世界首創

奈米泵及奈升(nl)潤滑技術開拓未來

Nanopump® and Nanoliter(nl) Lubrication pave the way to the future

*奈米泵是個精準以奈升(nl)供油潤滑的泵、以奈升(nl)給油潤滑技術將引領機械器具進入新領域。*以最少的供油提供最大限度潤滑效果, 引進此項技術可維持高產能的製造環境、減少對主軸的磨損、故障風險、對機器能有效保養, 降低了對環境不良的影響。

The Nanopump® enables precise lubrication in nanoliter units, **introducing a groundbreaking nanoliter(nl) lubrication technology that takes machine tools to a new level. By maximizing lubrication effectiveness with minimal oil consumption, it significantly reduces wear and the risk of failure. This innovation ensures efficient maintenance, lowers environmental impact, and fosters a more sustainable and productive manufacturing environment.**

各式各樣的奈米泵®

全部皆獨立式給油、給油量約10nl~90nl

Nanopump® unit

承載奈米泵的主軸　Nanoliter(nl) Lubrication spindle

載入奈升(nl)潤滑主軸的技術革新(背景)

1.以往的空氣加壓給油方式供應主軸過多油分、使軸承無法發揮最大產能,且多餘油霧充斥於工廠內部,助長地球溫暖化

2. 精密機器的軸承的理想旋轉狀態是在一個完全清潔、乾燥、沒有潤滑的情況下旋轉, 但是沒有潤滑的情況軸承只能維持幾秒鐘不壞。

3. 為了延長軸承的理想旋轉狀態, *奈升(nl)技術將 10 至 90 納升的最小油量精確輸送到幹式軸承中*

4. 這種對根本問題進行徹底重新設計的目的是在最佳性能與環境保護之間取得平衡

The Technological Innovation Embedded in the Nanoliter (nl) Lubrication Spindle

1.In traditional oil-air lubrication systems, excessive amounts of oil are supplied to spindle bearings, preventing them from achieving optimal performance. Moreover, this oversupply increases oil mist within the factory and may contribute to the acceleration of global warming.

2.The ideal rotation state of a bearing is experienced for only a few seconds when a perfectly clean, dry bearing starts rotating without lubrication.

3.To sustain this ideal lubrication state over time, nanoliter (nl) lubrication technology ensures *the precise delivery of minimal oil amounts, ranging from 10 to 90 nanoliters*, to dry bearings.

4.This redesign of the lubrication system from the ground up aims to balance peak performance with environmental preservation.

奈升(nl)主軸帶來的性能增強
"Performance Enhancements brought by Nanoliter(nl) Lubrication Spindles"

*奈升(nl)技術是因應將潤滑油精確地供應到軸承內「需要」潤滑的區域,不給油至不必要的場所所開發的技術。*圖 1 說明軸承內部的摩擦條件。通過從強滑動接觸區 (S) 到輕微滾動-滑動接觸區 (R-S) 進行潤滑，軸承可以實現其最佳性能。任何供應到其他區域的多餘油都會降低軸承的性能。圖 2 顯示了實現此目的的潤滑油供應方法。奈升(nl)技術有望實現以下性能改進：

The nanoliter (nl) lubrication technology was developed to supply lubricating oil precisely to the areas within the bearing that require lubrication while avoiding unnecessary supply to other areas. Figure 1 illustrates the friction conditions inside the bearing. By lubricating from the strong sliding contact area (S) to the mild rolling-sliding contact area (R-S), the bearing can achieve its optimal performance. Any excess oil supplied to other areas reduces bearing performance. Figure 2 shows the lubrication oil supply method that makes this possible. The following performance improvements are expected from this nanoliter (nl) lubrication technology:

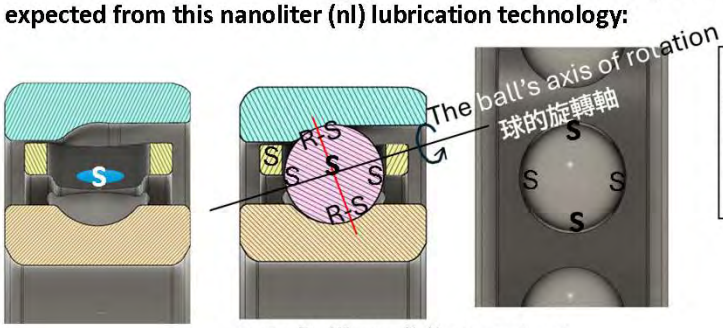


Fig.1 軸承內部的摩擦狀態

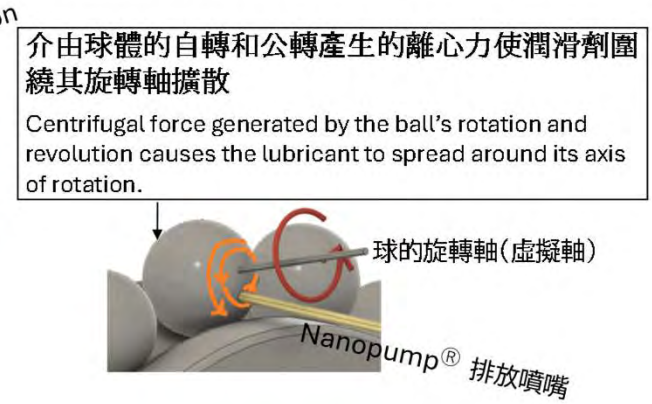


Fig.2 向軸承球供應潤滑劑的方法

1. 減少機器的摩擦和磨損 Reduction of Friction and Wear
2. 減少摩擦而產生的熱影響 Reduction of Thermal Impact
3. 減少排斥多餘油分的振動 Reduction of Vibration
4. 機器運轉動能可全力投入產能提升效率 Improved Energy Efficiency
5. 奈米給油提升主軸的安定性、延長機器保固期限 Extended Maintenance Intervals
6. 由於給油量減少、減少廢油、保護環境 Reduced Environmental Impact

由於以上優勢，將奈升(nl) 潤滑應用於傳統機械有望提高精度、可靠性和能源效率，從而長期降低成本
Through these effects, applying nanoliter (nl) lubrication to conventional machinery is expected to enhance precision, reliability, and energy efficiency, leading to long-term cost reductions.

用 奈升(nl) 潤滑革新主軸技術
"Revolutionizing Spindle Technology with Nanoliter(nl) Lubrication"

Nanoliter(nl) Lubrication spindle

奈升(nl) 潤滑技術減少了傳統油量的 1/50 至 1/100，顯著降低了主軸振動和噪音。
Nanoliter(nl) lubrication technology reduces oil supply by 1/50 to 1/100 of traditional amounts, significantly lowering spindle vibration and noise.

因此，它增強了與 AE(acoustick emission-聲發射)和 AI (人工智能)技術的相容性，從而顯著提高了過程監控和工具故障預測的準確性。這種下一代解決方案提高了工廠的生產力和可靠性。
As a result, it enhances compatibility with AE (Acoustic Emission) and AI technologies, leading to a dramatic improvement in the accuracy of process monitoring and tool failure prediction. This next-generation solution boosts both productivity and reliability in factories.

奈升(nl) 潤滑主軸的環境貢獻
"Environmental Contributions of Nanoliter(nl) Lubrication Spindles"

通過將奈升(nl) 技術應用於機床主軸, 除了性能改進外, 還可以預期與週邊設備相關的各種好處。這樣可以提高系統效率、降低成本並減少對環境的影響。具體好處如下:

By applying nanoliter lubrication(nl) technology to machine tool spindles, various benefits related to peripheral equipment, in addition to performance improvements, can be expected. This leads to greater system efficiency, cost reduction, and a decrease in environmental impact. The specific benefits are as follows:

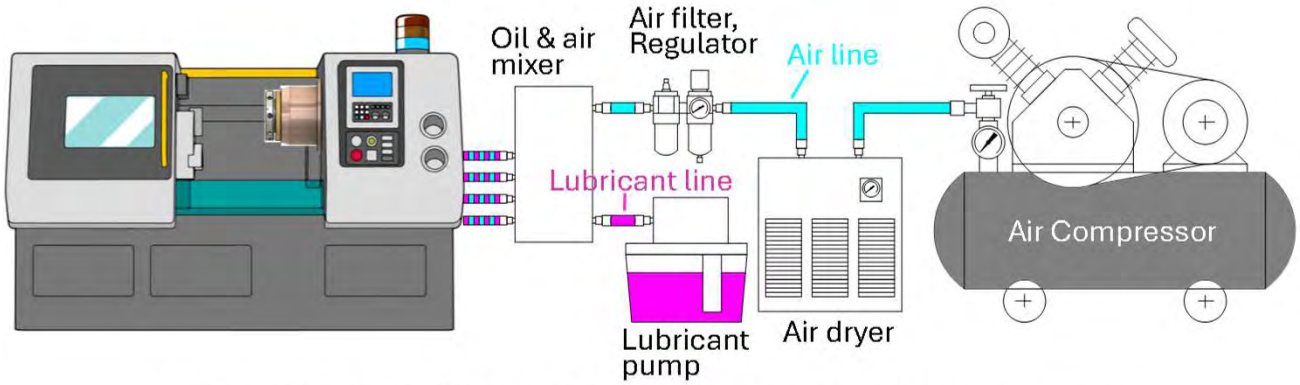


Fig.3 典型的空氣加壓給油系統 Typical oil-air lubrication system

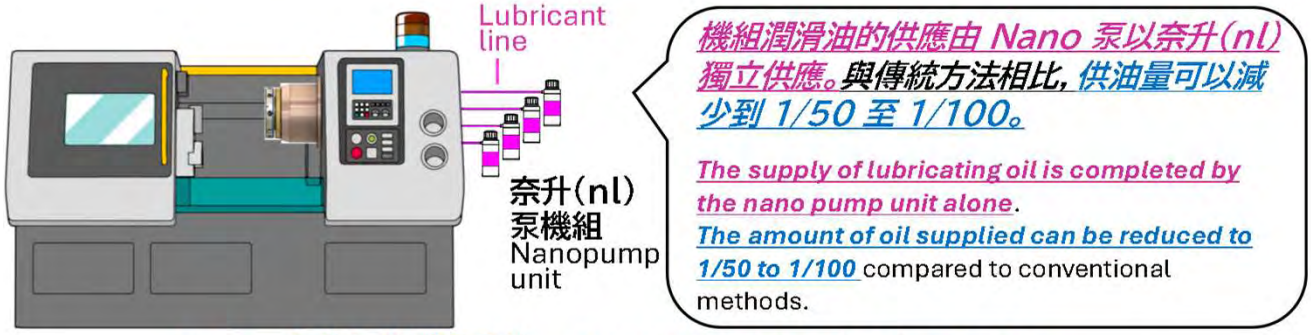


Fig.4 奈升(nl)潤滑系統 Nanoliter(nl) Lubrication System

1. **減少空氣加壓給油裝置的設置 Reduction of Oil-Air Lubrication Systems**
2. **空氣壓縮機設置的縮減 Reduction of Air Compressors**
3. **裁減油霧裝置設備 Elimination of Oil Mist Systems**
4. **減少潤滑油的管理成本 Lower Lubrication Oil Management Costs**
5. **有效降低工廠噪音 Noise Reduction**
6. **管線及設備的簡單化 Simplification of Piping and Equipment**
7. **減輕工廠內空氣調節系統的負担 Reduced HVAC Load**
8. **減輕對環境造成的負面影響 Environmental Improvement**
9. **提升員工作業的安全、保障員工健康 Improved Worker Health and Safety**
10. **有效供油可延長機使用年限 Extended Machinery Lifespan**

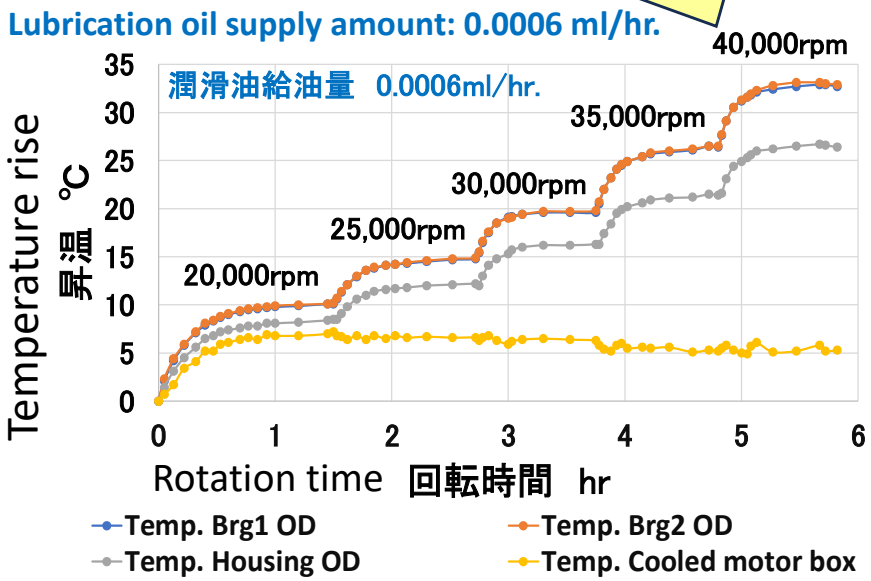
綜上所述, 奈升(nl) 技術將通過提高效率和降低工廠運營成本, 為實現可持續發展目標SDGs和carbon neutral做出巨大貢獻。

In summary, Nanoliter lubrication(nl) technology will greatly contribute to the realization of SDGs and carbon neutral by improving the efficiency and reducing costs of factory operations.

奈升(nl)潤滑主軸的回轉性能範例
"Example of rotational performance of a Nanoliter(nl) Lubrication spindle"

VG32 oil is supplied at 20 nl intervals every 120 seconds, confirming a spindle speed of 40,000 rpm. Achieved oil supply volume of less than 1/100 of the current level.

每120秒的間隔供給VG32油20nl、確保主軸轉速40,000rpm。
實現了供油量低於現有水平的1/100。



測試條件#7008,預載入壓力140N, 無軸承冷卻狀態,轉速以 5000 rpm 的增量增加, 測量軸受的外徑溫度的變化

Test conditions: 7008, preload 140N, room temperature 27℃, no bearing cooling. The rotational speed is increased by 5000 rpm increments, and the outer diameter temperature of the bearing is measured.

Design & Development
Upfield LLC
Dr. Hiroshi Ueno, Ph.D. (Engineering)
5-202-2 Handa, Sayama City, Osaka
E-mail: ueno@upfieldllc.com
Lab: 1-9-22 Fushiyama, Tondabayashi City

Sales
T.A.T. Co.,ltd.
Rresident TAKETO HIOKI
1-11-8, Awaza, Nishi-ku, Osaka-shi 55-0011
TEL 06-4390-4543 Fax 06-6534-7860
E-mail: t.hioki@tat-web.co.jp