A.14: Development and Characterization of Mass spectrometer dipole magnets for BARC

Dipole magnets are required by BARC, Mumbai for analyzing different mass species of the materials using their Mass spectroscopy set up. AMT Division has recently developed and characterized 2 nos. of dipole magnets as per the design of BARC. This report provides a brief overview of successful development of magnets and their characterisation.

The dipole magnets are designed to produce a magnetic field of 1 Tesla (NI of 6700 A T) in its pole gap of 16.5 mm. The magnetic field uniformity ($\Delta B/B$) required is $\pm 5 \times 10^{-4}$. The magnet cross-section is of 'C' shape, with 90o bending angle and radius of 300 mm. The overall size (l x w x h) of each magnet is 625x740x820 mm. One end of magnet pole edge is required to have fix angle of 26.5° and other end with variable pole edge angle of 26.5° ± 5°. The mechanical geometrical accuracy required on magnet pole gap is ± 0.010 mm. Fig.A.14.1 shows the dipole magnet developed for BARC.

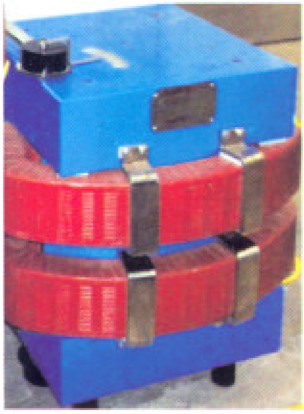

Fig A.14.1 Dipole magnet for BARC

The magnet core assembly is made out of two halves in order to have provision for finish machining of magnet pole surfaces and also placement of thick magnet coils. Each half of the magnet core was fabricated from 40 mm thick TATA-'A' grade low carbon steel plates. Initially, these plates were gas cut to the rough size & shape with an allowance for machining. These cut plates were initially pre-machined and stacked & compressed to the specified core length, using an accurately made stacking fixture for each half magnet core assembly and joined by welding. The welded each half core assembly was finish machined as per required magnet geometrical tolerances. The accepted two half cores were joined with fasteners for final magnet assembly.

The excitation coils were made from pre-insulated copper strip of size 6 x 2.5 mm, using a winding fixture. The ground insulation of wound coils was provided by wrapping glass fibre tape and then varnished. The mechanical and electrical parameters of coils were checked before assembly with each magnet core. The magnet pole gap size along its length was measured and found within the specified tolerances of ± 0.010 mm. Swivel pole pieces were introduced at one side of top and bottom poles of the assembled magnet with a mechanism for performing simultaneous swiveling of both top & bottom pole pieces for angular adjustment of ± 5° from their mean position. Two magnets were made successfully as per magnet specifications.

The magnetic characterization was carried out using Group3 Hall probe (accuracy 0.01%) at various radii along mid plane of pole region at different excitation currents up to 15A, using a CMM. The entry and exit magnetic edge angle were found by least square fitting of measured field data. Fig. A.14.2 shows the longitudinal

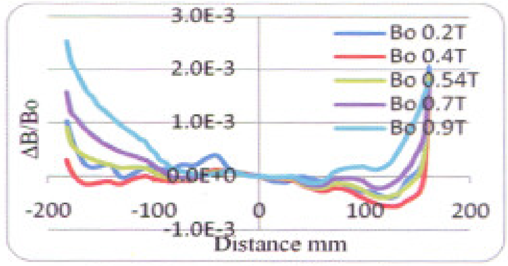

Fig.2. Longitudinal field quality

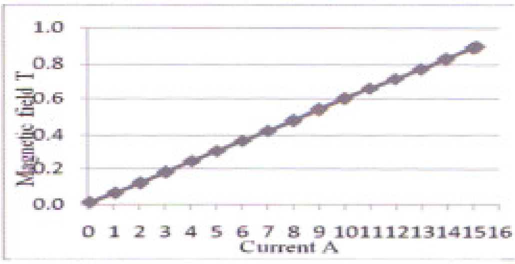

Fig.3. Excitation current vs. magnetic field

field quality and Fig. A.14.3 shows the graph of excitation current vs magnetic field of the magnet. For the first (second) magnet, calculated entry and exit edge angle were 26.06o (26.48°) and 25.27° (25.74°) with residual sum of squares 2.20 (1.70) and 7.80 (4.86) mm^2 respectively for all radii (280, 285, 290, 295, 300, 305, 310, 315 and 320 mm) at 0.9T, was determined to find out the good field zone. If radius of 280 and 285 mm was excluded during the calculation of edge angle, then, the residual sum of squares was reduced to 0.31 (0.68) and 0.60 (0.36) and edge angles changed to 26.67° (26.77°) and 26.51° (26.70°) for entry and exit side respectively. Therefore, both the magnets can be effectively used for the radius range of 290 mm to 320 mm. The calculated magnetic effective length of first and second magnets was 471.8217 and 473.6001 mm respectively at 0.9T. And this magnetic effective length was increased by 0.1% at 0.3 T for both the cases. The radial field qualities of first and second magnets was 9×10^{-4} and 6×10^{-4} respectively for good field region of ± 20 mm from mean radius at 0.9 T.

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