The College of Engineering
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Wisconsin Electric Machines and Power Electronics Consortium

RESEARCH REPORT
89-9

FEASIBILITY STUDY OF A CONVERTER OPTIMIZED INDUCTION MOTOR

T.A. Lipo and Hamid A. Toliyat
Dept. of Electrical and Computer Engr.
University of Wisconsin-Madison
1415 Johnson Drive
Madison, WI 53706-1691

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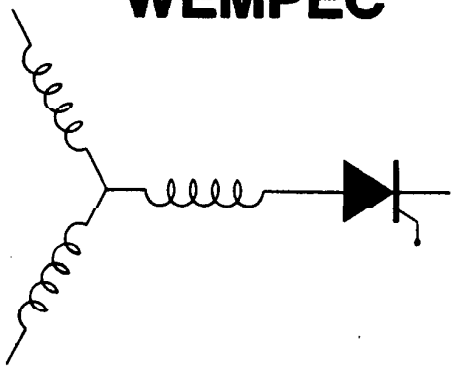

Department of Electrical and Computer Engineering
1415 Johnson Drive
Madison, Wisconsin 53706
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REPORT SUMMARY

SUBJECT: Plant electrical systems and equipment

TOPICS: Motors; Power converters; Adjustable speed drives; Drive systems

AUDIENCE: Utility and manufacturing-company engineers

Converter-Optimized Induction Motors: Feasibility Study

This study demonstrated the feasibility of designing motors specifically for use with adjustable speed drives operated with static power converters. Such designs could realize torque efficiency improvements as high as 10%, with very little cost increase.

BACKGROUND

Electric induction motors are normally designed for a three-phase applied voltage, which varies sinusoidally over time. Adjustable speed drives (ASDs) incorporating static power converters require the addition of filters to make converter output as sinusoidal as possible and to allow use with standard motors. The addition of the filters increases converter cost and reduces its efficiency. However, without filters the losses in the motor increase, often requiring the use of larger motor frames. A motor design that could accept natural converter output (essentially a rectangular wave) and accommodate voltages other than three-phase could increase converter efficiency and improve drive performance.

OBJECTIVE

To investigate the feasibility of designing special-purpose induction motors dedicated for use with static power converters.

APPROACH

The investigators conducted a theoretical harmonic analysis of induction motors with nonsinusoidal current and flux distributions in space and time. This analysis was sufficiently general to accommodate any winding configuration and any number of phases. It focused on motors with concentrated windings that can better accommodate the rectangular waveforms of static converters. The investigators derived equations that determine steady-state and transient performance of these motors and performed a digital computer simulation to analyze performance.

RESULTS

The study indicated that a specially wound, five-phase motor with a concentrated stator winding, operating with a static power converter, would show a 10% increase in torque efficiency compared with a conventional three-phase motor. (Torque efficiency is defined as output torque per root-mean-square ampere of armature current.) This improvement in calculated performance assumed identical frame sizes and peak flux density for both motors. These ASDs should show reduced converter and rotor harmonic

losses and lower pulsating torque, require less-expensive solid-state switches, and result in higher reliability than conventional ASDs.

EPRI PERSPECTIVE

Results of this study point the way to improved ASD performance and higher efficiency at lower cost. Potential for improvement increases with drive rating—an advantage to the utility industry, which uses many very large drives. Additional research is needed to verify this project's theoretical findings and to further refine systems and components.

PROJECT

RP2624-2
EPRI Project Manager: J C. White
Generation and Storage Division
Contractor: University of Wisconsin–Madison

For further information on EPRI research programs, call EPRI Technical Information Specialists (415) 855-2411.

Converter-Optimized Induction Motors: Feasibility Study

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Prepared by

UNIVERSITY OF WISCONSIN-MADISON
Department of Electrical and Computer Engineering
Madison, Wisconsin 53706

Principal Investigator
T. A. Lipo

Project Engineer
H. A. Toliyat

Prepared for

Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

EPRI Project Manager
J C. White

Rotating Machinery Program
Generation and Storage Division

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