Diagnostics of Rotor and Stator Problems in Industrial Induction Motors

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Contents

Abstract

In this project, two kinds of induction motor faults, stator short circuit fault and broken rotor bar fault, are investigated by using motor current signature analysis (MCSA) and zero crossing time (ZCT) method. These methods are based on the detection of sidebands around the supply frequency in the stator current signal.

The thesis starts by a review of these two common faults and two commonly used diagnostic methods. Before the motor stator short circuit faults experiments, baseline analysis is carried out on two same types of healthy motors. Meanwhile, signal processing programs, composed in MATLAB and LABVIEW, are verified to ensure the accurate diagnosis of motor faults. Through a control box, artificial turn to turn fault and phase to phase fault are structured in each test. MCSA and ZCT are utilized to extract broken rotor bar information from recorded stator current signal.

Although an induction motor is highly symmetrical, it may still have a detectable signal component at the fault frequencies due to imperfect manufacture, improper motor installation and so on. The misalignment experiments reveal that improper motor installation could lead to an unexpected frequency peak, which will affect motor fault diagnosis. Furthermore, manufacture tolerance and working environment could also result in disturbing the motor fault diagnosis.

Through both online and offline experiments, MCSA and ZCT methods could detect particular abnormal harmonics related to stator short circuit fault and broken rotor bar fault. Compared with the conventional MCSA method, the ZCT method has the advantage of reduced computational burden.

Statement of Originality

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Abbreviations

AI	artificial intelligence
BRB	broken rotor bars
DFT	discrete Fourier Transform
DSP	digital signal processor
FFT	fast Fourier Transform
FT	Fourier Transform
ICA	Independent component analysis
LV	low voltage
MCSA	motor current signature analysis
MMF	magnetic motive force
PCA	Principal component analysis
RPS	reconstructed phase space
ZCT	zero crossing times

Symbols

f_0	fundamental frequency
f_{comp}	component frequency
f_r	rotor frequency
f_s	supply frequency
f_{short}	the frequency component that is related to the short circuit
I_p	currents in the primary
I_s	currents in the secondary
n_p	number of turns in the primary
n_s	number of turns in the secondary
N	number of samples
p	number of pole
P	number of pole pairs
s	slip
S_r	rotor speed
$T(n)$	the time when the current is equal to zero
T_{ZC}	ZCT signal
ω_e	angular speed of the stator magnetic motive force in electrical radians per second
ω_r	the angular frequency of rotation of the rotor shaft
ω_{rm}	rotor rotating speed
ω_{sm}	the synchronous speed in mechanical radians

Publications

Referred Conference Publications (Full Paper)

[1] F. Duan and R. Zivanovic, "Estimation of DC Offset Parameters based on Global Optimization," *AUPEC'08 - 18th Australasian Universities Power Engineering Conference*, Sydney, Australia, December 14–17 2008.

[2] F. Duan and R. Zivanovic, "Induction motor fault diagnostics using global optimization algorithm," *AUPEC'09 - 19th Australasian Universities Power Engineering Conference: Sustainable Energy Technologies and Systems*, Adelaide, Australia, September 27–30 2009.

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