WHITE PAPER

Improving Efficiency and Uptime Through Smarter Drivetrain Design

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Improving Efficiency and Uptime Through Smarter Drivetrain Design

Whenever our engineers speak to operators across the oil and gas sector – from upstream to downstream – they report hearing the same story over and over again: operators are under increasing pressure to improve performance, but they also need to keep a close grip on spending.

This pressure to do more with less is fundamentally changing the way upgrades, investments, and maintenance works. When operators are trying to improve efficiency, extend asset life, and reduce unplanned downtime within tighter budget limits, every single component in the drivetrain comes under intense scrutiny. Decisions that might once have been treated as routine specification work now have a direct bearing on uptime, maintenance demand, and lifecycle cost – and with research from McKinsey[1] finding that just 1% downtime can cost oil and gas companies more than US$5 million per year the pressure is higher than ever.

This is particularly true for critical drivetrain components such as couplings. Often treated as a secondary consideration, couplings are now being recognised for the central role they play in managing loads, accommodating misalignment, and protecting connected equipment across a wide range of oil and gas applications.

A coupling, for example, may occupy only a small space within the overall machine, but operators are coming to realise that its impact on reliability and system behaviour can be significant. That principle applies across the full oil and gas value chain. From upstream drilling and production to midstream transmission and LNG infrastructure, and on to downstream processing and refining

This whitepaper looks at what drivetrain optimization means in practice.

Rotating equipment does not respond only to rated power and speed, but also to how the machine starts, accelerates, and experiences load fluctuations.

It explores why modernisation efforts such as efficiency upgrades, variable-speed operation and changing drive strategies can introduce new mechanical demands, even when the overall goal is to improve performance. It also looks at why drivetrain design deserves a more strategic role in oil and gas projects, and how the right combination of coupling selection, engineering analysis, and broader system support can help operators improve uptime, protect critical assets, and make the most of both their equipment and their capital budget.

[1] https://www.mckinsey.com/capabilities/operations/our-insights/ manufacturing-analytics-unleashes-productivity-and-profitability

Balancing Efficiency and Reliability

Across the oil and gas industry, efficiency and reliability are often discussed as separate priorities. In practice, they are closely linked, and most upgrade and modernisation projects succeed or fail on how well the two are balanced.

That balance matters more than ever as operators look to get more from existing assets. Outside of the booming LNG sector[2], the priority is no longer major greenfield expansion, but improving the performance of installed equipment. That may involve retrofitting systems, changing the driver, introducing variable-speed operation, or refining the day-to-day operating strategy. In each case, the aim is broadly the same: improve performance, reduce operating cost, and extend the useful life of critical equipment.

Efficiency is often the most obvious starting point. Compressors, pumps, and other rotating equipment consume substantial amounts of energy, so even modest improvements can make a meaningful difference to operating costs. This is one reason electric motors and variable-speed systems are gaining ground in suitable applications, as they can offer clear benefits in terms of energy performance, with research showing typical reductions in energy usage of 5-15%[3].

However, efficiency gains only deliver real value if the equipment remains dependable over the long term. For example, variable-frequency drives are typically set to operate at a defined nominal speed, but small inherent oscillations around that setpoint can still occur. These subtle speed variations can introduce oscillating torques into the drivetrain, which need to be considered as part of the overall system design. If this behaviour is not properly accounted for, any savings generated by improved efficiency can quickly be offset by increased vibration, premature wear, and unexpected downtime.

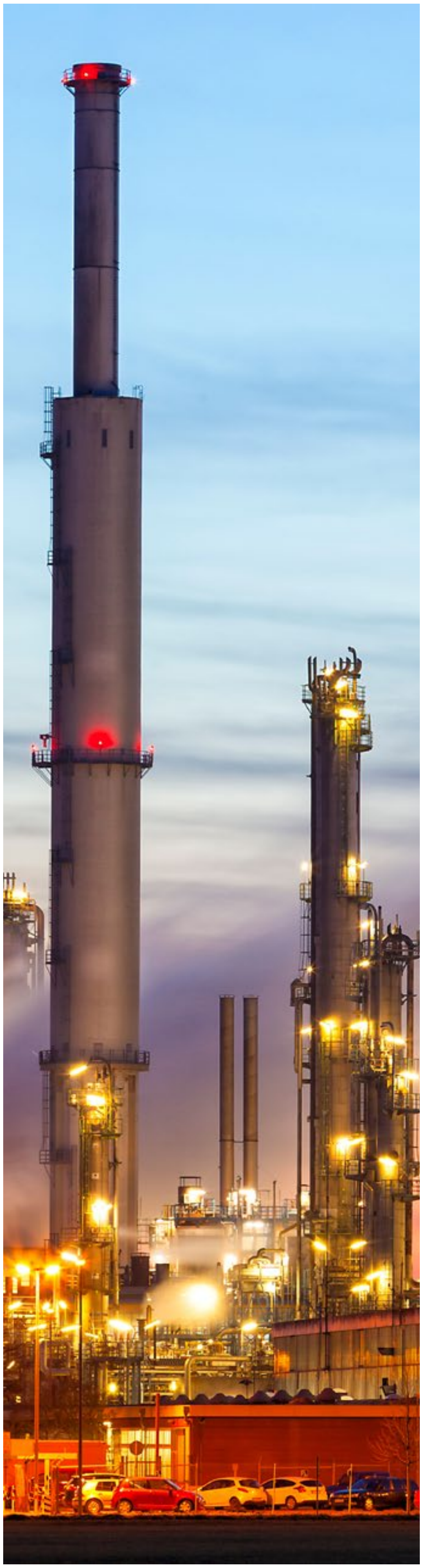
This is where modernisation becomes more complex than it first appears.

Improving performance is rarely a matter of replacing one component with another like-for-like. In many applications, a change in drive technology or operating strategy also changes the behaviour of the full rotating system. Rotating equipment does not respond only to rated power and speed; it responds to how the machine starts, how it accelerates, how loads fluctuate, how speed varies in operation, and how the driver and driven equipment interact.

Gas compression is a good example. It often represents a major source of energy consumption in oil and gas sites, with some platforms devoting 50% of their available power to the gas compression system[4]. Unsurprisingly, then, there is growing interest in improving efficiency and reducing lifecycle cost through electric motors and adjustable-speed operation where the application allows. Those approaches can deliver major benefits in terms of energy usage, but they also place greater importance on coupling selection, torsional behaviour, and the broader response of the rotating system. Applications that once ran at a relatively fixed operating point may now need to pass through torsional and lateral critical speeds to hit the desired operating speed, respond more dynamically to demand, or operate under different load conditions.

That can create a tougher mechanical environment than many operators expect. Changes in speed profile and driver type can affect vibration levels, resonance risk, startup behaviour, and the loads seen by couplings, shafts, and bearings. In some cases, a more efficient setup may also be a mechanically harsher one if damping, misalignment capacity, and overload protection are not properly matched to the duty.

The challenge is not just to install more advanced equipment, therefore, but to make sure the whole drivetrain can support that change reliably over time. This is why reliability must be treated as part of the same engineering problem as efficiency. In demanding pump, compressor, and turbine services, even relatively small drivetrain components can have a major effect on uptime if they are poorly matched to the application. The right selection, sizing, and support strategy help reduce wear, control vibration, protect connected equipment, and avoid avoidable downtime.



Just 1% downtime can cost oil and gas companies more than US$5 million per year.

[2] https://www.shell.com/what-we-do/oil-and-natural-gas/liquefied-natural-gas-lng/lng-outlook-2025.html
[3] https://www.osti.gov/pages/servlets/purl/2576741
[4] https://www.sciencedirect.com/science/article/pii/S2949891023003469

The Right Coupling Strategy Protects the Whole System

Couplings serve as an excellent example of how sensible component selection can deliver meaningful results over the long term.

These components sit between expensive pieces of rotating equipment, and they have to do far more than simply transmit torque from one shaft to another. In many oil and gas applications, the coupling has a direct influence on vibration behaviour, misalignment tolerance, overload response, and the long-term condition of the connected machine.

That is why coupling selection should be treated as an engineering decision, not a simple catalogue exercise.

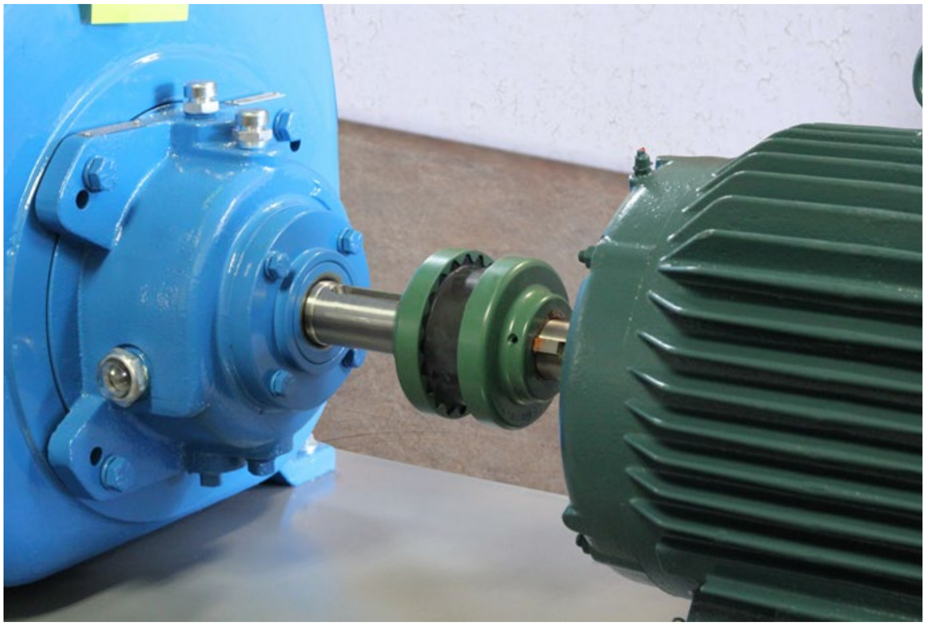
A well-matched coupling helps the whole drivetrain run more smoothly and predictably. It can accommodate the level of misalignment the application is likely to see, manage torsional behaviour across the operating range, and, where needed, absorb or dampen vibration that would otherwise be passed into shafts, bearings, and other components. In some cases, it can also provide a level of overload protection, either by acting as a mechanical fuse – deliberately failing before any damage is caused to more expensive components – or by working alongside a dedicated torque limiting device.

A poorly matched coupling, in contrast, does the opposite. It can raise bearing loads, increase wear, shorten maintenance intervals, and turn a manageable operating event into a more serious failure that can potentially take an entire site offline until repairs can be made.

For operators and OEMs, the practical advice is simple: coupling choice should begin with the application, not with the product range. A few questions are worth settling early:

- What is driving the machine: an electric motor, a gas engine, a turbine, or something else?
- Will the system run at a fixed speed, or across a variable range?
- Are shock loads, pulsating loads, or frequent starts expected?
- How well can alignment be controlled in practice?
- Is overload protection needed, and if so, how should it be handled?

The answers shape what "good" looks like.



A well-matched coupling helps the whole drivetrain run more smoothly and predictably.

In demanding pump, compressor, and turbine services, even relatively small drivetrain components can have a major effect on uptime.

In compressor and pump applications, for example, disc couplings are often a strong fit where speeds are high, alignment is well controlled, and precise torque transmission is needed. Torsionally soft couplings, by contrast, tend to be better suited to variable-speed duties, pulsating loads, damping requirements, and applications where resonance tuning matters. That distinction is useful because it keeps the focus where it belongs: not on which coupling is best in the abstract, but on which coupling best supports the real operating conditions of the machine.

This is also where looking beyond nominal power and speed pays off. Two machines with similar ratings may need very different coupling strategies if one sees frequent transients, a wider speed range, or more difficult alignment conditions. In those cases, the right choice is often the one that gives the operator the lowest overall risk and the best long-term value, and the right engineering partner can help to determine the best solution.

A good coupling strategy protects more than the coupling itself. It protects the bearings, the shafts, the driver, the driven equipment, and, ultimately, the uptime of the whole system.

Understanding Coupling Types and Their Role in Drivetrain Performance

Selecting the right coupling starts with understanding that not all designs behave in the same way. Different coupling types are built to handle different combinations of torque, misalignment, speed, and dynamic load, and those differences have a direct impact on system performance.

At a high level, most couplings fall into two broad groups: material flexing designs and mechanical flexing designs. Material flexing couplings rely on elastomeric elements or flexible metallic components to absorb misalignment and damp vibration, while mechanical flexing couplings accommodate movement through the interaction of metal components and typically require lubrication.

Within those categories, several common coupling types are widely used across oil and gas applications:

Jaw couplings
These are comparatively simple, general-purpose designs that use elastomeric elements to transmit torque while providing a degree of vibration damping. They are well suited to lower torque duties and applications where ease of installation and basic misalignment capability are sufficient.

Tire couplings
Tire-type couplings use a rubber or polyurethane element to transmit torque in shear. Their key advantage lies in their ability to handle high levels of misalignment while also reducing the transmission of shock loads and vibration. This makes them a practical choice for pumps, compressors, and general rotating equipment where operating conditions are less tightly controlled.

Disc and diaphragm couplings
These metallic designs are typically used in high-speed, high-performance applications. They offer high torsional stiffness, precise torque transmission, and the ability to operate at elevated speeds with minimal backlash. As a result, they are commonly specified for turbomachinery and compressor trains where alignment is well managed and performance demands are high.

Torsionally soft couplings
These couplings incorporate elastomeric elements specifically to absorb vibration and damp torque fluctuations. By shifting torsional resonances away from the operating range, they help protect connected equipment from damaging oscillations. This makes them particularly valuable in variable-speed applications or where pulsating loads are present.

Gear and grid couplings
These mechanical flexing designs are known for their high torque capacity. Gear couplings, in particular, can transmit very high torque within a compact footprint, while grid couplings combine steel strength with a degree of torsional damping. Both are widely used in heavy-duty industrial applications but require proper lubrication and maintenance to perform reliably.

Fluid couplings
Fluid couplings introduce a different approach by using hydraulic principles to transmit torque. They allow for soft starts, controlled acceleration, and inherent overload protection, reducing mechanical stress on the drivetrain during transient events.

The key point is not that one coupling type is better than another, but that each offers a different balance of characteristics.

Some designs prioritise torque density and stiffness. Others focus on misalignment capability or vibration damping. Some perform best in steady-state operation, while others are better suited to variable speed or fluctuating loads.

In oil and gas applications, where operating conditions are rarely uniform and the cost of failure is high, that distinction matters. Selecting a coupling based only on nominal power and speed risks overlooking the factors that most strongly influence reliability in service.

Different Applications Need Different Answers

This careful, considered philosophy can be applied right across the drivetrain. From motors to bearings, the right answer depends on the duty, the operating profile, and what the operator is trying to achieve with the available budget, footprint, and maintenance resource.

For that reason, matching the product to the application matters just as much as product quality. In high-speed or precision duties, where alignment is well controlled and accurate torque transmission is critical, disc or diaphragm couplings are often the better fit. These designs are well suited to compressor trains, turbine-driven equipment, and other demanding services where reliability at speed is essential.

Regal Rexnord's portfolio includes a broad range of solutions in this space, including **CENTA™**, **Falk™ Steelflex™** and **Stromag™** couplings. The **Kop-Flex™ Max-C™** resilient coupling is widely used in turbomachinery applications where they use large synchronous motors, as it is easily able to handle the high levels of torque experienced during startup. Meanwhile, the **Bibby™ Turboflex™** high performance disc couplings are ideally suited to sensitive high speed turbocompressors, while still offering an economical solution and being fully compliant API-671/ISO10441 for critical oil and gas, energy, and petrochemical applications.

The needs of a powertrain can vary hugely depending on scale, application, and usage.

Other duties place a different set of demands on the drivetrain. Where operators are dealing with higher vibration, variable-speed operation, pulsating loads, or more difficult alignment conditions, torsionally soft or highly elastic couplings such as those in the **CENTAFLEX™** range can offer a better balance of protection and performance. In these cases, damping capability and flexibility become more important, particularly where the system needs help managing oscillation, tuning resonance behaviour, or coping with the real movement and variation seen in service.

Overload protection also deserves careful thought. In some systems, the coupling may be expected to act as the weak point and protect more expensive assets by failing first. In others, a more deliberate torque-limiting strategy makes better sense, especially where transient overloads are part of the operating reality and avoiding secondary damage is a priority. Regal Rexnord's broader oil and gas offering reflects that wider protection mindset, combining coupling solutions with torque limiters through its **Rexnord™ Autogard™** brand, **Perceptiv™** monitoring technologies, and related drivetrain products to help operators build a more robust system overall.

This is also where breadth of offering becomes a real advantage. Because Regal Rexnord can draw on a wide portfolio of coupling types and related drivetrain technologies, it is better placed to match the solution to the duty rather than trying to force the duty to suit a narrow product range. That gives operators and OEMs more room to make the best decision for their application between upfront cost, maintenance requirements, installation constraints, and long-term performance.

The common thread is straightforward enough: the most cost-effective choice is rarely the cheapest part at the point of purchase. It is the solution that gives the operator the best combination of reliability, maintainability, and service life in the real application. In oil and gas, where downtime is expensive and operating conditions are rarely forgiving, that is usually the decision that pays back fastest.

The Power of a Reliable Engineering Partner

Of course, not every drivetrain issue is so easy to spot at the specification stage. A system may appear sound on paper, with the right power rating, the right nominal speed, and a suitable coupling in place, yet still carry hidden mechanical risks that only emerge once the machine is running in the real world.

This is especially true when equipment operates across a wide speed range, sees frequent starts and stops, or is exposed to fluctuating loads. Under those conditions, the real behaviour of the drivetrain depends on far more than nameplate data. Shaft stiffness, coupling characteristics, inertia, damping, and the interaction between the driver and driven machine all play a part in determining how the system responds in service.

That is why torsional vibration analysis (TVA) is such a valuable engineering tool. Rather than looking at components in isolation, TVA examines how the complete rotating system behaves across the operating range. It helps identify where resonance may occur, whether transient events could create damaging torque peaks, and how the drivetrain is likely to respond during startup, shutdown, and changing load conditions.

The oil and gas industry places several high demands on its equipment, including the components used in the powertrain.

In practice, that can help answer some very important questions before a system is installed or upgraded. Will the machine pass through a critical speed during startup? Is a variable-speed operating window likely to excite torsional resonance? Is the chosen coupling providing the damping and flexibility the application really needs? Could a change in driver or duty cycle create new stresses elsewhere in the train?

By identifying these issues early, TVA gives operators and OEMs a far better chance of solving the real problem before it becomes an operational one.

This is also where engineering support becomes a true differentiator. Selecting from a broad range of products is useful, but it is only part of the job. What many customers need is help understanding how their system will behave, potential risks that need addressing, and where design or specification changes will have the greatest effect.

Regal Rexnord supports that process with both drivetrain expertise and product breadth. Instead of treating couplings as standalone parts, the business can help customers look at the wider rotating system and make decisions based on operating reality rather than assumption.

That allows operators to move beyond simple component replacement and towards a more informed engineering approach — one that reduces uncertainty, protects critical assets, and makes upgrade decisions more likely to deliver the intended result over the long term.

Regal Rexnord offers both comprehensive drivetrain expertise and unmatched product breadth.

Better Drivetrain Decisions Support Better Oil and Gas Operations

The oil and gas sector will continue to evolve. The pace and direction of that change will vary by region, application, and energy mix, but the broad pressures are already clear. Operators are being asked to improve efficiency, strengthen reliability, control lifecycle cost, and get more value from existing assets, often while working within tighter capital limits and more demanding operating conditions.

Meeting those goals depends on more than replacing worn parts or specifying higher-performing equipment in isolation. It depends on understanding how modernisation affects the full drivetrain and on making decisions that reflect how the machine will actually operate over time. A change in driver type, speed range, or operating strategy can create real gains, but only if the surrounding components are selected and engineered to support that new reality. Otherwise, an upgrade that looks strong on paper can introduce new vibration issues, maintenance burdens, or reliability risks that erode its value in service.

That is why drivetrain design deserves more attention in oil and gas projects than it sometimes receives. Whether the application sits upstream, midstream, or downstream, the same principle applies: when the coupling, protection strategy, monitoring approach, and surrounding components are all well matched to the duty, the plant is in a far better position to run efficiently, reliably, and predictably.

That system view is reflected in Regal Rexnord's broader oil and gas offering, which spans couplings, bearings, gear drives, clutches, brakes, monitoring technologies, and lifecycle support across a wide range of applications.

For operators and OEMs trying to make the most of both their budget and their equipment, that is the real opportunity. Better drivetrain decisions do not just improve one part of the machine. They help protect uptime, extend asset life, reduce avoidable intervention, and give modernisation projects a better chance of actually delivering the performance gains they promise.

Regal Rexnord's oil and gas offering spans couplings, bearings, gear drives, clutches, brakes, monitoring technologies, and lifecycle support across a wide range of applications.

About the Company

Regal Rexnord Corporation is a global leader in the engineering and manufacturing of factory automation sub-systems, industrial powertrain solutions, automation and mechanical power transmission components, electric motors and electronic controls, air moving products, and specialty electrical components and systems.

Through longstanding technology leadership and an intentional focus on producing more socially conscious and environmentally-friendly products and sub-systems, the Company is regularly addressing increasingly relevant secular demands of customers in the medical, alternative energy, aerospace, food & beverage, general industrial and warehouse/intralogistics end markets, among others. In short, Regal Rexnord's 30,000 associates around the world are proud to be working each day towards fulfilling the Company's purpose: to create a better tomorrow with sustainable solutions that power, transmit, and control motion.

Regal Rexnord is comprised of three operating segments: Industrial Powertrain Solutions, Power Efficiency Solutions, and Automation and Motion Control. Regal Rexnord is headquartered in Milwaukee, Wisconsin and has manufacturing, sales and service facilities worldwide. For more information, visit www.regalrexnord.com.

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