Technical Bulletin

Minerals

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Vulco® R67 rubber compound successfully improves mill performance

Introduction

The Vulco® R67 rubber compound is being introduced to the mill system applications after successful experimental field trials showed considerable performance improvements over the current standard Vulco® R63 rubber compound.

Our customers have always been very satisfied with the performance of our R63 rubber however we identified an opportunity to develop a more abrasion resistant rubber compound to further increase the performance for our customers. This led to the development of the R67 rubber compound. This new elastomer material was developed through extensive laboratory testing which was optimised and refined to further improve the material's properties for aggressive mill system applications. The outcome of these improvements is a rubber compound which delivers an increased wear life of more than 20%, resulting in significant cost savings for our customers.

Background

- R67 rubber was developed by the Weir Minerals Applied Materials Technology Group based out of Salt Lake City, USA and Sydney, Australia.
- The compound utilises new additives, reinforcing fillers, process aids, and high molecular weight based elastomers combined with new methods of processing to achieve the optimum material.
- R67 extends the operational time for most mill lining.
- The end-results from our in-house laboratory and field testing demonstrate that R67 rubber is significantly superior to that of Weir Minerals standard R63 rubber and other rubbers used in the market for mill system applications.
- The laboratory test results are shown in this technical bulletin.

Material description

R63 – A high grade rubber material with high elasticity and tear strength. The combination of these two characteristics makes the rubber highly resistant to both abrasive wear and tearing.

R67 – A premium grade rubber material used in severe mill system wear applications. A black rubber compound of high hardness, elongation, tensile and tear strength suitable for mill liner, shell and grate plates. These superior physical and viscoelastic properties are ideally suited for mill system and other severe applications.

Background on Viscoelastic Properties

Storage/Elastic Modulus – The storage or elastic modulus (G') is defined as the ratio of shear stress to the shear strain with the addition of a small oscillatory strain. G' is essentially a measurement of the rigidity of the material and its response to shearing strains. G' can also be considered as the amount of energy that is stored by the material during dynamic testing. R67 shows significant higher G' than the standard R63 rubber (Figure 1). This suggests the R67 will be more rigid in response to shear strains.

Loss/Viscous Modulus – The loss or viscous modulus (G") is defined as the amount of energy that is dissipated during dynamic testing, usually as heat. The R67 compound exhibits higher G" than the standard R63 (Figure 2), suggesting that more heat is dissipated during dynamic applications, which is important for mill system applications where heat is generated during the grinding process.

Vulco® R67 wear resistant mill liner with green ends

Side by side comparison of Vulco® mill liners with R67 rubber (left) versus R63 rubber (right)

Tan Delta – The ratio of loss modulus (G") and the storage modulus (G') is defined as the tan delta (tan δ). Tan δ is used commonly in the tire industry to describe heat build-up (reversion) and rolling resistance. Having a lower tan δ would suggest the rubber material is more resistant to heat build-up therefore increased resistance to hysteresis. The lower tan δ (Figure 3) suggests the R67 rubber is more resistant to heat build-up particularly important for mill system applications.

Background on abrasion testing

Weir Minerals abrasion tester follows the ASTM D5963 international standard test method for rubber property – abrasion resistant. This test is used extensively in rubber products including tyres, conveyor belts, hoses, footwear, and floor coverings. Although direct wear performance from this accelerated test cannot be used to correlate with actual field wear, this method does provide suitable comparative test data for quality control, specification compliance testing and research and development. Table 1 shows the performance of R67 and its superior abrasion resistance to R63. This result enables us to scale up from experimental trials and have confidence in field performance.

Why abrasion testing?

The abrasion tester (Figure 4) using the ASTM D5963 international standard test method is currently the only certified test available to measure the abrasion resistance of rubber compounds and best simulates the wear behaviour during the abrasion wear process in the mill system applications.

Abrasion testing and field results

The abrasion tester is used to simulate the wear mechanism in highly abrasive applications used in mill systems. This test method provides an overall understanding of how the rubber material performs relative to a known standard. The results from table 1 show the increased performance of R67 to the standard rubber compound R63. These results also correlate well with field trials at customers sites, resulting in significant cost savings and wear life improvement for the customer.

Conclusion

- The unique formulation of R67 allows the rubber compound to be used in aggressive and high wear mill system applications.
- R67 rubber has high Shore A° hardness.
- R67 has significantly higher elongation than standard rubber compounds used in mill system applications.
- R67 rubber has higher tear strength.
- R67 has superior viscoelastic properties.
- R67 rubber will provide improved wear performance in applications for mill systems.
- R67 replaces and supersedes a number of Weir Minerals rubber compounds. These include R63, RB101, 177 and 121.
- R67 has reported more than 20% increase in wear life.

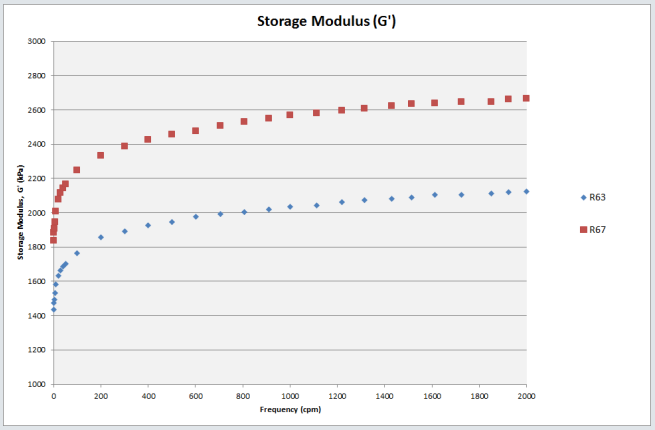

Figure 1. Storage Modulus (G') of R67.

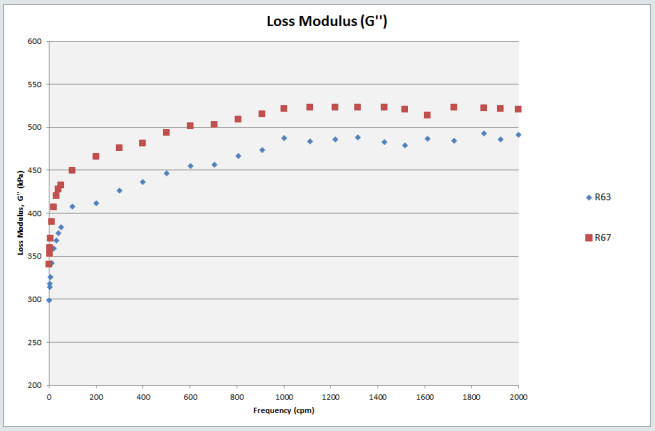

Figure 2. Loss modulus (G") of R67.

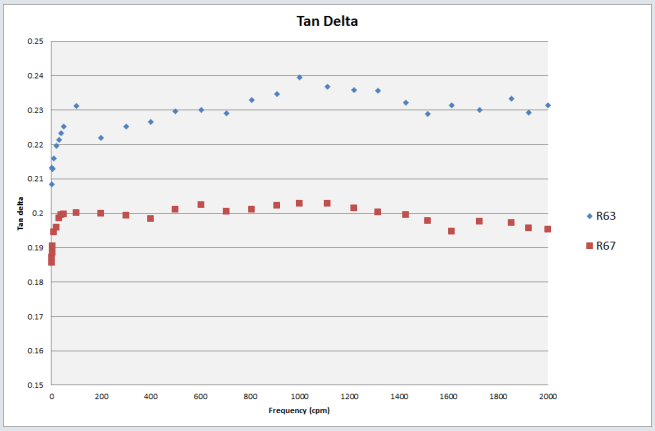

Figure 3. Tan delta (tan δ) of R67.

Figure 4. ASTM D5963 Abrasion tester.

Table 1. Typical physical and wear properties of R63 and R67

Typical Physical Properties	Units	R63	R67
Hardness	Shore A	65	65
Resilience Bayshore	%	35	40
Density	g/cm^3	1.11	1.17
Tensile Strength	MPa	20	25
Elongation @ Break	%	450	700
Modulus @ 100%	MPa	2	2
Modulus @ 500%	MPa	-	7
Tear Die C	N/mm	70	110
Abrasion resistance (ASTM D5963)	%	200	300+

Features

- Excellent abrasion and tear resistance
- 65 Durometer (Shore A)
- Natural rubber blend
- Used in lifter bars, head/shell plates, and grates

Sizes/Availability

- R67 rubber is available in lifter bars ranging between 4" and 9.75" wide and up to 16" tall.
- Manufactured at multiple Weir facilities across the globe

Typical Physical Properties

Density (g/cm^3)	1.17
Hardness (Shore A)	65
Resilience (Bayshore %)	40
Tensile Strength (MPa)	25
100% Modulus (MPa)	2
500% Modulus (MPa)	7
Elongation at Break	700
Tear Initiation Resistance (N/mm)	110

Key Features and Benefits

- Vulco® R67 wear resistant rubber and metal cap mill liners are versatile, economical and efficient.
- Rubber and metal cap liners weigh up to 80% less than steel alone and are faster, easier and safer to install.
- Liners are engineered to promote ideal ball charge motion and to optimise grind.
- The rubber compounds used in Vulco® R67 liners are specially formulated for maximum abrasion resistance and are custom engineered to fit specific geometry and operating conditions.
- Rubber liners have higher noise absorption properties than traditional composite or metal liners thus reducing the likelihood of hearing impairment due to grinding noise. They are also lighter in weight which can help prevent lifting strain injuries.

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