

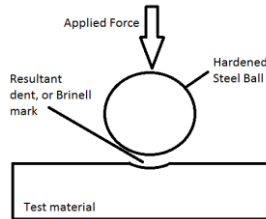


Issue 4: Bud's Take on Ceramic Ball Bearings & Induction Heating

I was asked a very good question during a recent trade show. I would like to share my answer here. Bearing manufacturers consider induction heating the safest method to heat bearings for installation. The concern is will heat expansion damage the raceway surface when using a bearing with ceramic (Si_3N_4) rolling elements (balls.)

Explanation of the Question:

This was a valid and well thought out question. We know that ceramic material is much stronger in compression than standard bearing steel (52100, SUJ2) and has a lower rate of thermal expansion. This results in a reduction of the size of the contact ellipse. If induction heating expands the inner ring, does the contact stress cause permanent deformation (damage)?



Pic 1: Concept of Brinell Hardness

A brinell is the mark left in metal that is created by another piece of metal (or hard object.) In the book *Essential Concepts of Bearing Technology* by Tedric Harris he states, "To cause permanent deformation (0.0001 times ball diameter) in the raceway of a ball bearing the contact stress would be greater than or equal to 609,000 psi."



Pic 2: Induction Heater (TM Easytherm 3.5)

Calculation:

A complicated calculation is required to determine true contact stress. I asked one of our vendors with advanced computer engineering programs to run the calculations. The criteria used were; standard bearing steel for inner ring and outer rings, ceramic balls, C3 clearance with a heating temperature of 220 degrees F. To create worst case scenario we assumed zero expansion on the outer ring.

Base #	Ball Material	Initial Clearance (in)	Result contact stress (psi)	Allowable contact stress (psi)
6313	Si ₃ N ₄	0.0009-0.0017	252,800	609,000
6320	Si ₃ N ₄	0.0012-0.0023	247,100	609,000
6324	Si ₃ N ₄	0.0014-0.0026	258,000	609,000
6330	Si ₃ N ₄	0.0018-0.0036	272,500	609,000

Table 1: Contact stress calculated results

Conclusion:

First, thank you to my customer for the super question. Thank you to my supplier’s engineering team for running the contact stress calculations.

I am happy to report, based on the worst case scenario criteria put forth, the results proved that induction heating will not cause enough contact stress to result in brinell damage. In the bearing sizes we reviewed, the resultant contact stress was more than 50% less than the maximum allowable contact stress of 609,000 psi.

