Application of Stochastic Simulation in Electric Machine Using Stochastic Response Surface Methodology

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***Abstract* — Tolerance analysis is vary important in electric machine industry for improving product robustness and reducing the cost. It requires yielding uncertainties of design variables. Stochastic simulation needs to evaluate the uncertainties. This paper presents a way of tolerance analysis using stochastic response surface methodology in electric machines.**

INTRODUCTION

The design of electric machines needs to allowance for dimensional tolerances due to limitations on the manufacturing and measuring precision on every part. In general, the larger tolerance in manufacturing processes, the lower it is to cost of manufacturing electric machines. These dimensional tolerances, however, can effect on a performance of electric machines. Therefore, the design techniques are required to find the tolerance band of design variables in order to minimize the cost and satisfy the performance in electric machines. When such a tolerance is defined as uncertainties of design variables. Stochastic simulation treats usually the uncertainty of design variables as random parameters. This paper introduces Stochastic Response Surface Methodology (SRSM) [1], one of the stochastic simulation methods, to evaluate statistical properties of electric machines output. The SRSM provides an ability of improving the robustness of electric machines by controlling design parameters. As an Example, Tolerance analysis using SRSM is applied to design for a synchronous generator.

CALCULATION METHOD AND RESULT

Generally the no-load EMF waveform of synchronous generators is a criterion of performance assessment and the maximum distortion factor of the output voltage is specified in the literature [2]. Three design variables in a synchronous generator are considered for the reduction of the EMF harmonics as shown Fig. 1. The aim of design is to reduce the EMF harmonics of the synchronous generator and then it accomplishes tolerance analysis of design parameters to satisfy variation band of its outputs.

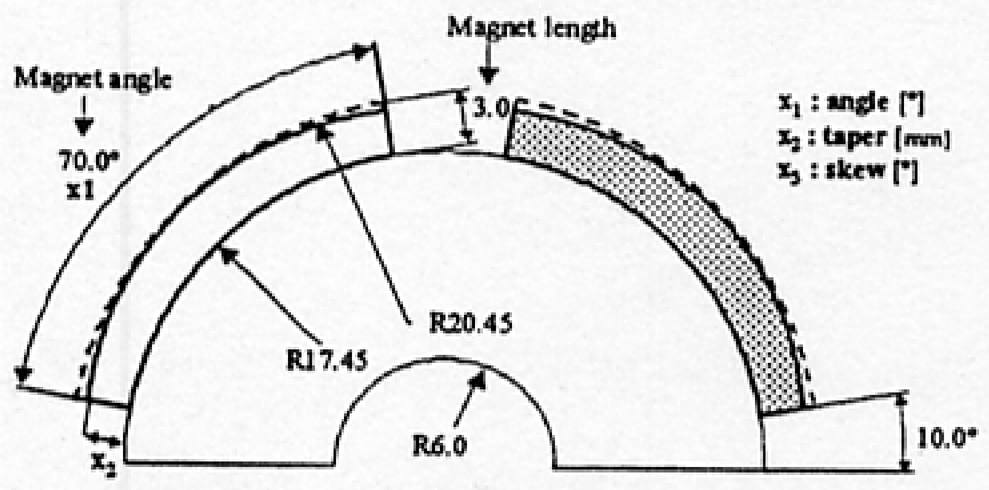

Fig. 1. Rotator of synchronous generator

Variation band of outputs according to design variables tolerance can be calculated by modeling of uncertainty of design variables, which is achieved through the SRSM. The SRSM approximates the output function using a polynomial fitting and then it samples the approximation to calculation specific statistical quantities of outputs.

The variation and distribution of design variables with mean (μ) and standard deviation (σ) are shown in Fig. 2. The tolerance of design variables is regarded as 3σ and its distribution is assumed as normal distributions. When uncertainty 10(%) of design variables occurs, the distribution of output variation is predicted as shown Fig. 3. The result can be obtained from stochastic simulation and then which is accomplished by the SRSM. In the final paper, these points plus further results and a detail of this method will be given.

REFERENCES

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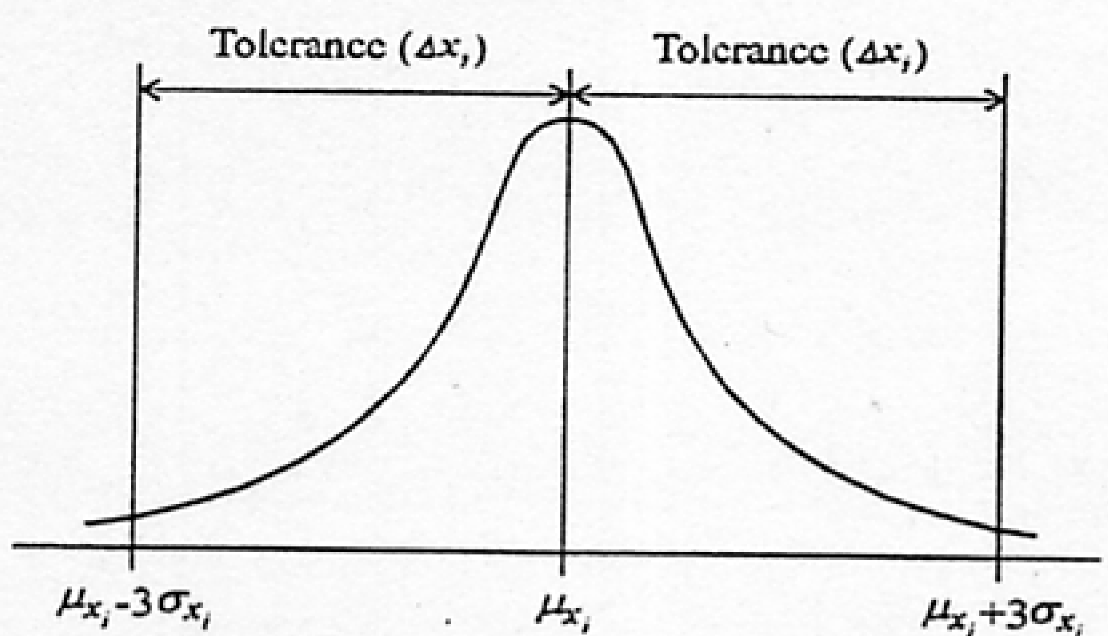

Fig. 2. Tolerance band of design variables

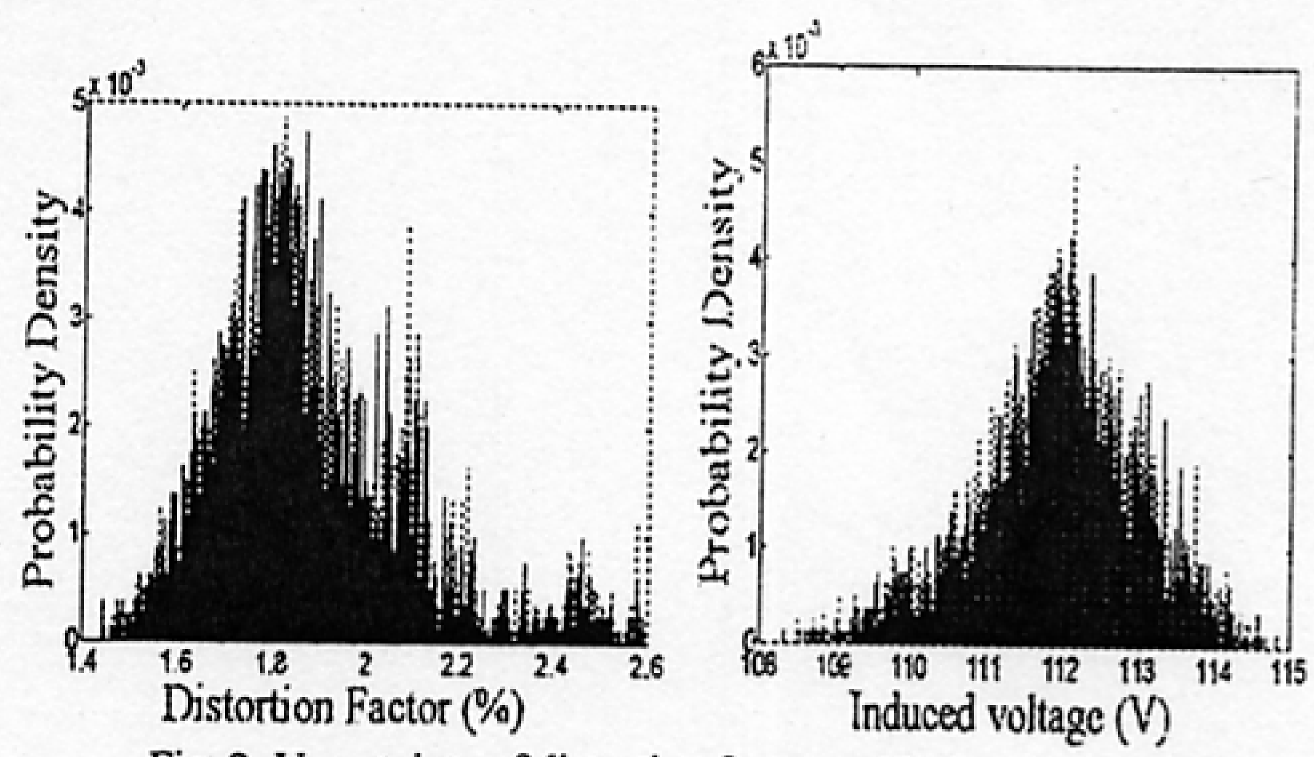

Fig. 3. Uncertainty of distortion factor and induced voltage