A.14: Manufacturing of quadrupole magnet cores for IRFEL at ACDFS, RRCAT

Quadrupole magnet cores were manufactured for IRFEL project (5 nos.) at ACDFS RRCAT. Aperture of these magnets is 60 mm and iron length 180 mm made from low carbon steel plates (40 mm thick). These Quadrupole magnet cores consist of 4 pole blocks as shown in Fig. A.14.1. Each pole block (Fig. A.14.2) is machined separately and 4 pole blocks were assembled to form one Quadrupole Magnet core.
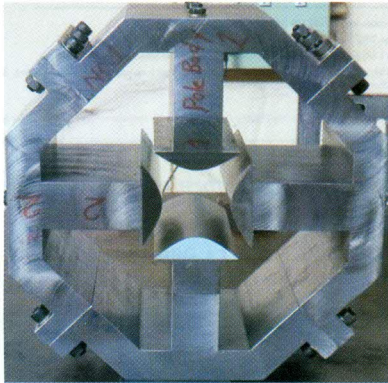

Fig. A.14.1: Quadrupole magnet core

Requirement of machining: In quadrupole magnets, the pole profile and their position with respect to adjacent poles is most important. The tolerance for pole profile was 0.02 mm and the profile tolerance of adjacent pole butting faces 0.02 mm. Hence, it is essential to machine a single pole block on one setting. This machining work was carried out on 4 axes milling machine (with rotary table).
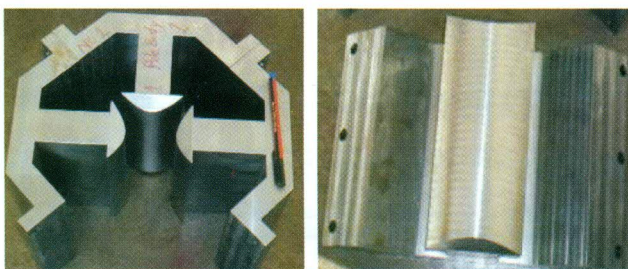

Fig A.14.2: Quadrupole Magnet pole blocks

CNC machine: 4 axes milling machine suitable for this application is 'UME-600' at RRCAT. This is Universal CNC milling machine (cutter can be mounted on vertical Z-axis and horizontal Y-axis) having rotary table (C-axis). This machine is having both CNC controllers - Hidenhein and ISO.

For machining, pole block was mounted on rotary table, cutter was mounted on horizontal Y-axis. Machining was carried out on all faces (pole face and butting faces) by rotating pole block on single setting.

Machining Fixture: A fixture was developed to machine pole blocks (21 nos) as shown in Fig. A.14.3. This fixture was mounted on rotary table of 4 axes milling machine. This fixture has provision to locate and clamp pole blocks to achieve dimensional repeatibility while machining.
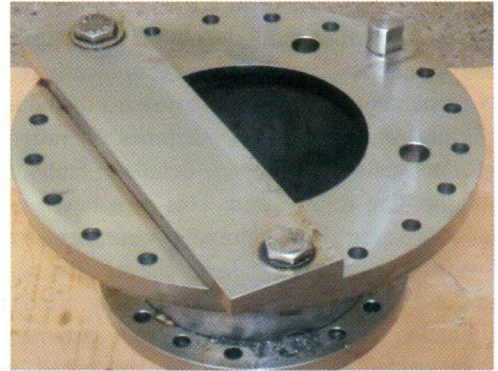

Fig. A.14.3: Fixture on which Magnet pole blocks were mounted and clamped while machining

Fig A.14.4: Machining of Quadrupole Magnet pole blocks on 4 axes CNC machine

CNC codes: 4 axes CNC machining codes were generated using software Unigraphics NX. Pole block model is prepared on the same software. Cutting tool selected is dia 25mm indexable end mill cutter with coated carbide inserts. CNC codes were generated considering the CNC machine as Horizontal machining center with B-axis rotary table. CNC codes were modified according to machine requirement.

Machining of pole blocks: Initially, two pole blocks were machined and inspected for profile tolerances. After machining of four pole blocks, they were assembled and checked for pole aperture dimensions and found well within specified tolerances. Total 21 pole blocks were machined.

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