KOMBOWASHER

CAPABILITY STATEMENT

THE REVOLUTIONARY MILL LINER SEALING SOLUTION

THE REVOLUTIONARY MILL LINER SEALING SOLUTION DELIVERING BUSINESS PROCESS IMPROVEMENT, SAFETY AND SUSTAINABILITY OUTCOMES

The Kombo Washer is an interconnected combination washer and nut device used to secure mill liners in mining processing operations globally. Australian designed, owned and patented, the Kombo Washer was developed and proven in the Kalgoorlie Goldfields and is precision manufactured by Flaig + Hommel GmbH in Germany for global distribution.

The patented interconnected design and non-stick elastomer provides for easy handling and significantly faster installation and removal times – maximising mill availability and utilisation by reducing planned and unplanned mill downtime and increasing mill profitability. One gold mining client has proven savings in excess of $500k per reline event using the Kombo Washer.

The Kombo Washer is uniquely engineered to completely seal both the bolt hole and thread to prevent slurry fines from migrating up the thread and seizing the nut to the bolt, to take a full clamp load without deforming the sealing elastomer, and to maintain full torque over the reline interval – it holds tight and never loosens during operation, reducing the risk of liner failure.

The Kombo Washer is the world's first and only reusable mill liner fastening system. Engineered to be reused for 5+ reline events, it provides amortised cost savings and significant sustainability outcomes. Its future proofed design allows for robotic installation and removal.

The Kombo Washer significantly outperforms the legacy 3-piece fastening system that's been used by the mining industry (unchanged) for more than 100 years. It is available in a full range of metric and imperial sizes.

BENEFITS

- SEALS COMPLETELY AND HOLDS TIGHT
- MAXIMISES MILL AVAILABILITY AND UTILISAION
- IMPROVED MILL SAFETY
- SUSTAINABLE AND FUTURE PROOF
- MULTI-YEAR COST SAVINGS
- AUSTRALIAN DESIGN + GERMAN PRECISION

OUR MISSION

TO INSTALL THE KOMBO WASHER AS THE GLOBAL INDUSTRY STANDARD FOR WEAR PLATE FASTENING SYSTEMS

KOMBO WASHER VS LEGACY THREE PIECE SYSTEM

KOMBO WASHER

OVERVIEW

- Faster installation and removal
- Seals completely
- Holds tight – won't back off
- Reusable and sustainable
- Safer and future proof

KEY USER BENEFITS

Reduced planned downtime

The easy to handle one piece assembly and non-stick elastomer ensures efficient installation and removal every time – 10 seconds on, 10 seconds off. The non-leak design reduces the need to descale the mill before each reline event. In field use indicates 3 to 4 hours planned downtime saving on a 750 bolt mill reline event, driving profit improvement of $1m+ per annum in high value mining operations conducting 2 to 3 relines per year.

Reduced unplanned downtime

The patented design of the Kombo Washer seals damaged holes and imperfect mill surfaces as well as the thread of the bolt, stopping slurry fines from migrating up the thread and causing bolt fatigue and breakage. The collated nut design will never loosen during operation reducing the risk of disengaged wear plates. The non-leak design reduces the need to clean the mill deck for safety. The Kombo Washer may drive profit improvement in excess of $1m per annum in high value mining operations by reducing the number and length of unplanned downtime events in a year.

Improved mill safety

The one-piece design reduces physical risk to maintenance staff in terms of pinched fingers, muscle strain, cuts, and abrasions during the reline process. The non-leak design reduces the physical risk to operations staff due to slippery surfaces and eye splashes as well as improves equipment aesthetics with clean and dry surfaces.

Sustainable, cost effective and future proof

The Kombo Washer is the world's first and only reusable mill liner fastening system. Engineered to be reused for 5+ reline events, it provides amortised cost savings and significant sustainability outcomes through the manufacturing, transport and recycling phases. Its future proofed design allows for robotic installation and removal.

LEGACY THREE PIECE SYSTEM

OVERVIEW

- Slower installation and removal
- Leaks frequently
- Loosens during operation
- Single use only

KEY USER ISSUES

Slower installation and removal

The common rubber gasket, cup washer and nyloc nut all consume time when being assembled individually on to the protruding bolt, approximately 12 seconds per assembly. It typically takes 15-20 seconds to remove the assembly (that is, if all goes to plan) – more often than not, the rubber gasket will stick to the surface of the mill and then subsequent removal of residue rubber will extend the removal process ever further.

Leaks frequently

The rudimentary design of the rubber gasket means it can only seal on the two interfering surfaces and does not completely seal around bolt threads; nor does it seal distorted bolt holes and irregular surface conditions. Such anomalies create leaks of slurry which can migrate up the thread, causing the nut and bolt to seize together which then results in the nut having to be cut off.

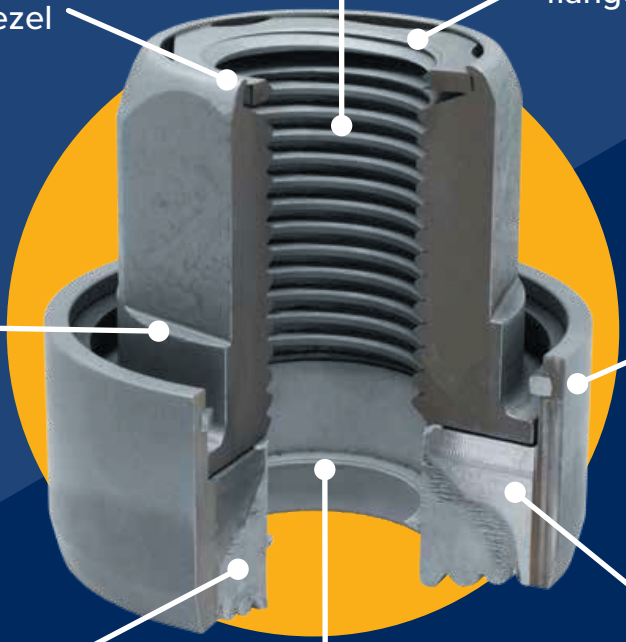
Loosens during operation

Conventional locknuts loosen during operation and rely heavily on the elastomer (nylon) to maintain a prevailing torque on the bolt. The loosening of the nut increases the potential for premature failure of the clamp pressure which in turn may result in failure of the bolted joint.

Single-use only

The pressured steel cup washer deforms under full tightening load. The seal degrades and sticks to the mill surface. The nyloc nuts are single-use only; the nylon distorts to the form of the thread and compression set and heat degrades the nylon and must be discarded after one use.

KOMBO WASHER – HOW IT WORKS



Thread has extra length to ensure friction surface of the union is maximised

Prevailing torque and locking bezel

Prevailing torque flanged nut

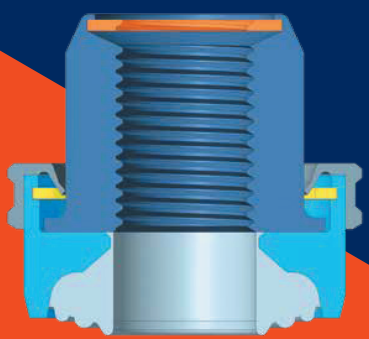
Raised shoulder to optimise socket purchase

External dust cover to protect from external environment

Non-stick elastomer with conical rings to seal against uneven surfaces and compress into the thread and hole simultaneously

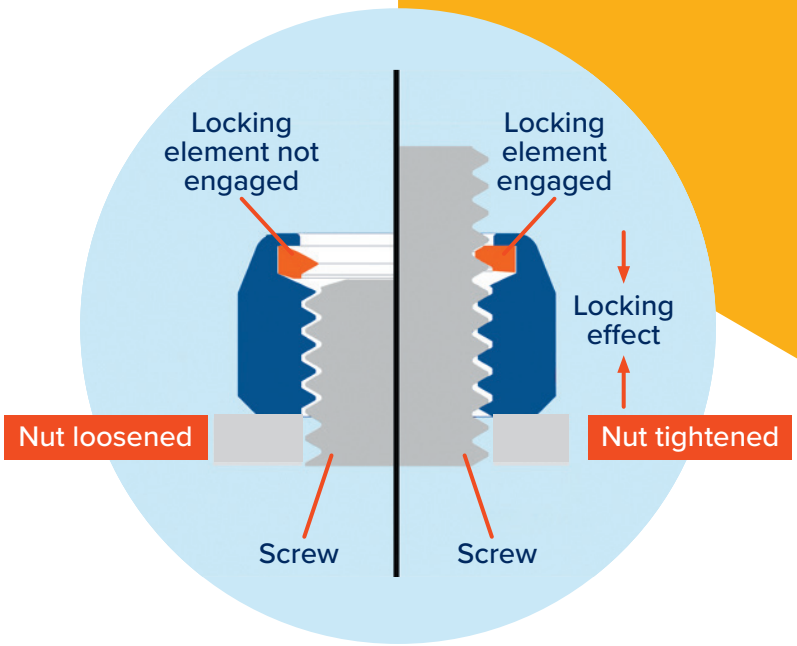
Internal lip to seal the thread to prevent material migration along the bolt

Washer body designed to withstand large clamp pressure and to compress the elastomer against the thread of the bolt



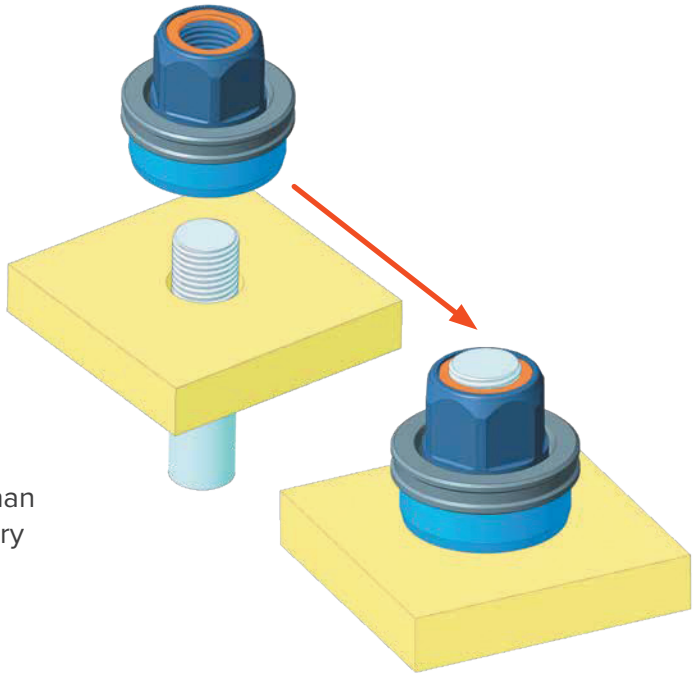
ALL-STEEL LOCK-NUT

The Kombo Washer offers double-safety – the locking element works in the radial and the axial direction and produces an even clamping action of the nut from preload to the full range (360°) of the bolt's threads.



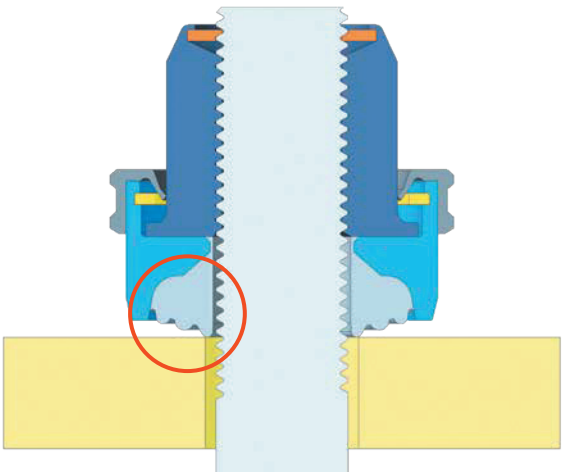
INSTALLATION AND REMOVAL

- Fast on and off – seal won't stick to mill surface
- Simple one piece assembly is easy to handle *(Conventional cup washers require handling three parts)*
- Typical installation and removal times are less than 10 seconds on and 10 seconds off each and every time – significantly reducing mill downtime *(Conventional cup washers typically take 15-20 seconds to remove – sometimes even up to 6 minutes to remove leftover rubber residue)*



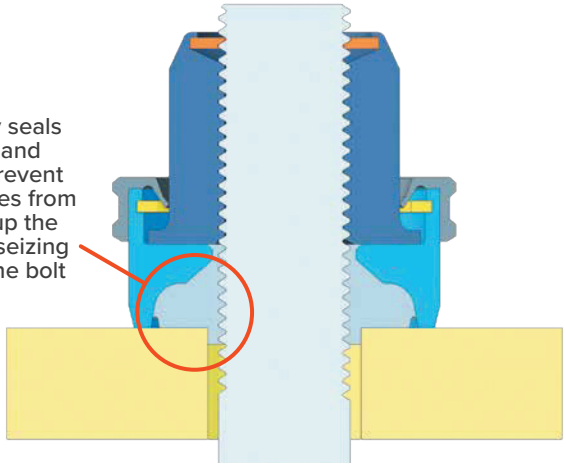
THE ULTIMATE SEAL SOLUTION

Seal prior to compression



Seal after full compression

Completely seals bolt hole and thread to prevent the slurry fines from migrating up the thread and seizing the nut to the bolt



PROVEN IN THE FIELD

CASE STUDY: KALGOORLIE SUPERPIT FIMISTON SAG MILL

NORTHERN STAR RESOURCES LIMITED

FEB 2020

Initial installation of 497 Kombo Washers (756 Capacity)

AUG 2020

1st reline – 488 Kombo Washers re-installed

JAN 2021

2nd reline – 476 Kombo Washers re-installed

KCGM's estimated savings are $483,705 per reline on 756 washer SAG Mill

Kombo sealing washer's attrition rate is less than 1% on each reline

Reported no leaks

Reline crew feedback is positive

Reported Kombo Washers held torque better from retorque shutdown

Reline process easier and cleaner to manage, one part as compared to three parts, and no waste on the mill deck and ground floor (Improved housekeeping)

“THESE ARE A GREAT IDEA, VERY EASY TO USE AND ARE A BENEFIT EITHER WAY – TIME, REUSABILITY, LESS WASTE AND LESS CLEAN UP.”

CORY JONES, PROCESS CONTROL ENGINEER
KCGM SUPER PIT, NORTHERN STAR RESOURCES LIMITED

TECHNICAL DETAILS

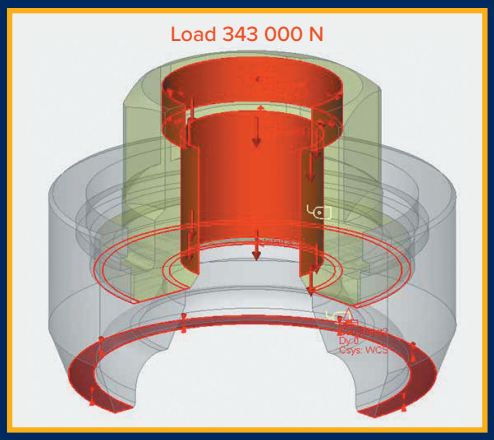
KOMBO WASHER STRENGTH – M36 EXAMPLE

Assembly takes full clamp load without deforming

M36 at full installation torque of 2200 Nm will provide 343,000 N clamp force.
This holds the liner plates tightly in place.

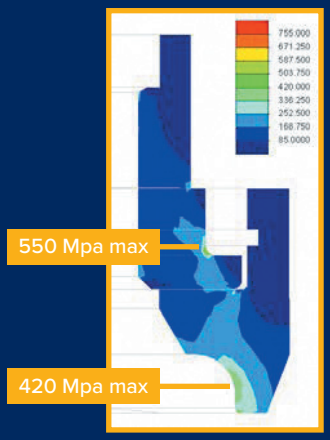
Material properties	
Tensile strength, ultimate	772 Mpa
Tensile strength, yield	580 Mpa
Modulus of elasticity	205 Gpa
Poisson's ratio	0.29

FEA (Finite Element Analysis) constraints



Bottom face of the NUT is fixed in Z-direction and free in XY

FEA Results



LEGACY PRODUCT WEAKNESS – M36 EXAMPLE

Washer fails at 50% load

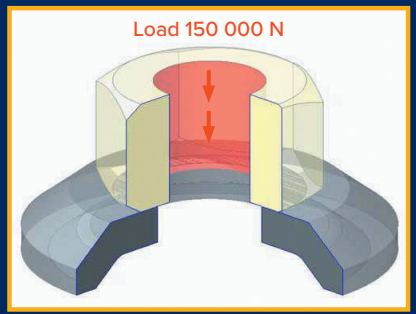
The washer bends beyond the yield point of the material at less than 50% of the design required load value of 343,000 N.

At full required load the washer collapses and permanently deforms. Resulting bend creep results in loss of load tension on the bolt and loose wear plates.

Material properties	
Tensile strength, ultimate	440 Mpa
Tensile strength, yield	370 Mpa
Modulus of elasticity	200 Gpa
Poisson's ratio	0.29

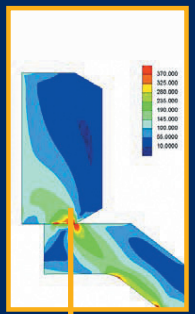
Standard Product #1 Analysis

FEA constraints



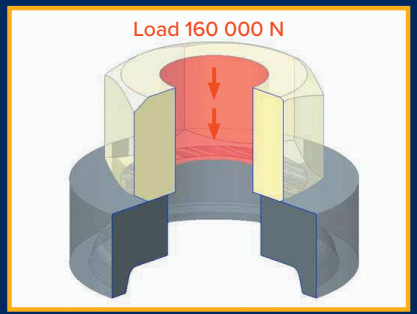
Bottom face of the NUT is fixed in Z-direction and free in XY

FEA Results



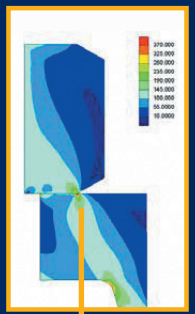
Standard Product #2 Analysis

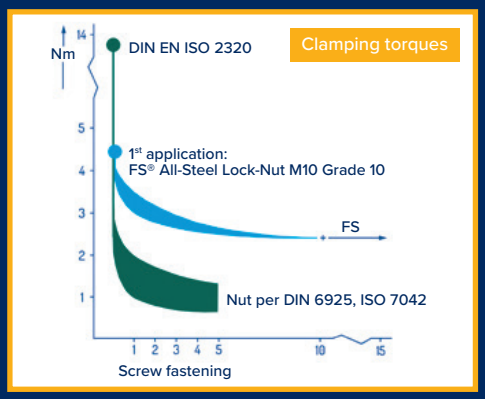
FEA constraints



Bottom face of the NUT is fixed in Z-direction and free in XY

FEA Results





Property class according to DIN EN ISO 898-2:

04, 05, 8, 10, 12

Mechanical properties:

DIN EN ISO 2320 (DIN EN 20898-2 / DIN EN ISO 898-2)

Stainless steels:

A2-035, A2-040, A2-70, A2-80, A4-035, A4-040, A4-70, A4-80

Surface coatings:

Galvanic surfaces according to DIN EN ISO 4042 (zinc-iron, zinc-nickel, etc.), zinc flake coating according to DIN EN ISO 10683

Threads:

Metric and Imperial: standard thread. All other dimensions, materials and surfaces, per drawing, upon request.

Clamping torques [Nm]			
d	1. Screw fastening	1. Unscrewing	15. Unscrewing
	max.	min.	min.
M 24	56.0	11.5	8.0
M 36	95.0	21.0	16.0
M 48	130.0	40.0	25.0
M 52	160.0	50.0	30.0

After the 5th time of unscrewing the fastener, the clamping torque will remain constant. Recommended tightening speed is 100-150 rpm for steel and galvanized steel, a maximum of 30 rpm for stainless steel.

Verification calculations are recommended for the locking torques. (VDI 2230-2015). Further locking torques can be found in the separate Kombo Washer data sheet.

Kombo Washer All-Steel Lock-Nuts, made of austenitic steel can be bolted together without additional lubricants. The nuts are covered with a special surface coating, preventing them from pitting onto the bolts.

KOMBOWASHER

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