



# SKF solutions for pumps in extreme environments

Pushing the limits of pump performance in extreme operating environments



The Power of Knowledge Engineering

# Performance and reliability from deep sea to...



## Sub-sea screw pumps

With demand for new ocean oil and gas sources driving companies deeper than ever, demand for equipment that can reach those reserves more reliably and affordably is rising, as are pressures to minimize safety risks for workers in remote and potentially dangerous environments. Sub-sea screw pumps offer an enticing solution – the industry’s prime solution for extracting oil as deep as 3 000 meters in a single-step process. And advanced bearing technologies from SKF are helping to make it possible.

## The SKF solution

Able to offer a level of performance and reliability that standard steel bearings, journal bearings and magnetic bearings cannot match, the SKF sub-sea screw pump solution features several advanced bearing materials and designs.

The SKF bearing arrangement for each rotor consists of two CARB toroidal roller bearings to accommodate shaft deflection and axial displacement. A four-point angular contact ball bearing is used to locate the shaft axially. The bearings are constructed from SKF super-tough VC444 stainless steel, which features high amounts of nitrogen for superior fatigue and corrosion resistance.

In addition to this arrangement, bearing design upgrades can be made according to application needs. SKF hybrid bearings include ceramic rolling elements which reduce inertial forces and heat. Special cage designs offer further resistance to corrosive environments. NoWear coating contributes to reduced friction, and INSOCOAT coating provides protection from electric currents.

Currently used in commercial rig installations, the SKF solution for sub-sea screw pumps is helping companies:

- Achieve single-step oil extraction as deep as 3 000 meters
- Increase field recovery rates by up to 20%
- Reduce oil recovery times
- Cut maintenance and operating costs
- Avoid critical pump failures
- Minimize production losses
- Extend pump service life
- Increase worker safety

*CARB toroidal roller bearing with NoWear coated stainless steel rolling elements and specially designed cage. CARB toroidal roller bearing accommodates a wide range of loads and speeds from low to high.*



# deep freeze



## Cryogenic pumps

As their name suggests, cryogenic pumps move extremely cold, liquefied gases throughout the world's plants and pipelines and operate under extreme conditions.

Beyond the negative temperatures, these pumps may run continuously under start-stop cycles. Bearing arrangements operate without any traditional lubricants, relying instead on the liquefied gases flowing through them for lubrication.

Unfortunately, these liquefied gases are often polluted with liquid contaminants and abrasive particles, and may run under less than optimal fluid conditions for the pump. Bearings are also subject to high rotational speeds, vibration during stand-stills and stray electric currents.

Considering these operating conditions, it is not surprising that bearing service life for cryogenic pumps is typically less than six months, with extremely high maintenance and repair costs, worker safety risks, and lost production along the way. Backed by related R&D experience with product-media lubricated bearing solutions, SKF engineers have developed a solution that increases cryogenic bearing service life by up to six times and helps to minimize sudden and unexpected failure.

## The SKF solution

The SKF cryogenic pump solution features VC4444, a specially heat-treated variant of SKF super-tough stainless steel that delivers excellent protection against corrosion, wear and fatigue.

This SKF solution also includes hybrid bearings – deep groove ball bearings with ceramic rolling elements – plus a flexible, single piece glass fiber reinforced PEEK cage. Both of these components help boost reliability in this harsh, media lubricated application.

SKF can propose and implement specific upgrades, specify bearing designs, and document and supervise mounting as required.

The SKF cryogenic pump solution is helping companies:

- **Increase MTBR by up to six times**
- **Reduce maintenance and associated costs**
- **Reduce unplanned downtime**
- **Avoid critical pump failures**
- **Minimize production losses**
- **Extend pump service life**
- **Increase worker safety**
- **Reduce secondary damage to pump parts**

# Advantages of VC444 material

## Superior corrosion and fatigue resistance

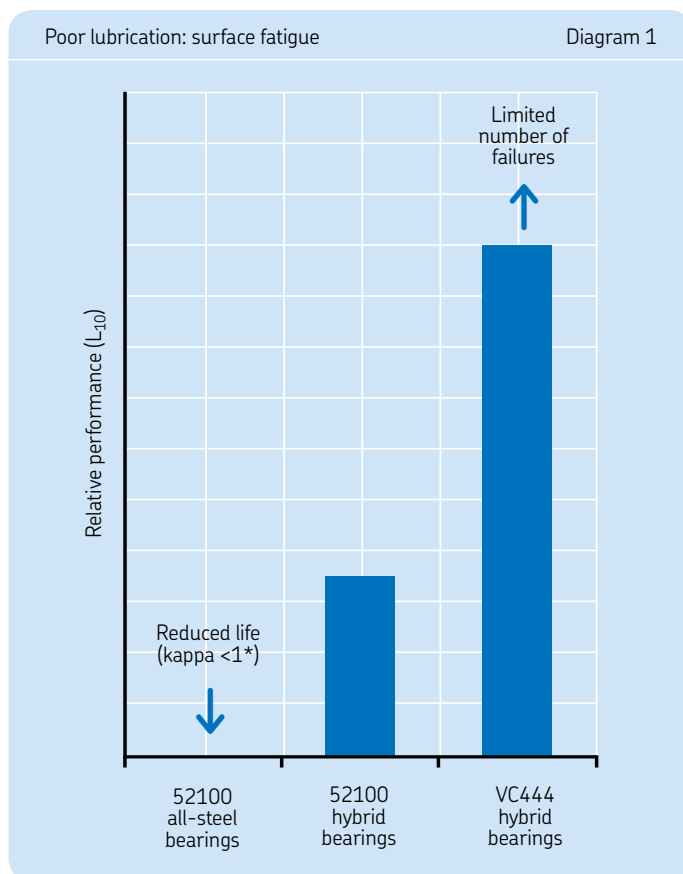
VC444 is a new generation of high-chromium-nitrogen steel with superior corrosion resistance, enhanced fatigue properties and a high degree of toughness. This new ultra-clean steel has a minimum number of inclusions and an extremely low carbon content. The reduced carbon content, which is the result of adding nitrogen, increases corrosion resistance and enhances the grain structure of the steel.

## Extended service life

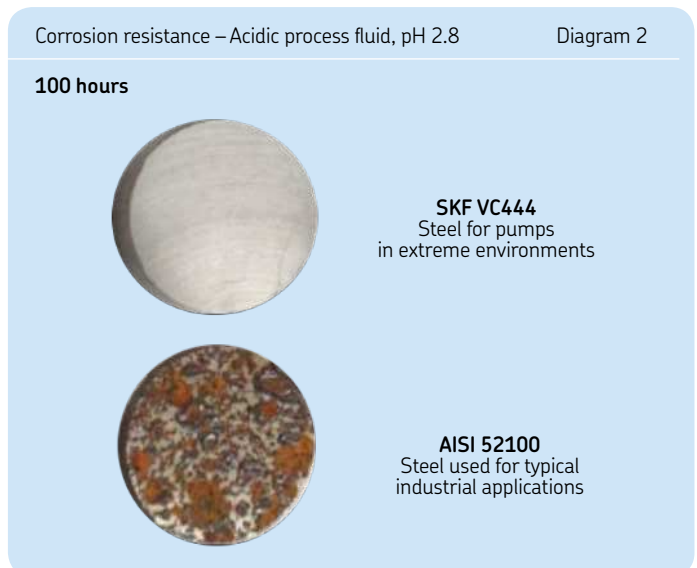
SKF hybrid bearings made from VC444 bearing steel use bearing grade ceramic (silicon nitride) rolling elements. When compared to steel, silicon nitride rolling elements are lighter and harder, resulting in the following benefits:

- **Reduced inertial forces within the bearing**
- **Reduced heat generated by the bearing**
- **Increased stiffness of the bearing arrangement**
- **Increased service life of the bearing**
- **Extended maintenance intervals**
- **Higher speeds**
- **Reduced frictional moment within the bearing**

SKF bearing solutions, whether with VC444 steel rings or ceramic rolling elements, have been shown to provide a dramatic increase in bearing service life under good lubrication conditions, when compared to all-steel bearings made from 52100 steel.



Under poor lubrication conditions, SKF super-tough VC444 stainless steel resists surface fatigue nearly three times as long as standard hybrid steel. (Diagram shows SKF in-house life test results.)



High nitrogen levels in SKF super-tough VC444 stainless steel make it highly resistant to corrosive fluids.

\* Actual kinematic viscosity of lubricant divided by kinematic viscosity required to achieve surface separation

# Develop your pump solution with SKF Engineering Consultancy Services

Whether you want to confirm that your special pump solution will be “right” from the start, or to troubleshoot an existing pump design problem, SKF Engineering and Application consultants can help.

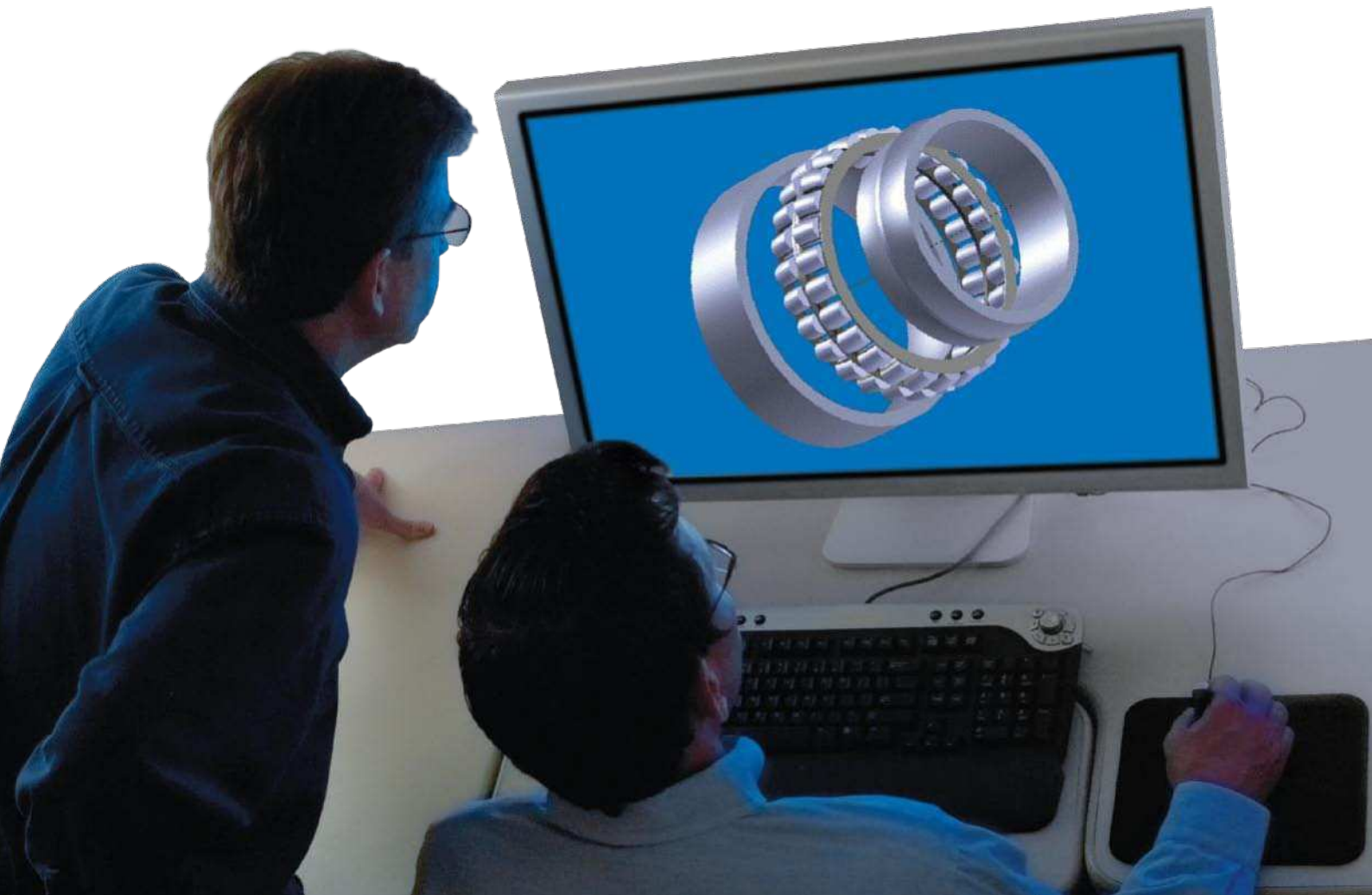
Backed by more than 100 years of rotating machinery expertise and extensive oil and gas industry application experience, SKF consultants will work with you to help ensure that your solution package is ideal for your application and operating conditions.

SKF Engineering Consultancy Services experts were instrumental in developing our sub-sea and cryogenic pump solutions, working closely with OEMs and end-users alike on the initial pilot projects. We can do the same for your project with a range of advanced tools and services.

Using proprietary simulation software, we can help designers optimize designs while still in the prototype stage. Designers can explore the merits of various options with a virtual SKF test rig that simulates component performance under a variety of conditions.

SKF also subjects prototypes to actual application conditions and performs root cause failure analysis, as well as metallurgical, lubrication, seal and chemistry testing. Benefits include:

- **Reduced product life cycle costs**
- **Reduced time to market**
- **Faster delivery times**
- **Improved product reliability**





### **The Power of Knowledge Engineering**

Drawing on five areas of competence and application-specific expertise amassed over more than 100 years, SKF brings innovative solutions to OEMs and production facilities in every major industry worldwide. These five competence areas include bearings and units, seals, lubrication systems, mechatronics (combining mechanics and electronics into intelligent systems), and a wide range of services, from 3-D computer modelling to advanced condition monitoring and reliability and asset management services. A global presence provides SKF customers uniform quality standards and worldwide product availability.

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