

Influence of manufacturing processes on magnetic properties of stator cores

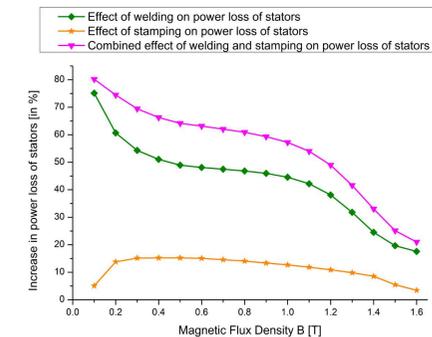
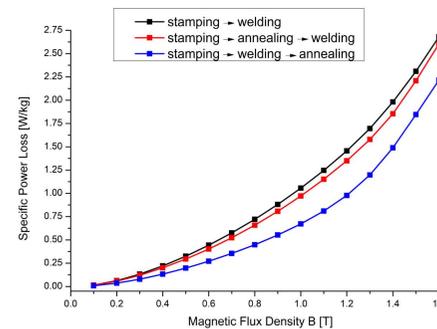
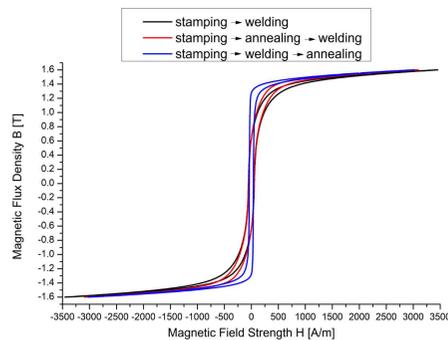
Differences between the prior and post-production magnetic properties of stator laminations are considered as one of the main sources of discrepancy between the expected and actual electric motor performances. The experimental data from bulk and local measurements clearly indicated the negative impact of residual stresses of mechanical and thermal origins on power loss and permeability of investigated stators.

Test object

Three manufacturing procedures were used by our industry partner Tempel Steel to produce stator cores for studying the effects of mechanical and thermal processing on magnetic properties of stator cores made of non-oriented steel laminations with nominal thickness of 0.27mm. The first stator was manufactured using the standard processes of laminations' stamping and TIG welding. For the second stator the stamped laminations were annealed to remove the residual stress from cutting, and subsequently TIG welded. In case of the third stator the stack of stamped and welded laminations underwent the final annealing to relieve the combined residual stresses originating from both manufacturing processes.

Test procedure & results

The primary (excitation) and secondary (sensing) coils were wound on the back irons of stators and the B/H loops were measured for all three stators at peak flux densities of 1.6T at measurement frequency of 50Hz.



The BH characteristics obtained for stator with combined residual stresses from stamping and welding (black curves) indicated the lowest permeability, as the magnetic field strengths required to reach the given levels of flux densities were the highest. The BH characteristics measured for the stator made of annealed laminations (red curves) showed gradually improved permeability with higher dB/dH response. A significantly higher permeability was observed for the stator subjected to final stress relief annealing, where slopes of BH characteristics (blue curves) were much steeper, especially in the low magnetic field H regions. These magnetization behaviors can be explained by analyzing the influence of welding and stamping on grain and magnetic domain structures.