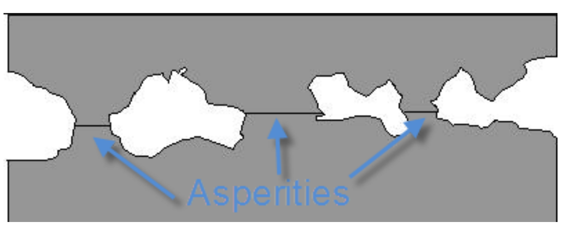
TECH BRIEFS

Galling Resistance of 25 Alloy and ToughMet 3® when Self Mated and Mated with Various Metals

Galling occurs when metals adhere to each other during sliding contact. This is especially important when considering threaded connections. If the surfaces adhere during connection, they will be damaged when they are disassembled leading to costly repair or replacement. The ability to disassemble and reassemble a connection is a valuable attribute to many applications. One example where this is especially important is in a drill string. Tubular components in a drill string need to be connected quickly, securely and be assembled rapidly and repetitively.

How Galling Occurs

No metal is perfectly smooth. All materials have valleys and ridges forming asperities. The surface areas of these asperities are extremely small creating a large amount of local pressure when they come together, much larger than the overall pressure. Some material combinations are able to form a bond under these conditions. In certain materials, this can be controlled and done purposely to form a strong weld without a heat affected zone. In cases such as threaded connections, this undesirable effect is called galling which leads to thread damage and in extreme cases complete seizure.



Material Interactions

In order for galling to occur, there has to be pressure and direct metal to metal contact with heat acting as a catalyst. Different material structures have different tendencies to gall. Some materials have protective oxides that act as a barrier preventing galling. Materials also create different amounts of heat and dissipate that heat at different rates. Another phenomenon is one material might initially gall onto the other with that material acting as a protective layer. What initially seems like a few straight forward factors quickly compounds into an extremely complex interaction.

General Rules for Galling:

- Softer materials have a higher tendency to gall
- Materials that are 100% miscible in their liquid state including self mated materials have high tendency to gall
- A smooth surface creates more contact areas creating more heat leading to higher galling tendencies
- A rough surface has a high occurrence of asperities interfering and deforming also creating heat
- Materials that have a high work hardening rate have a lower tendency to gall
- Materials that have a high strength to elastic modulus ratio have a lower tendency to gall

Strategies to Prevent Galling:

- Use lubrication to act as a barrier between the surfaces while reducing frictional heating
- Make the connection slower reducing the heat produced
- Use a thread locking compound to avoid applying stress that would lead to galling

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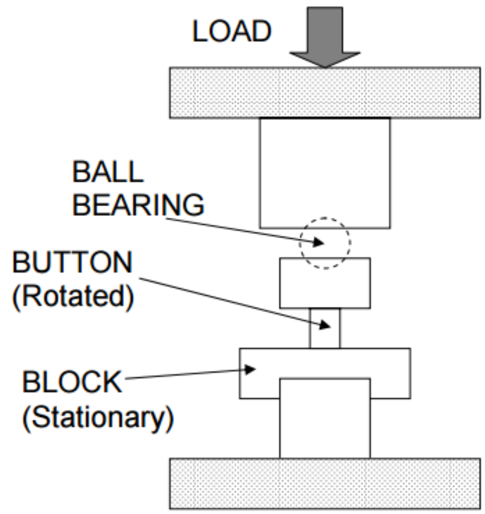
- Apply a surface hardening treatment (for steel)
- Hard face the mating surface with a coating
- Mate two different materials

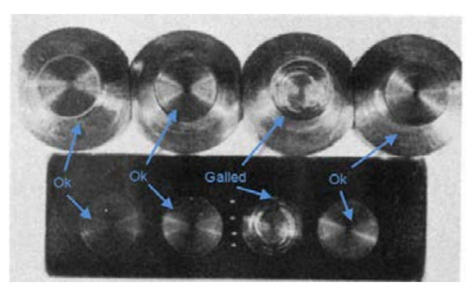
All these strategies are effective to varying extents but every one of them contains a compromise. The use of lubricating or locking compounds and slowing the speed all negatively affect productivity. Surface hardening steels sacrifice corrosion resistance. Coatings add cost and will have tendency to rub off. Mating two different materials can be effective but there will be an extra set of material properties to consider.

ToughMet 3 and 25 Alloy
Two exceptions to the tendency of self mated materials to gall are ToughMet 3 and 25 alloy. Not only are they galling resistant when used with themselves they are resistant when used with many other popular alloys used in well exploration. These alloys have superior non magnetic qualities to other materials commonly used and have a similar strength. They will perform both as an alternative and when used in conjunction with other popular materials.

Galling Test Method:
Due to the many variables that affect galling, materials that gall in one application may not under the same load in a different application. Therefore, it is not possible to develop a general test that can be used to determine the materials to be used based on a design force or pressure to be applied. Instead, a method called button on block was developed. This test standardizes the conditions and treats all the material combinations the same. It is useful in the beginning stages of design to choose material to test further in a specific application.



In this method, a button is placed on a block and turned 360°under a load. Both specimens are then observed under a 10x magnification. New specimens are tested and observed until galling is observed. Once galling is observed, the average of the last pressure applied and the highest pressure at which galling was not observed is taken and reported as the galling threshold pressure. The cross-sectional area of the button is used to calculate the pressure even though it is not necessarily accurate at low loads. In some cases due to the interaction with material properties and the nature of the tests, one of the materials severely deforms below the yield strength. This does not necessarily indicate that the materials would gall under that stress when in threaded contact. However, it does make it impossible to get a meaningful test result above that pressure. This effect is indicated on the charts below.



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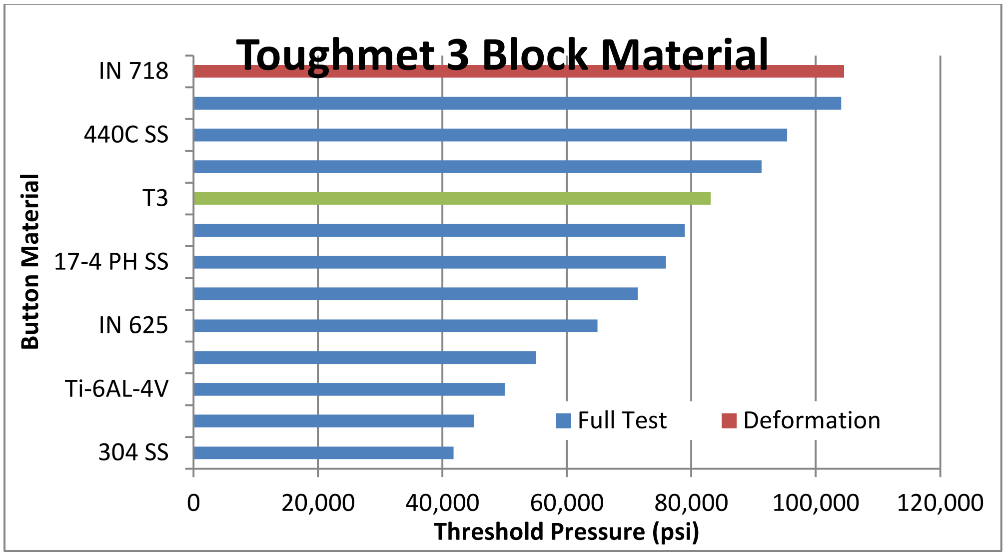
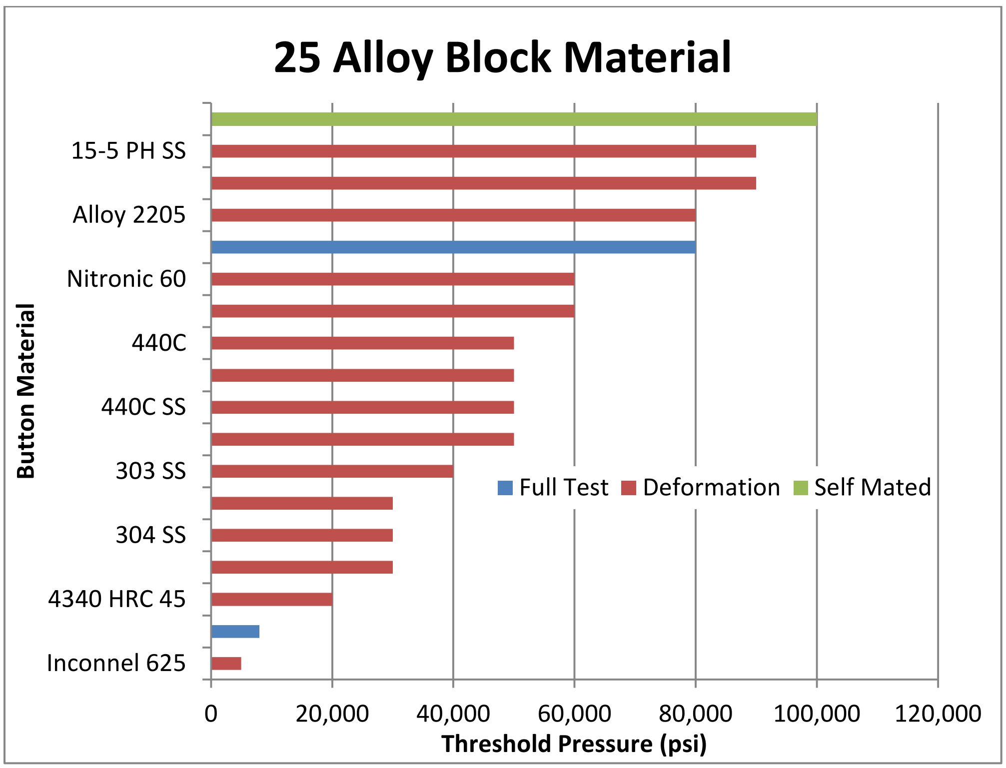
Results:





Safe Handling Of Copper Beryllium

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Safety Data Sheet (SDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Performance Alloys, Technical Service Department at 1-800-375-4205.

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