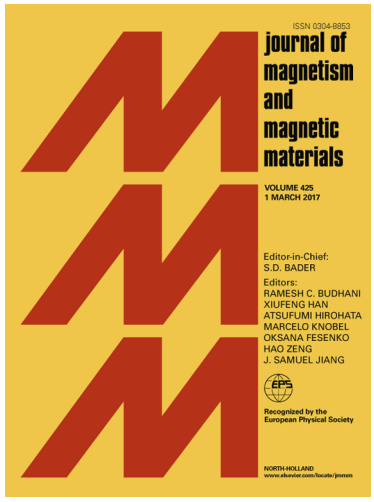

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Abstract —In this paper, electromagnetic design and permanent magnet shape optimization for permanent magnet synchronous generator with hybrid excitation are investigated. Based on generator structure and principle, design outline is presented for obtaining high efficiency and low voltage fluctuation. In order to realize rapid design, equivalent magnetic circuits for permanent magnet and iron poles are developed. At the same time, finite element analysis is employed. Further more, by means of design of experiment (DOE) method, permanent magnet is optimized to reduce voltage waveform distortion. Finally, the validity of proposed design methods is validated by the analytical and experimental results.

Keywords: analysis, optimization, permanent magnet, generator

1. INTRODUCTION

The permanent magnet (PM) synchronous machine has remarkable advantages such as high efficiency, high power density and brushless structure [1-2], etc. However, it is difficult to regulate the air-gap magnetic field due to the inherent property of permanent magnet. Therefore, voltage regulation in generator mode is hard to be realized[3-4]. In order to solve the above problems, a hybrid excitation synchronous machine, which combines the advantages of permanent magnet and electrical synchronous machines, has been investigated for several decades[5-8]. In [5], magnetic flux path is long, which results in large leakage flux. Y. Amara proposed a complex hybrid excitation structure[6]. However, the power density is low and leakage flux is significant. Z.R. Zhang proposed a claw rotor structure[7]. Anyway, the flux path generated by dc winding flows through PM, which increases excitation current and causes demagnetization of PM in