



STEEL BEARINGS

Your essential guide



Your essential guide to this essential workhorse

Choosing a bearing material is one of the most important bearing design decisions. Traditionally steel has reigned supreme, as the bearing material of choice.



While it may be tempting to step away from the most common bearing material, in favour of ceramic or plastic bearing types, steel very much still has its part to play in certain applications. But which ones? And how do you weigh up if steel is the right choice for you?

As the final guide in our materials miniseries, we present the differences between chrome steel and stainless steel, along with our handy advantages and disadvantages summaries. We also delve into the applications where stainless steel bearings feel right at home, helping you to make an informed choice on material selection.

Corrosion resistance matters, so we cover this topic as well as some other burning customer queries in our FAQ section. If you have any remaining questions after reading this guide, call a member of the SMB Bearings technical team on +44 (0)1993 842555

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WHAT'S THE DIFFERENCE?

What's the difference between stainless
steel vs chrome steel bearings...



SAE52100 CHROME STEEL

- ⚙️ **HIGH HARDNESS FOR LONGER LIFE RATINGS**
- ⚙️ **LOW COST**
- ⚙️ **CAN BE EXPOSED TO TEMPERATURES OF 120°C CONSTANTLY OR UP TO 150°C INTERMITTENTLY**
- ⚙️ **POOR CORROSION RESISTANCE SO NOT RECOMMENDED FOR LOW TEMPERATURE USE DUE TO CONDENSATION RISK**

Chrome steel is the standard steel used for most ball bearings as it is harder than stainless steel and gives greater life ratings. For applications that require low noise, it is favoured over 440 grade stainless steel for its superior low noise qualities.

Chrome steel performs well in moderately hot temperatures and can tolerate continuous temperatures of up to 120°C. Above this temperature, it undergoes greater dimensional change and the hardness is affected, reducing load capacity. It can withstand temperatures up to 150°C intermittently, but above this temperature, bearing life is significantly reduced. To guard against corrosion, these bearings require a protective oil coating on the outer surfaces so cannot be used dry.







However, the real cost savings come from the reduced friction that plastic bearings can offer compared with steel. Plastic bearings can reduce costs up to 25 per cent with their low coefficient of friction because easier to spin bearings use less energy.



STAINLESS STEEL

Martensitic grades were developed in order to provide a group of stainless alloys that would be corrosion resistant and can be hardened by heat treatment. The martensitic grades are chromium steels containing no nickel.

The most common austenitic alloys are iron-chromium-nickel steels and are widely known as the 300 series. The austenitic stainless steels are the most corrosion resistant of the stainless group providing unusually fine mechanical properties. These are, however, more costly. So, how do you pick between the popular 440 martensitic grade and 316 austenitic grade options?








-  **GOOD CORROSION RESISTANCE TO WATER AND MANY WEAK CHEMICALS**
-  **GOOD FOR TEMPERATURES FROM -70°C UP TO 250°C CONSTANT OR 300°C INTERMITTENT**
-  **SLIGHTLY SOFTER THAN CHROME STEEL SO LOWER LOAD RATINGS**
-  **WILL CORRODE IN SALT WATER OR SALT SPRAY AND HAS POOR RESISTANCE TO ACIDS/ALKALIS**
-  **MORE EXPENSIVE THAN CHROME STEEL**
-  **MORE RESISTANT TO CORROSION DUE TO THE GREATER CHROMIUM CONTENT AND THE ADDITION OF NICKEL**

440 grade stainless steel is the most commonly used for corrosion resistant ball bearings. In 440 grade stainless steel, the chromium reacts with oxygen in the air to form a chromium oxide layer, known as the passive film, on the surface of the steel. It is hardened by heat treatment and gives a good combination of strength and corrosion resistance. However, the load capacity of 440 grade stainless steel is approximately 20 per cent less than chrome steel, so life ratings will be slightly reduced. Sapporo Precision use KS440 stainless steel (X65Cr13) which has superior hardness and low noise qualities to the more common AISI-440C grade.

440 grade stainless steel does come out on top when considering high temperature applications. It will withstand higher temperatures than chrome steel, coping with up to 250°C constant exposure and up to 300°C intermittently with reduced load capacity. Above 300°C, bearing life can be considerably shortened.

For general corrosion resistance, this grade exhibits good corrosion control properties and can be used in fresh water and weak chemical environments. However, if exposed to seawater environments or aggressive chemicals, 316 grade stainless steel should be considered.

AIS316 AUSTENITIC STAINLESS STEEL

-  **VERY GOOD CORROSION RESISTANCE TO WATER, SALT WATER AND MANY CHEMICALS**
-  **GOOD FOR TEMPERATURES UP TO 500°C AS FULL COMPLEMENT TYPE**
-  **SUITABLE FOR CRYOGENIC APPLICATIONS DOWN TO -250°C**
-  **ONLY SLIGHTLY MAGNETIC**
-  **MORE EXPENSIVE THAN 440 GRADE DUE TO LOW PRODUCTION QUANTITIES**
-  **SUITABLE FOR VERY LOW LOAD AND LOW SPEED ONLY**
-  **NOT SUITABLE FOR LOW NOISE APPLICATIONS**

316 grade stainless steel is commonly referred to as marine grade stainless steel and is used for greater corrosion resistance to seawater, salt spray and some acids/alkalis. 316 grade stainless steel exhibits good corrosion resistance in marine environments when used above the water line or when temporarily submerged, if washed down with clean water afterwards.

In addition to excellent corrosion resistance properties, these bearings are also suitable for very high temperature applications — up to a whopping 500°C. This is provided a suitable cage material is used or the bearings are full complement. Polyethylene, PEEK or PTFE are often used for retainers in 316 stainless steel bearings.

In addition, they can also be used in cryogenic applications as the steel retains its toughness down to -250°C. 316 stainless steel bearings have a negligible response to a magnetic field so are suitable for use in MRI equipment, for example.

In contrast, 316 grade stainless steel cannot be hardened by heat treatment and will only support low loads and low speed applications.

WHEN?

When should I invest in stainless steel bearings?...



WHEN SHOULD I INVEST IN STAINLESS STEEL BEARINGS?

Stainless steel bearings may be more expensive than chrome steel, but there are several key advantages that stainless steel offers, which are invaluable for certain applications. Being able to operate in extreme environments is crucial for many processing industries.

According to the IMPACT study conducted by NACE International, the world's leading corrosion control organisation, it has been estimated that between US\$375 and \$875 billion annually could be saved on a global basis if correct corrosion control measures were followed. Suddenly, the cost of stainless steel bearings seems very reasonable!



WILL THE BEARING BE OPERATING IN A CORROSIVE ENVIRONMENT?

Stainless steel bearings are widely used in the food and beverage and pharmaceutical industries where equipment is exposed to chemicals and undergo regular wash downs. They are also used where a protective oil coating on the bearing is not possible such as Ultra High Vacuum or cleanroom applications. These bearings can be supplied with chemically resistant lubricants or food approved lubricants for the pharmaceutical industry.

Check out our corrosion resistance chart to gauge which type of steel bearing best suits your corrosion resistance needs.

Non-corrosive environments	Moderately corrosive environments	Highly corrosive environments
For normal use, low to moderately high speed, all loads, low to medium temperature (less than 120°C constant and/or 150°C intermittent) opt for chrome steel bearings.	For normal use, low to high speed, all loads, low to medium temperature (less than 120°C constant and/or 150°C intermittent) use corrosion resistant 440 stainless steel bearings.	For highly corrosive environments with very low load/speed, use 316 stainless steel bearings with a chemical or saltwater resistant lubricant. 316 stainless steel does have a lower rolling accuracy than full ceramic bearings, so these should also be considered.
For high speed use, low to medium temperature (less than 120°C constant and/or 150°C intermittent) use chrome steel bearings with high speed grease. Consider polyamide cage and/or ceramic balls for higher speeds. Consider high temperature grease if in the higher temperature range.	For low load and speed use, low to medium temperature (up to 100°C constant) use corrosion resistant 440 stainless steel bearings. Plastic bearings may also be considered.	Stainless steel bearings are not suitable for use in highly corrosive environments with moderate to high load and low speed requirements. Check out our ceramic bearings guide, if you are sourcing a bearing for this environment.
For high temperature use (121°C to 250°C constant and/or 151°C to 300°C intermittent) use 440 stainless steel bearings with a stainless steel cage.	For high speed use, low to medium temperature (less than 120°C constant and/or 150°C intermittent) use corrosion resistant 440 stainless steel bearings. Consider polyamide cage and/or ceramic balls for higher speeds.	
For high speed and high temperature environments use (121°C to 250°C constant and/or 151°C to 300°C intermittent) use 440 stainless steel bearings with stainless steel cage and ceramic balls.	For high temperature use (up to 250°C constant), with very low load/speed, use corrosion resistant 440 stainless steel bearings with high temperature grease.	

FREQUENTLY ASKED QUESTIONS



Are you still curious to know more? Here are some of the questions the team at SMB Bearings are most commonly asked...

ARE ALL COMPONENTS OF MY BEARING FABRICATED FROM THE SAME STEEL?

NO

No, the material of your rings, balls, closures and retainer may vary — so here’s a look at the chemical composition of a regular chrome steel bearing versus a stainless-steel bearing.

Non-corrosive environments	Chrome steel bearings	Stainless steel bearings
Inner/outer rings	SAE52100 / SUJ2 / 100Cr6	AISI440C / SU440C / X105CrMo17 Or KS440 / AD34 / X65Cr13
Balls	SAE52100 / SUJ2 / 100Cr6	AISI440C / SU440C / X105CrMo17
Shields	SPCC steel sheet	AISI304 / SU304 / X5CrNi1810
Retainer	SPCC steel strip	AISI304 / SU304 / X5CrNi1810 Or AISI420 / SU420 / X20Cr13

STAINLESS STEEL VS CERAMIC BEARINGS

440 stainless bearings have moderate corrosion resistance but struggle with many stronger chemicals and salt water. 316 stainless steel has much greater chemical resistance and can be used at sea above the waterline or for temporary submersion if washed down. Ceramics have excellent corrosion resistance to many chemicals including concentrated acids and alkalis and can be permanently submerged in seawater without corroding.

Ceramic bearings have the highest temperature rating. Silicon nitride can cope with 800°C. Followed by 316 stainless steel at 500°C, then zirconia at 400°C and 440 stainless steel at 300°C. For low temperature use, 316 stainless steel wins

at -250°C followed by silicon nitride (-210°C), zirconia (-190°C) and then 440 stainless steel (-70°C).

For load and speed ratings, 440 stainless steel bearings are the clear winners. Full ceramic zirconia bearings can support roughly 90 per cent of the 440 stainless bearing load and 20 per cent of the speed. This is closely followed by ceramic silicon nitride bearings with 75 per cent load/25 per cent speed. Unfortunately, the much softer 316 stainless steel bearings with 15 per cent load and roughly 6 per cent speed fall behind in this race.

CAN STAINLESS STEEL BEARINGS BE USED WITHOUT ANY LUBRICATION?

A stainless steel bearing can be used “dry” or without any lubrication. Chrome steel bearings rely on a protective film of oil to prevent corrosion. This oil film is not required by stainless steel bearings.

Unlubricated stainless steel bearings should only be used at extremely low speeds. This is because lubrication reduces friction and prevents excessive heat build-up where metal to metal contact occurs. An unlubricated bearing will run much hotter at anything other than very low speed, leading to more rapid wear.



ANY OTHER QUESTIONS?

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