained professionals puts ACE in the vanguard of today's most solutions-oriented independent testing laboratories. Our broad scope for research makes ACE a great partner for preserving product integrity in increasingly competitive industries and markets.

CONSULTING

ANAB

ANSI National Accreditation Board

ACCREDITED

ISO/IEC 17025

TESTING LABORATORY

Methods to Review

- Glass Transition Temperature DSC / DMA
- Temperature Retraction
- Brittle Point
- Gehman Torsional Stiffness
- Cold Conditioning

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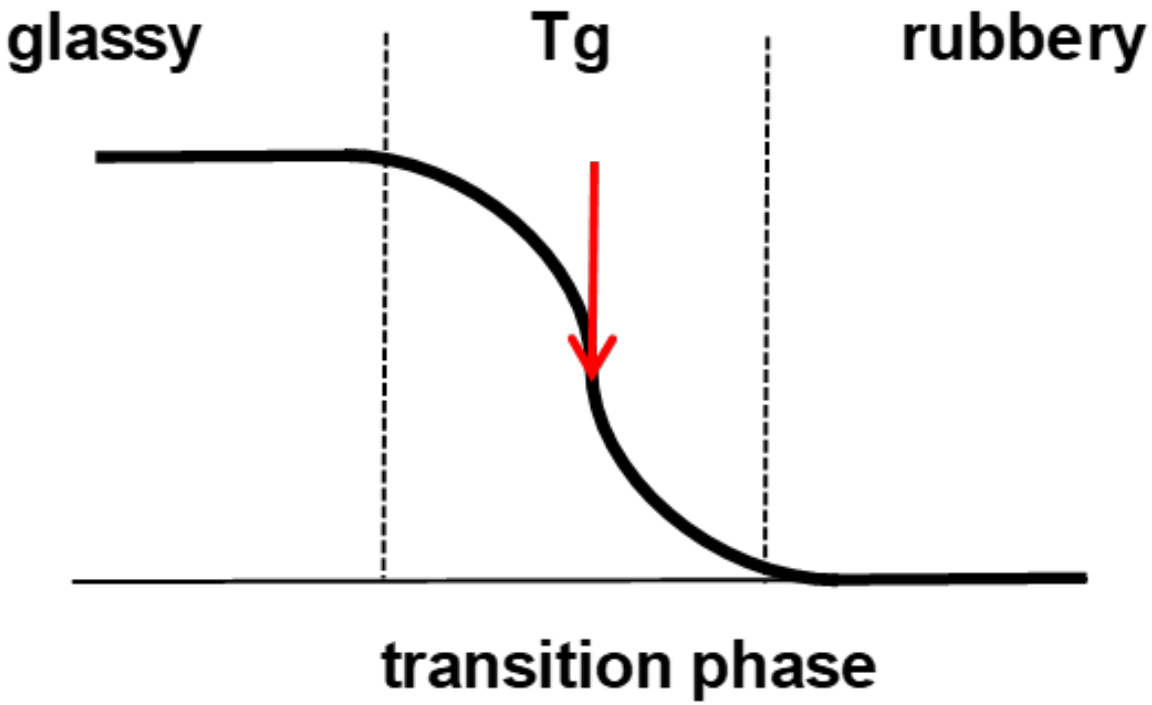
Recommended Temperature Ranges

Material	Min Temp	Max Temp
Silicone	-55°c	300°c
FKM	-26°c	230°c
EPDM	-51°c	150°c
Nitrile	-40°c	100°c
SBR	-46°c	100°c
CR	-40°c	121°c
HNBR	-51°c	104°c

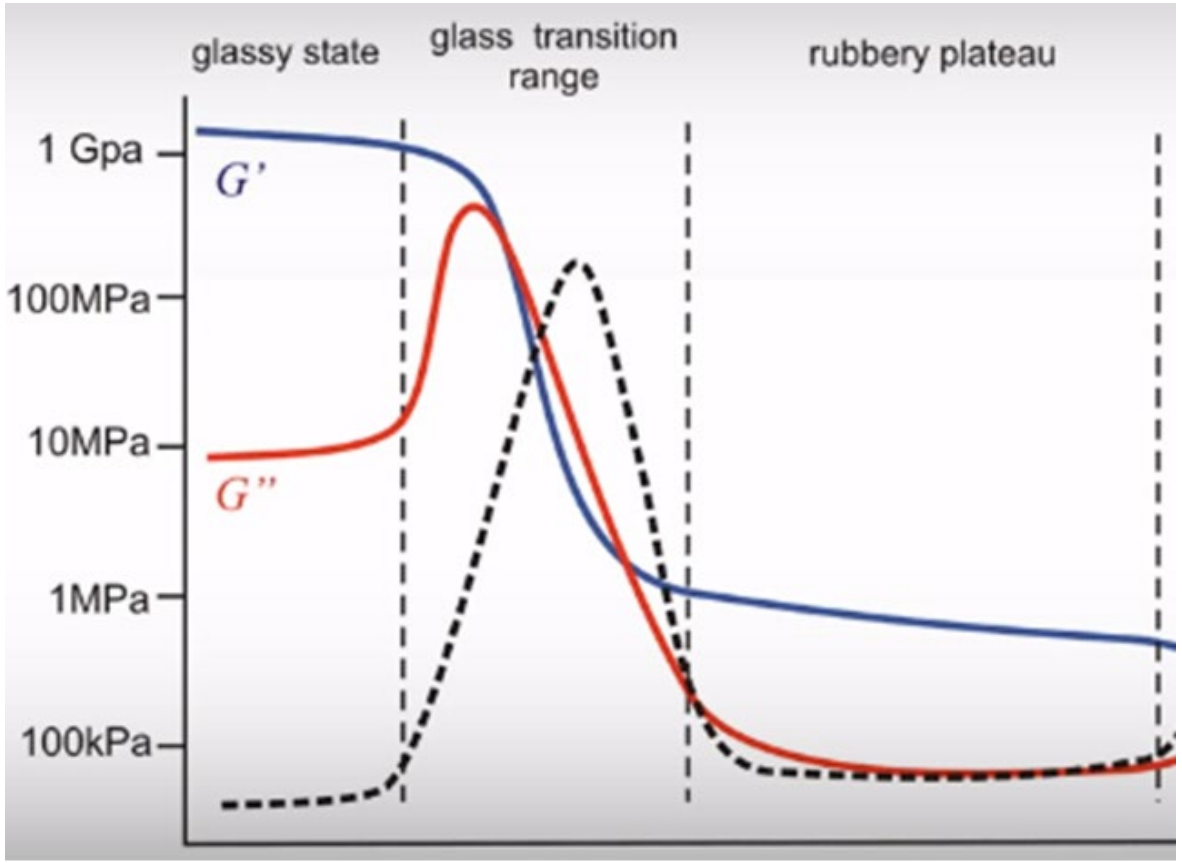
Glass Transition Point

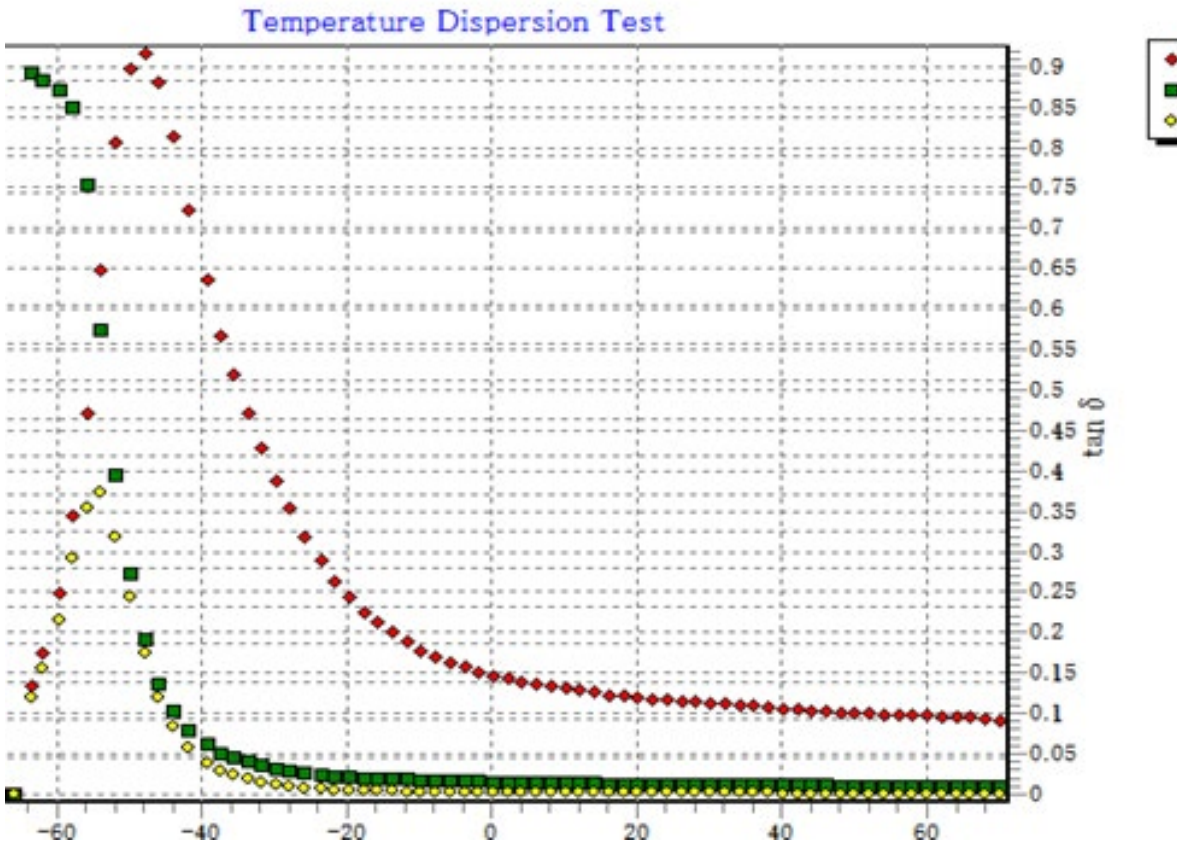
Glass Transition



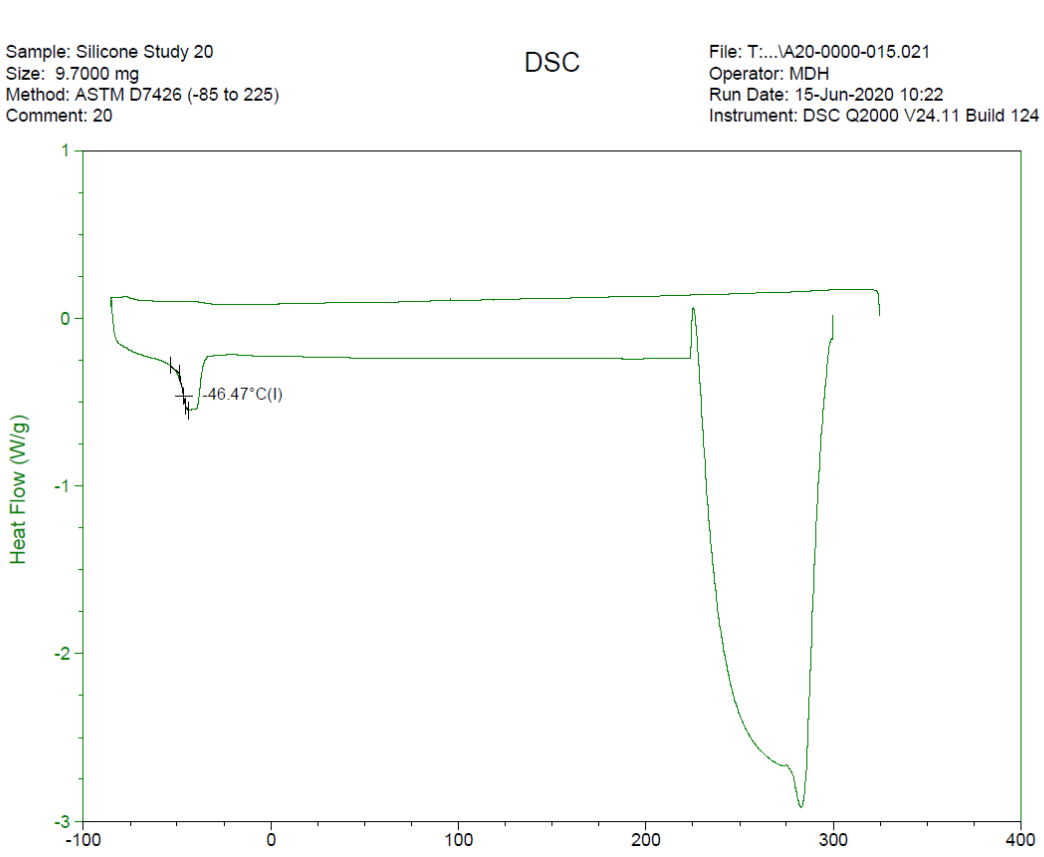
- Glass Transition (Tg) is the temperature in which a polymer changes from being elastomeric to being ridged
- Popular methods include
  - ASTM D3418
  - ASTM D7426
  - ASTM E1356
  - ISO 11357-2

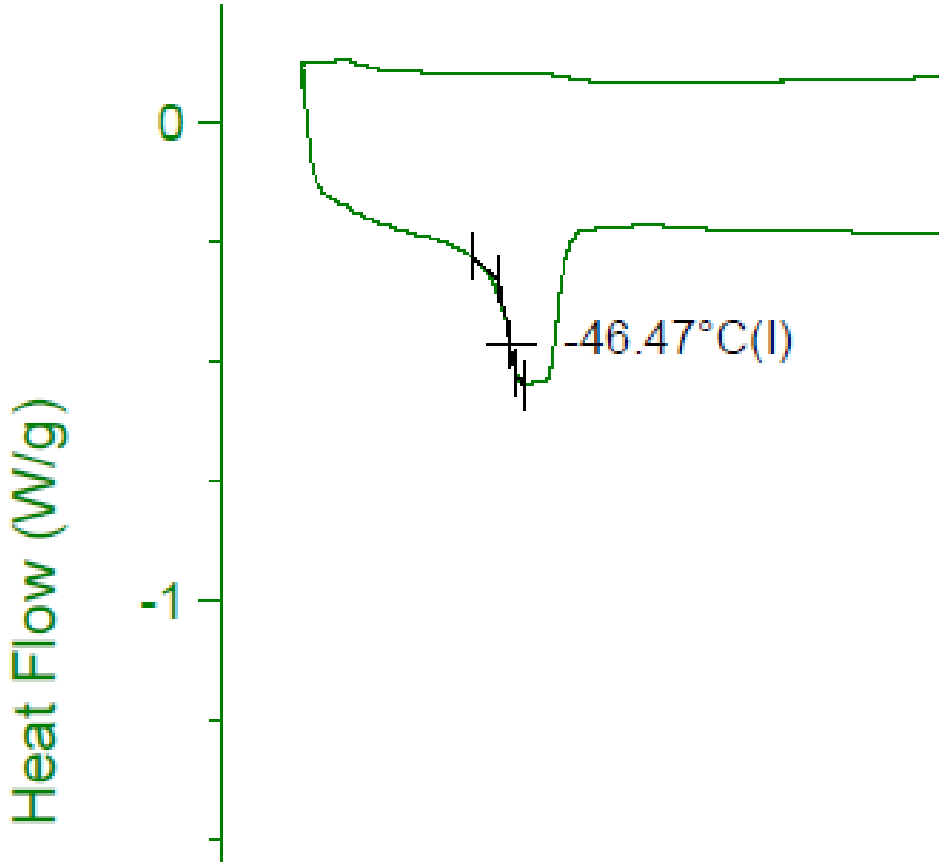
DMA

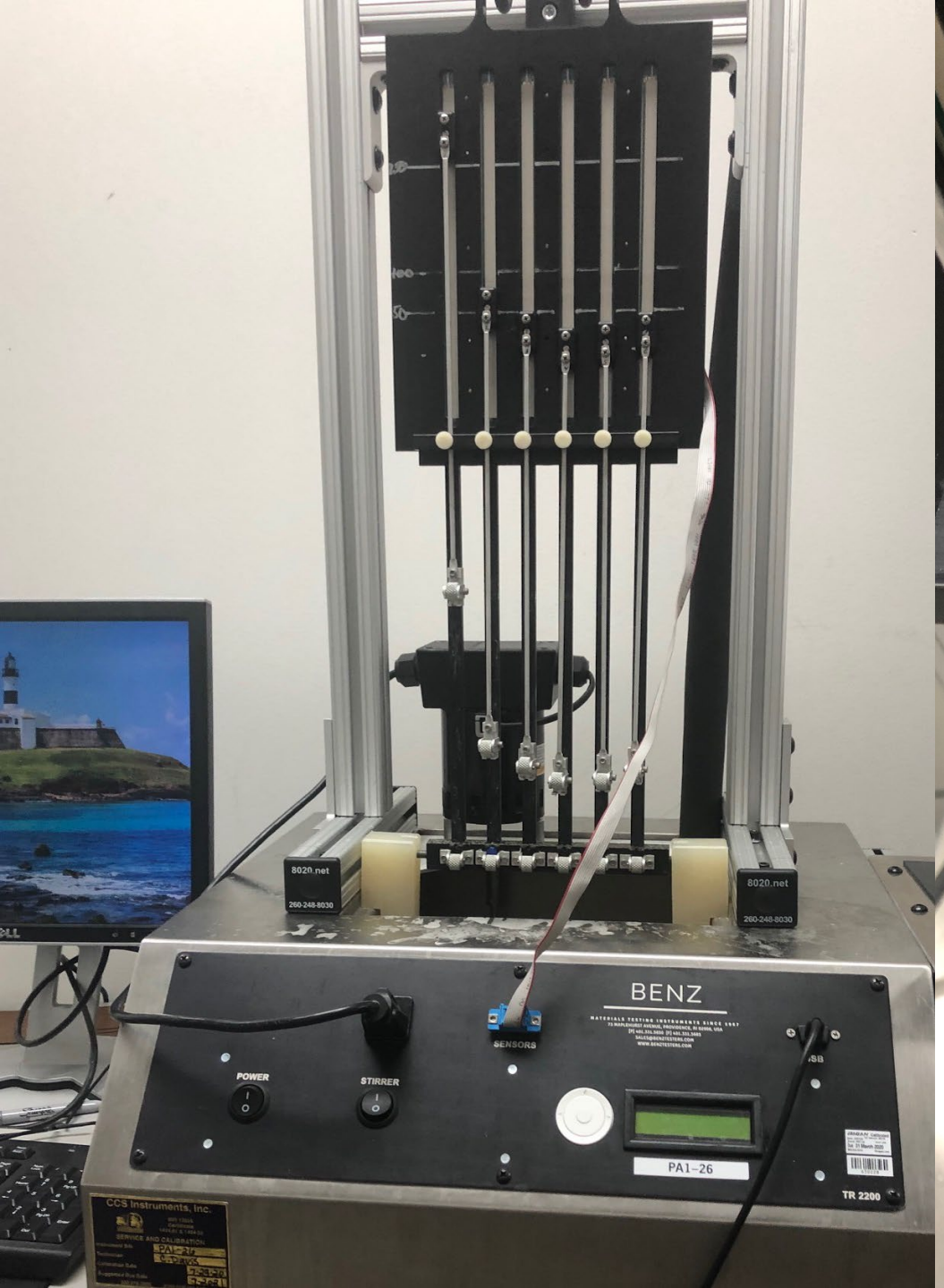

glassy state
glass transition range
rubbery plateau
1 Gpa
100MPa
10MPa
1MPa
100kPa
G'
G''


Temperature Dispersion Test
tan δ
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-60
-40
-20
0
20
40
60

DSC


Sample: Silicone Study 20
Size: 9.7000 mg
Method: ASTM D7426 (-85 to 225)
Comment: 20
DSC
File: T:...\A20-0000-015.021
Operator: MDH
Run Date: 15-Jun-2020 10:22
Instrument: DSC Q2000 V24.11 Build 124
Heat Flow (W/g)
-46.47°C(I)
1
0
-1
-2
-3
-100
0
100
200
300
400

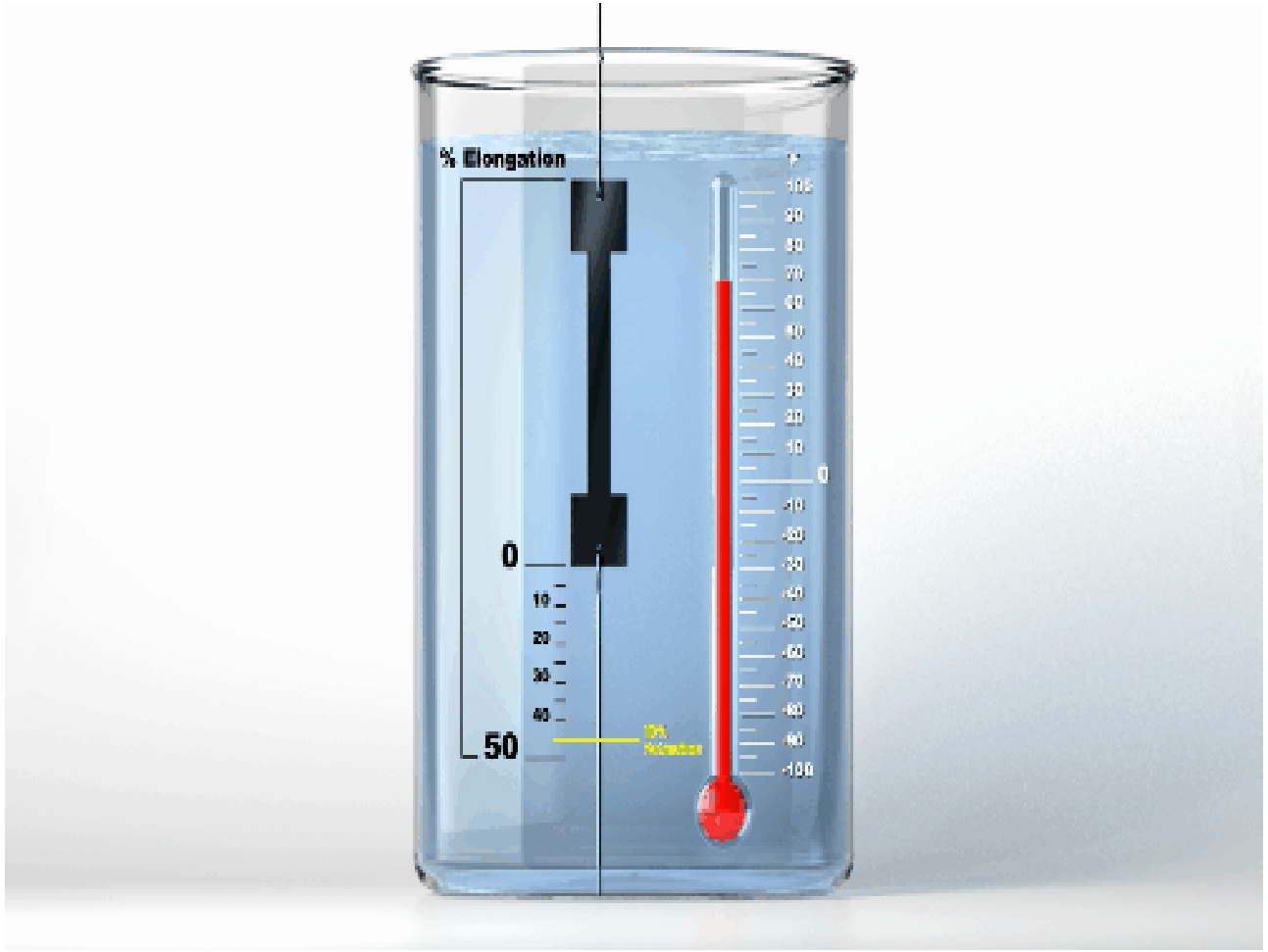

Heat Flow (W/g)
0
-1
-46.47°C(I)



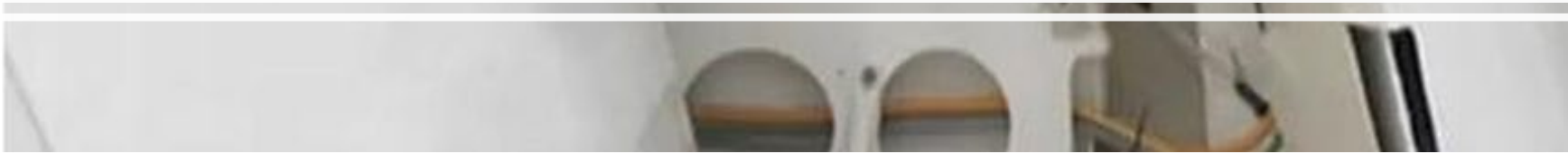
Temperature Retraction

- ASTM D1329
- ISO 2921

Temperature Retraction

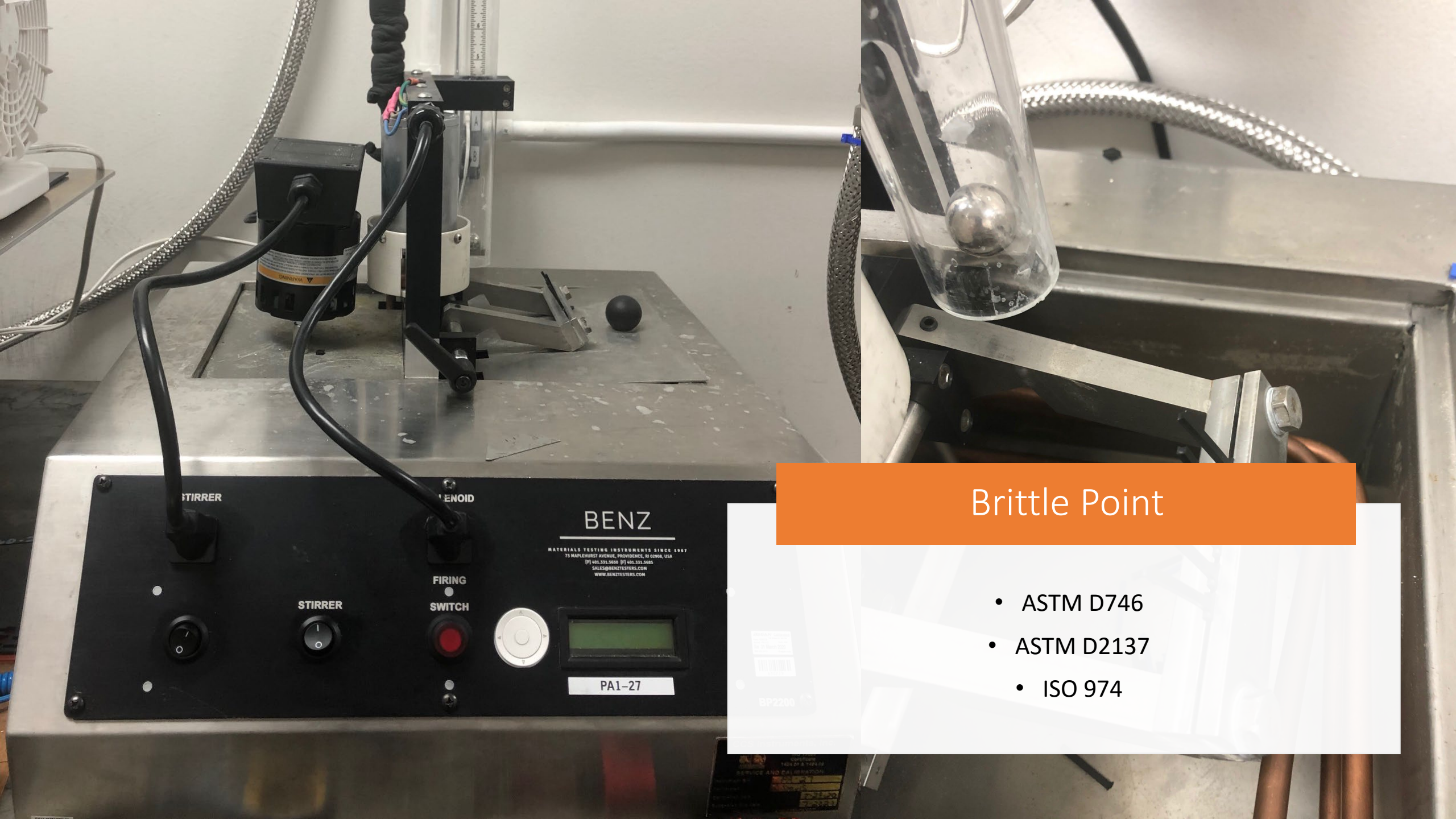


Field Application



Case Study

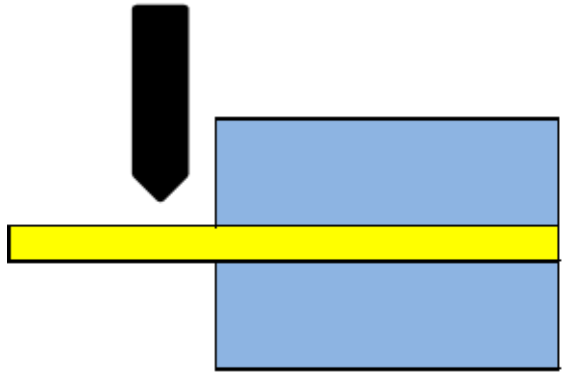
- O-ring keeping the propellent separate from ignition sources failed due to operation in low temperature.
- The -0.5°C temperature that day was below the performance capability of the elastomer O-ring.
- Likely a combination of both temperature retraction and brittle point failure.



Brittle Point

- ASTM D746
- ASTM D2137
- ISO 974

Cold Testing – Brittle Point



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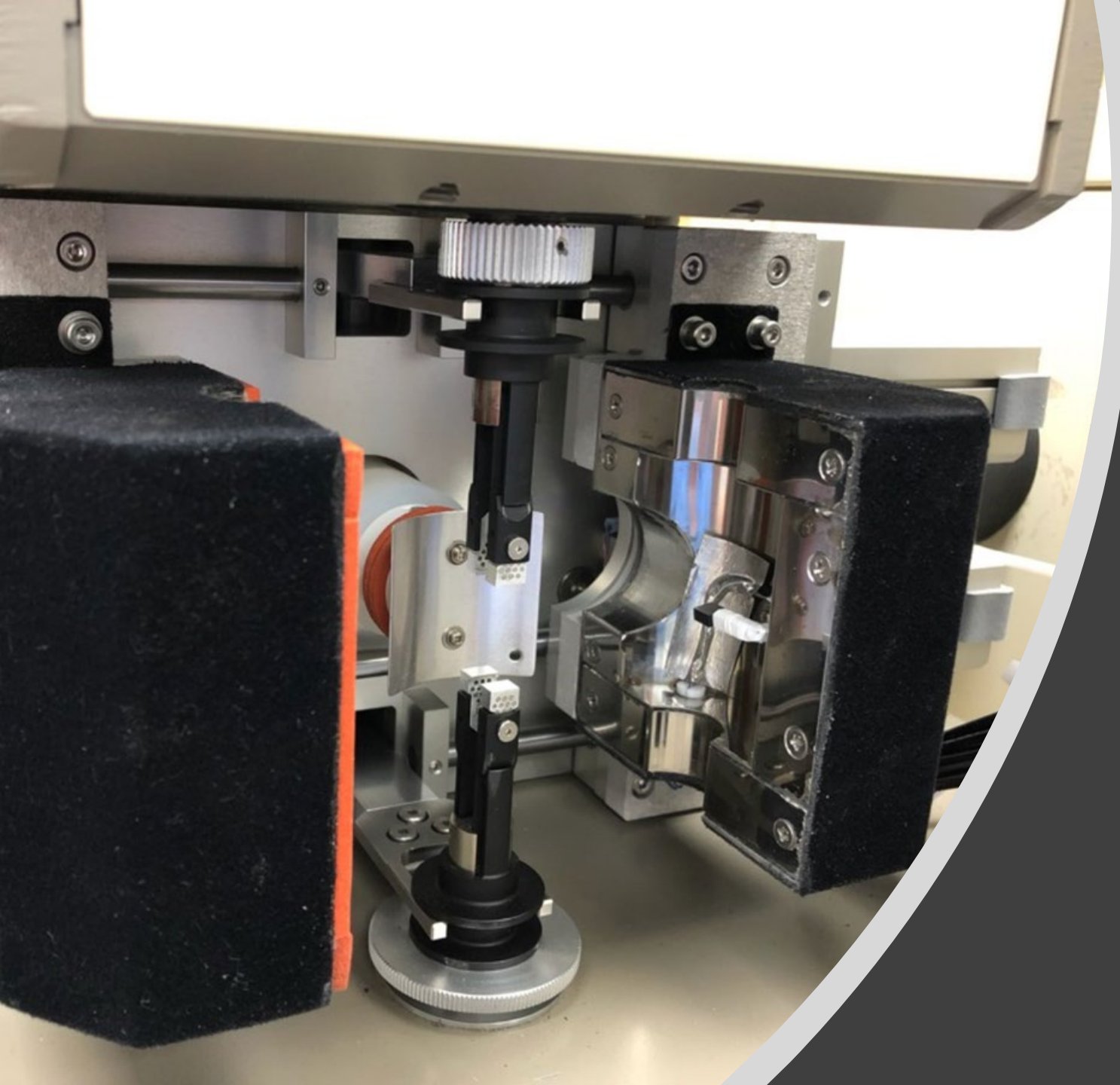
Field Application

- Off the road arctic tires see temperatures lower than all other standard OTR tires.
- Sitting at low temperatures can stiffen the elastomer and cracks occur once force is applied.
- The ability to withstand impact or cut resistance is greatly reduced at these low temperatures.

Torsional Stiffness

- Torsional modulus comparison at specified low temperatures to room temperature
- ASTM D1053
- ISO 1432



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DMA Tension Method

Most accurate stiffness measurement method.

Conditioned Testing

Cold Conditioning

- Cold Bend
- Mandrel wrap
- Aged Physicals
- Compression Set

Field Application

- Dynamic gaskets on the international space station not only need to withstand low temperatures, they must be able to perform in them.
- Many low temperature applications are static compression gaskets. Dynamic applications provide another level of complexity.
- Customized test can be developed to best simulate the application.

Send us your questions

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Questions???