



WHITE PAPER

HYDRO LUBRICATION

Lubrication Redefined Through the Engineering of Water



B3C Fuel Solutions

Executive Summary

Meaningful innovation in lubrication must improve the attributes that matter most: wear, friction, heat handling, vibration, biodegradability and sustainability, while addressing logistics and cost. The field of tribology, the science of friction, wear and lubrication, continually seeks advances across these critical areas.

Tribology specialist B3C Fuel Solutions has redefined lubrication through the engineering of water. Instead of relying on conventional oil, **Hydro Lubrication** uses water as a functional component combined with specialized chemistry to deliver the protection and operating stability required by modern equipment. Beyond its biodegradability and sustainability advantages, **Hydro Lubrication** offers performance advantages over conventional lubricants across key performance measures while creating even greater opportunities in cost, transportation, storage, resource use and environmental impact.

B3C Fuel Solutions' portfolio of hydro lubricants, developed under the **Better Than Oil™** tradename, is among the most advanced and diverse hydro lubricants available and used today, demonstrating the usefulness and potential of Hydro Lubrication across an expanding range of applications and industries. As the world's leading manufacturer of hydro lubricants, B3C's portfolio includes bar and chain, blade and chain, air tool, conveyor belt, penetrating, and other industrial lubricants. The unique formulation offers similar performance to traditional PAG (Polyalkylene Glycol) oil formulations at much lower cost parameters.

Engineering Water

Innovative lubrication must improve performance, meet biodegradability and sustainability demands, and remain cost effective. B3C's extensive research and testing to achieve true innovation in lubrication led to one of the world's most abundant resources as a base for its lubricants: water. Readily available, non toxic and non flammable, water also offers exceptional cooling and friction reducing properties. Through advanced engineering and specialized chemical formulation, water based hydro lubricants such as the **Better Than Oil™** portfolio have proven the ability to outperform conventional petroleum based lubricants across key performance measures and by their very nature (water-based) provide much greater tolerance to water encroachment and its potential subsequential issues.

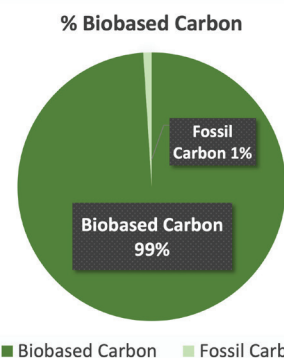
Biodegradability and Sustainability

Biodegradability and sustainability are increasingly sought after and often required in modern lubrication. Global standards such as ISO 14001 emphasize environmental performance, resource efficiency and waste reduction, while ISO 50001 promotes energy efficiency.

Hydro lubricants address these priorities by replacing petroleum oil with water and biodegradable chemistry. The result is a petroleum-free lubricant with greater biodegradability, reduced environmental persistence, easier water cleanup and more efficient use of resources.

B3C hydro lubricants are up to 99% biobased per ASTM D6866-20 testing and potentially 100% biobased given fossil carbon can be introduced erroneously through contaminants, including during testing.

ASTM D6866-20 - Standard Test for Determining Biobased Content of Liquid, Solid, Gas



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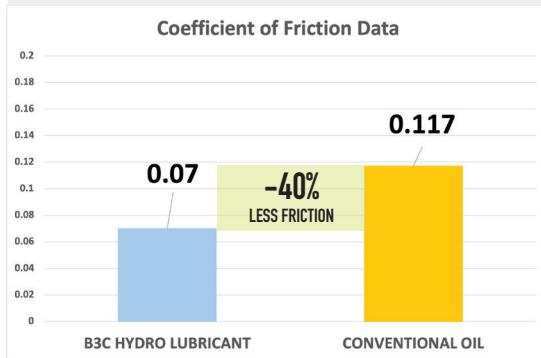
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Friction and Wear

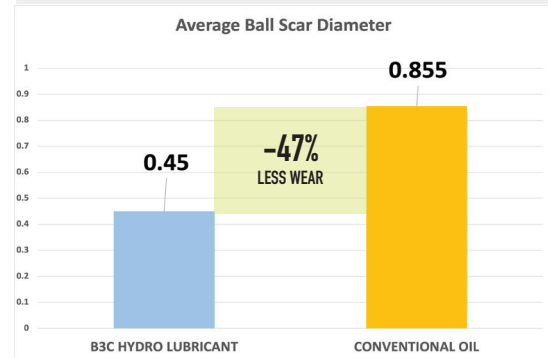
Reducing friction is fundamental to effective lubrication, helping limit wear, heat generation, vibration and energy loss. Hydro Lubrication achieves exceptional friction reduction by combining a primarily water based formulation with advanced lubricity and antiwear chemistry. ASTM D4172 testing measures both Coefficient of Friction (COF), the resistance between moving surfaces, and Four Ball Wear, the resulting wear scar under controlled test conditions. With greater than 40% improvement in testing, lower COF and smaller wear scars indicate that hydro lubricants offer superior lubrication performance, providing clear measures for comparing hydro lubricants with conventional lubricants.

ASTM D4172 – Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)



Using Industry Standard Falex Four-Ball Wear Test (ASTM D4172), B3C Hydro Lubricant reduced friction (as measured by the Coefficient of Friction) as much as -40%.

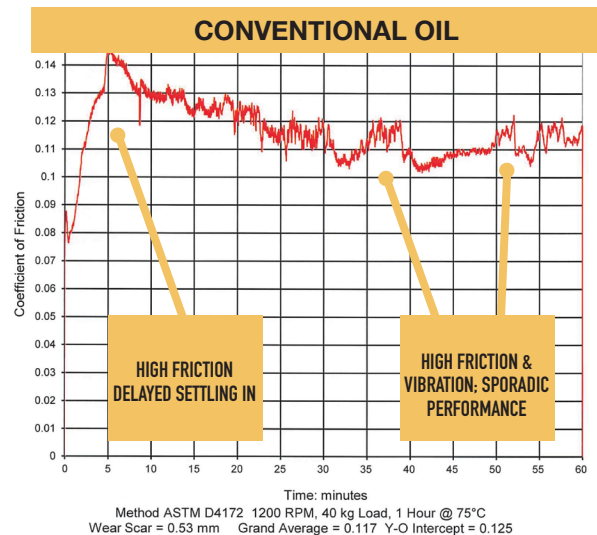
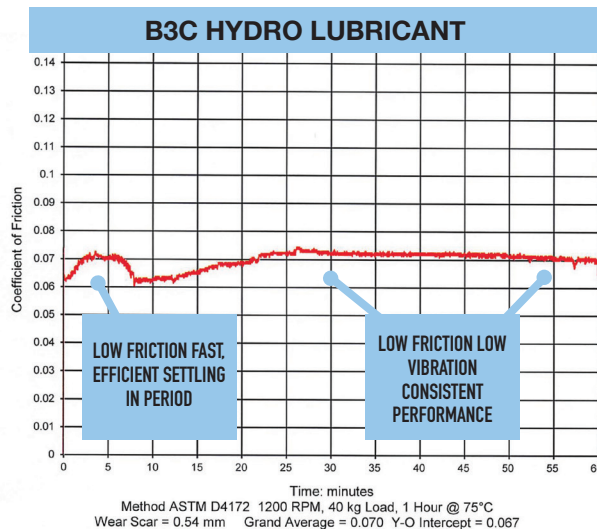
ASTM D4172 – Standard Test Method for Wear Preventive Characteristics of Lubricating Fluid (Four-Ball Method)



Using Industry Standard Falex Four-Ball Wear Test (ASTM D4172), B3C Hydro Lubricant reduced wear (as measured by ball scar diameter) as much as -47%.

Vibration Reduction

Friction and vibration are closely related, as unstable friction at moving contact surfaces can generate oscillation, vibration and inconsistent mechanical performance. The ASTM D4172 data provides insight beyond average Coefficient of Friction by showing how friction behaves throughout the test cycle. Testing demonstrates that hydro lubricants reach a low friction state quickly and maintain a remarkably stable friction profile, while comparison lubricants exhibit a longer settling in period with higher and more variable friction. Hydro lubricant's combination of low and stable friction translates directly into smoother operation and reduced vibration.

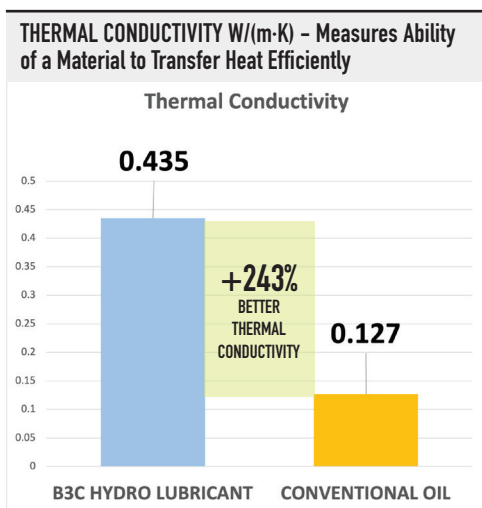


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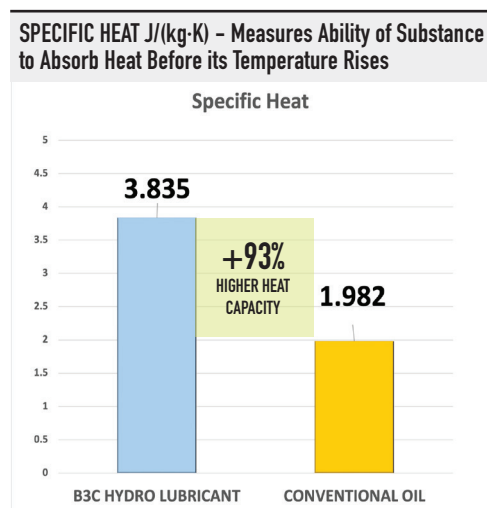


Better Heat Handling

Hydro lubrication offers a significant advantage in heat management, beginning with lower friction and vibration that can reduce heat generation at moving surfaces. Its water-based formulation provides an additional thermal advantage. Thermal conductivity, measured in $W/(m \cdot K)$, indicates how effectively a lubricant transfers heat, while specific heat capacity, measured in $J/(kg \cdot K)$, indicates how much heat it can absorb before its temperature rises. B3C testing demonstrates 243% greater thermal conductivity and 93% greater specific heat capacity than petroleum based oil, providing a powerful combination: less heat generated and greater ability to absorb and dissipate the heat that remains.



Hydro Lubricant dissipates heat away 243% more efficiently than conventional oil and therefore does a superior job of cooling.



Hydro Lubricant has 93% higher heat capacity; i.e. it takes more heat energy to raise the temperature of the lubricant.

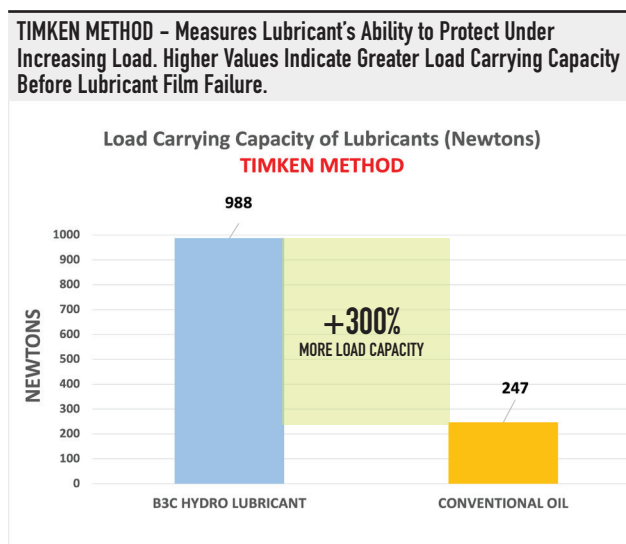
Load Carrying Capacity in Newtons

Hydro lubricants provide exceptional load carrying capacity, building on the advantages of lower friction, vibration and heat.

The Timken Method evaluates a lubricant's ability to maintain protection as increasing force is applied between moving metal surfaces, with a higher failure load indicating greater load carrying capacity.

Hydro lubricants sustained over 988 Newtons of force compared with 247 Newtons for conventional oil, providing more than 300% greater load carrying capacity.

Under moderate load, the hydro lubricant also required less amp draw, demonstrating the potential to carry greater loads with reduced power demand. The implications are great for hydro lubricants to help increase battery life in battery operated equipment where lubrication is critical, i.e. battery operated chainsaws.



Hydro Lubricants demonstrate over 300% better load bearing capacity compared to conventional oil.

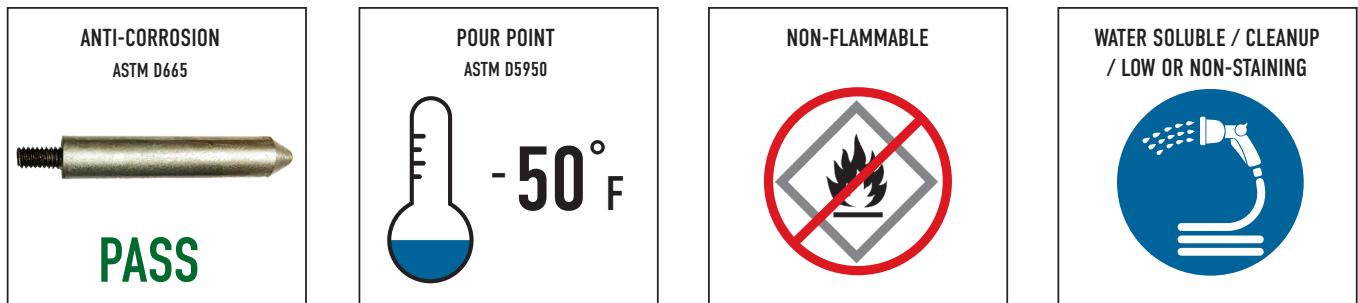
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Additional Critical Attributes (Anti-Corrosion, Temperature, Flammability, Water Cleanup)

In addition to reducing friction, wear, vibration and heat while supporting greater loads, hydro lubricants offer important advantages across demanding operating environments. Corrosion protection can be evaluated using ASTM D665, which measures a lubricant's ability to prevent rust on steel in the presence of water. B3C hydro lubricants demonstrated highly effective protection in this test. ASTM D5950 pour point testing, which determines the lowest temperature at which a lubricant remains capable of flow, demonstrates performance down to minus 50°F for B3C Hydro Lubricants. The water based chemistry also makes hydro lubricants nonflammable, providing an additional safety advantage where heat, sparks or ignition sources may be present.

Water compatibility provides another practical advantage. Unlike petroleum oils that can require solvents or degreasers for removal, water soluble hydro lubricants can allow equipment, surfaces and spills to be cleaned with water, reducing residual oil, cleanup complexity and dependence on additional cleaning chemicals.



Efficiency Beyond Lubrication

The advantages of Hydro Lubrication extend well beyond the lubricant itself. Lower friction, vibration and heat can reduce mechanical and energy losses, while replacing petroleum oil with water replaces dependence on finite resources with a resource available in abundance. Combined with biodegradability, water cleanup and longer component protection, Hydro Lubrication creates opportunities to reduce energy, resource consumption, environmental impact and total operating cost.

The Concentrate Advantage

B3C's expertise in Hydro Lubrication has led to one of its most significant advancements: Concentrated Hydro Lubrication. Because water represents a significant portion of the finished lubricant, B3C has engineered concentrated formulations that allow much of that water to be added at the point of use rather than manufactured, packaged, stored and transported as finished lubricant.

This concentration technology can be engineered across a wide range of ratios and applications. A mix of 1 part concentrate to 4 parts water reduces finished lubricant volume stored and transported by 80%, while 1 part concentrate to 19 parts water reduces that volume by 95%. As concentration increases, so does the potential to reduce packaging, storage space, freight weight, transportation, fuel consumption and associated environmental impact.

B3C has taken concentration beyond logistics and developed it as a functional lubrication platform. By engineering specific water ratios, viscosity, tack, penetration and film characteristics can be adjusted for different operating requirements. This allows B3C's Concentrated Hydro Lubrication technology to span a broad spectrum of applications, from sprays and penetrating lubricants to drip systems, conveyors, chains, tools, heavy industrial applications and grease like lubrication.

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A Broad Hydro Lubrication Portfolio

B3C's work in Hydro Lubrication extends across a diverse range of applications, including bar and chain, conveyor and open chain, blade and chain, hand and industrial air tools, penetrating and general purpose lubricants, pump protection, rock drilling lubricants and concentrated formulations.

Each presents different requirements for friction, wear, load, tack, penetration, temperature and operating environment. This breadth demonstrates the versatility of Hydro Lubrication and B3C's ability to engineer the technology across a growing range of lubrication applications.

Further, B3C's Hydro Lubrication products are proven, accepted and in practical use today by Original Equipment Manufacturers (OEMs), industrial users and consumers, with broad availability across retail channels.

The Future is Now

Hydro Lubrication represents more than an alternative to conventional oil. It is a more advanced lubrication platform. By engineering the unique properties of water with specialized lubrication chemistry, Hydro Lubrication can improve the attributes that matter most, including friction, wear, vibration, heat management, load capacity, biodegradability, sustainability and operating safety.

Concentrated Hydro Lubrication extends these advantages even further, creating significant opportunities to reduce transportation, storage, packaging, resource use, cost and environmental impact while expanding the functional range of the technology.

B3C Fuel Solutions has established a leadership position in this emerging field. With extensive research, testing and one of the world's broadest portfolios of hydro lubricants already in use across consumer, commercial and industrial applications, B3C has advanced Hydro Lubrication from technology to practical application.

The performance is proven, the applications are expanding and the future of lubrication is already here.

