MAGNETIC CIRCUIT SATURATION OF INDUCTION MACHINE DUE TO THE ROTOR POSITION

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ABSTRACT

This article contains a solution of electromagnetic field distribution with oversaturated areas localization and description. The rotor position is important for the maximal magnetic circuit saturated identification and oversaturated areas size influence of magnetic circuit due to the variable magnetic resistance of path. Influence of rotor position on saturated magnetic circuit is analyzed with step on twenty angular rotations per rotor slot pitch. This analysis is done for 3-phase 1.1kW induction machine by FEM.

1. INTRODUCTION

Generally, the magnetic circuit of electrical machines is never whole oversaturated. Due to this effect, the magnetic field distribution is different than in case of non-oversaturated magnetic circuit. After that the air gap size is variable due to the oversaturated areas of magnetic circuit. For induction machine is usually considered an equivalent air gap size with constant size regardless of magnetic circuit saturation. The finite element method is used for localization of oversaturated areas in case of different equivalent circuit parameters due to the loads. Actually, only one value of each current is known, but for electromagnetic field calculation is necessary to known value of current for each slot.

2. INITIAL CONDITIONS

Briefly, it is necessary to set few conditions to the correct function of solver, as like as the definition of used magnetic circuit material, including the material definition (Tab.1) of coil, air-gap, slot wedge, slot lining and shaft. The next step is applying the vector parallel flux potential onto the border line of model, forms an integral part of electromagnetic field calculation.

Material	**Properties**
Sheets	Steel M54 BH Curve
Copper	μ_r=0.99999
Slot wedge and lining	μ_r=1.10000
Air	μ_r=1.00000
Shaft	μ_r=150

Tab. 1: Material definition.

3. MAGNETIC FIELD DISTRIBUTION

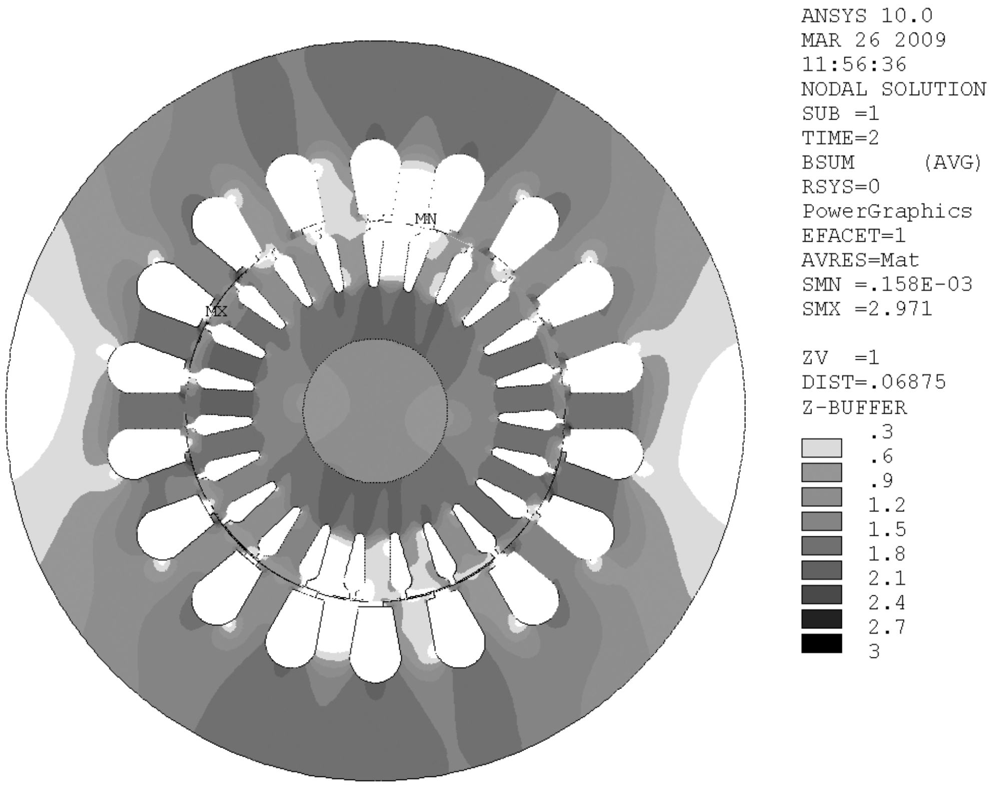

Fig.1 Behavior of flux density for 0.7826°

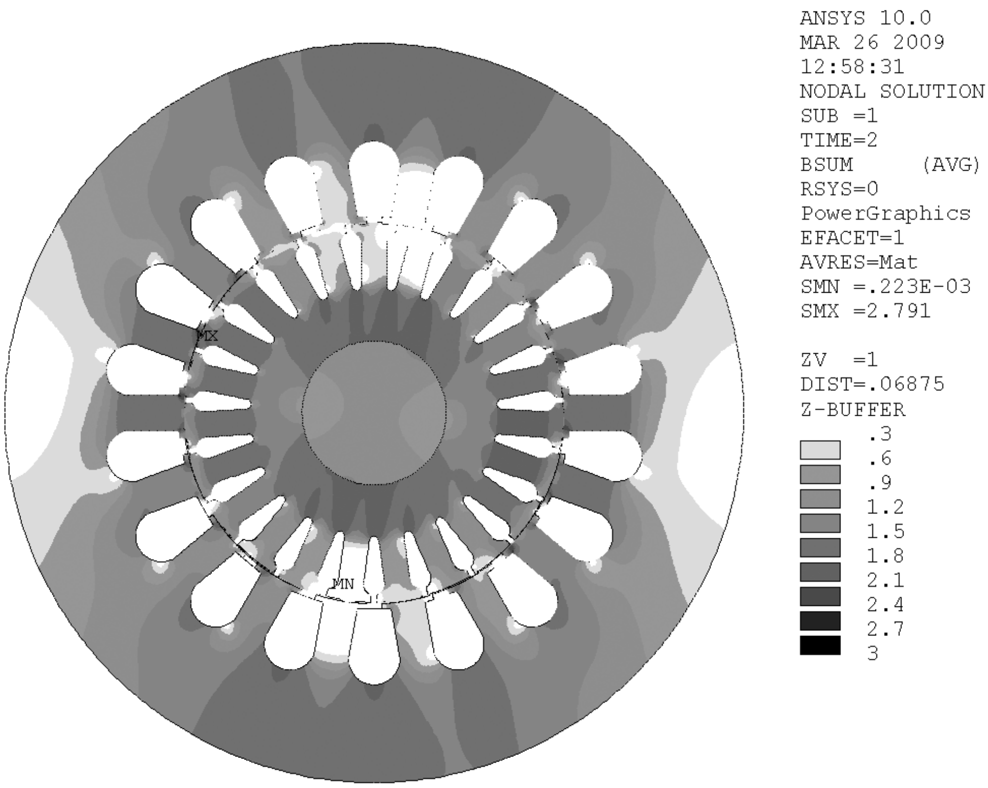

Fig.2 Behavior of flux density for 7.0434°

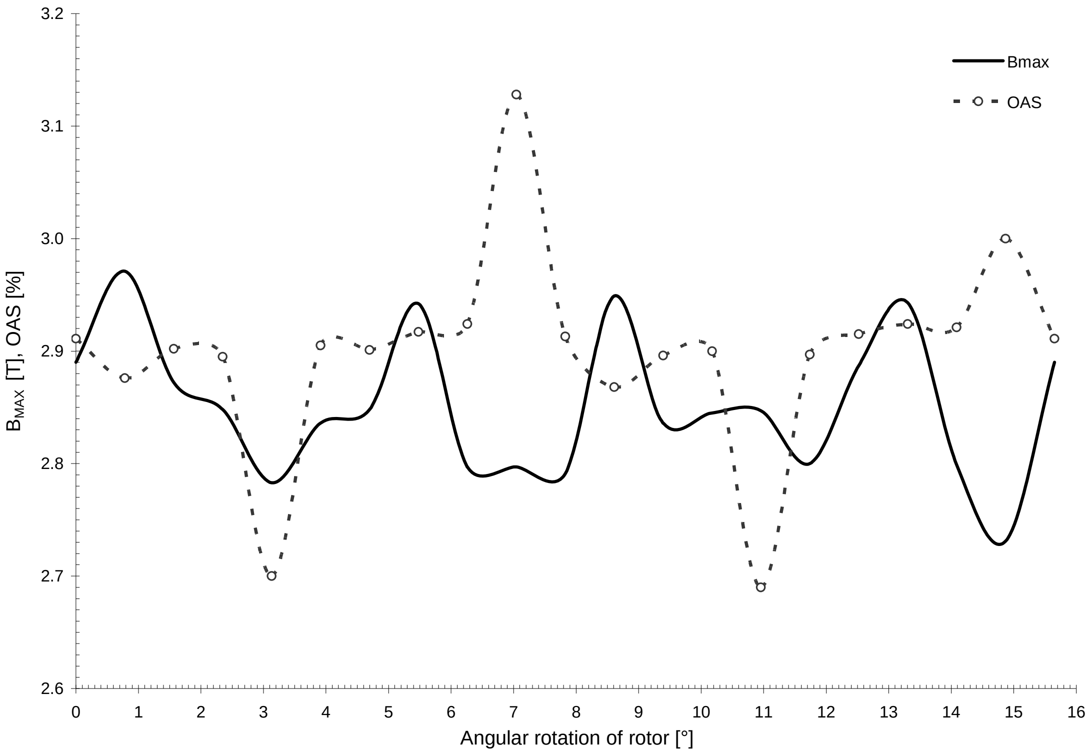

Fig.3 Behavior of the maximal flux density value (B_{MAX}) and oversaturated areas size (OAS) on angular rotation of rotor

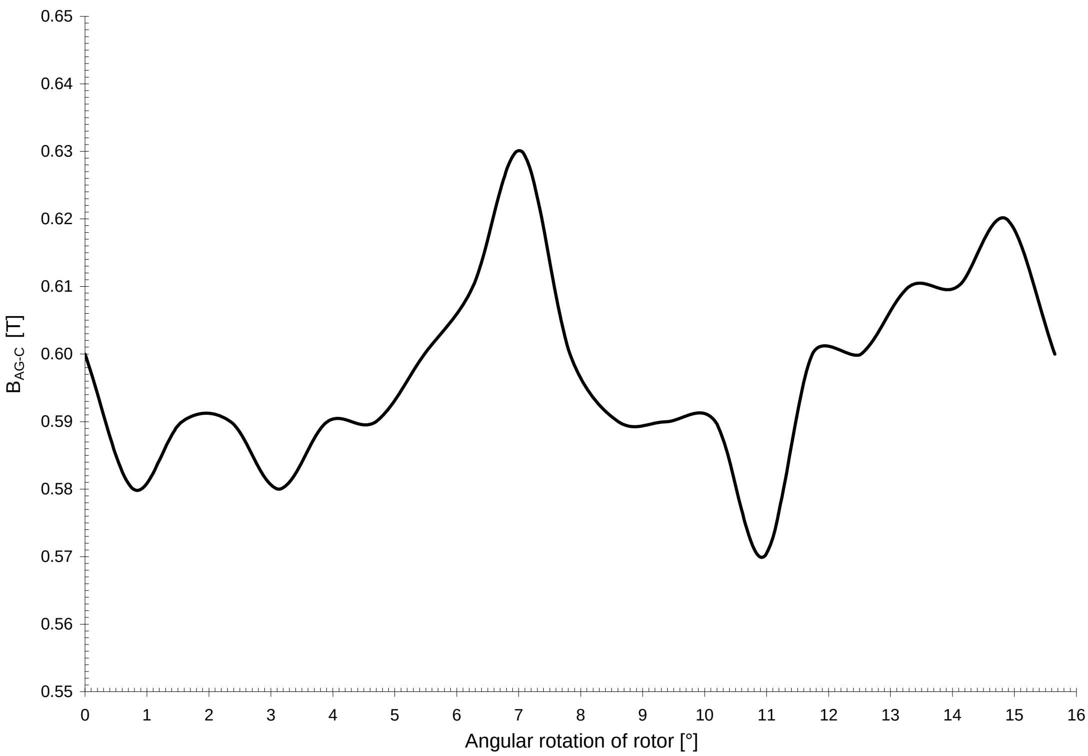

Fig.4 Behavior of the flux density in the center of air gap (B_{AG-C}) on angular rotation of rotor

This analysis is made for 3-phase 1.1kW induction machine by finite element method in ANSYS program for twenty angular rotation with steps 0.7826° and for load: $\hat{I}_S = 3.111A\angle -35.82°$ and $\hat{I}_R = 156.21A\angle 178.99°$. The maximal value of flux density is 2.971T and the flux density in the center of air gap is 0.58T in case of angular rotation 0.7826° (Fig.1), with 2.876% oversaturated areas size. However, not for the same angular rotation of rotor is not the maximal value of flux density and oversaturated areas size. Oversaturated areas size (3.128%) is maximal for angular rotation 7.0434° (Fig.2). The value of magnetic circuit saturation is defined by material BH curve. In compare with previous case, the maximal value of flux density is 2.797T and the flux density in the center of air gap is 0.63T. On the Fig.3 is shown a behavior of the maximal flux density value (B_{MAX}) and oversaturated areas size (OAS) on angular rotation of rotor. Behavior of the flux density in the center of air gap ($B_{AG\text{-}C}$) on angular rotation of rotor is shown on the Fig.4.

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