Mixed Si-Fe wound cores five legged transformer: Losses and flux distribution analysis

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The paper proposes a five legged wound core transformer constructed of two high permeability Si-Fe wound cores and two conventional Si-Fe wound cores. The resulting five legged wound core transformer topology is shown in Fig. 1(a). The two large internal wound cores are manufactured of high permeability electrical steel (HiB). The two small outer wound cores are manufactured of conventional electrical steel (M4). The specific arrangement is based on experimental evidence concerning the peak flux density non-uniformity of the five legged transformer [1], [2]. Since the peak flux density of the two outer cores is lower than that of the two internal cores, low cost, low permeability, conventional grain-oriented electrical steel can be used for the outer cores.

![Figure 1](image_url)

Figure 1: (a) Mixed Si-Fe wound cores five legged transformer. (b) No-load loss versus peak flux density of the typical (HiB) and the mixed wound cores (HiB-M4) transformer.

The experimental analysis is based on a three-phase, five legged wound core transformer shown in Fig. 1(a). The cores have been annealed to remove stresses induced by manufacturing processes during their production. Three twenty-turns excitation coils in delta connection were supplied from a 400V, 50Hz three phase supply via an autotransformer in order to magnetize the cores from 0.2 T to 1.8 T. Two turns search coils wound around the total width of the sheet, were inserted in each core along the limb, yoke, and corner of the cores. The voltages induced in the search coils were captured by directly connecting the search coils into a NI6143 DAQ card inputs. Analysis of the captured data was carried out by using LabView software.

Losses, flux distribution, flux waveforms and their harmonics are presented in this paper. A comparison of the mixed Si-Fe wound cores five legged transformer and the typical one, constructed of the HiB electrical steel, is also carried out. Fig. 1(b) shows that for peak flux densities up to 1.5 T the difference between the no-load loss of the typical and the mixed Si-Fe wound cores five legged transformer is within 6%. As a result, the adoption of the proposed transformer core topology by the transformer manufacturing industry may lead into significant financial gains.
