ALGORITHMS FOR INDUCTION MOTORS EFFICIENCY DETERMINATION

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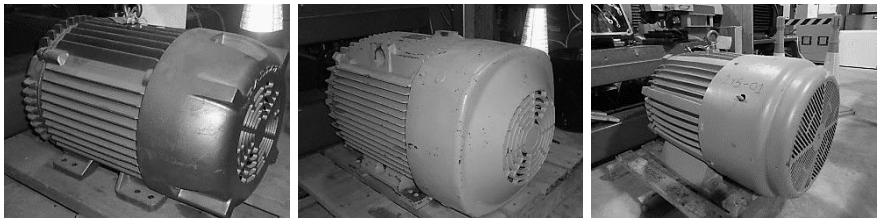
Background

- Environmental concerns as well as increasing demand for energy are strong motives for further investment and research in demand side energy management techniques.
- In Canada and the United States, approximately 60% of the electrical power generated is utilized by electrical motors.
- Efficient operation of the motors can directly bring significant savings in energy consumption and indirectly reduce green house gas emissions as well as requirements for the installation of new power plants, transmission lines and distribution systems.
- Energy saving calculations by means of any tool and the relevant decisions, such as replacement of an existing motor, are strongly dependent on an accurate knowledge of the motor efficiency.
- Therefore, the evaluation of efficiency of installed motors in the field or rewound motors in a workshop is a necessity to detect the motors with poor efficiencies and to take the appropriate action.
- To do so, a credible methodologies are required to make the efficiency estimation possible without performing costly dynamometer testing.

Objective

- Development of mathematical tools and testing methodologies to estimate the efficiency of repaired, rewound or any existing three-phase induction motor based on no-load tests as well as the nameplate data which can be performed in most electric motor service centers in North America.
- Development of mathematical tools and testing methodologies to estimate the efficiency of induction motors in running condition (in-situ) based on balanced, unbalanced or unbalanced distorted three-phase voltages.
- Design a new stray-load loss formula to help improve the efficiency estimation accuracy.



25, 60, and 100 hp induction motors tested using the proposed techniques.

Photos : courtesy of Hydro-Québec

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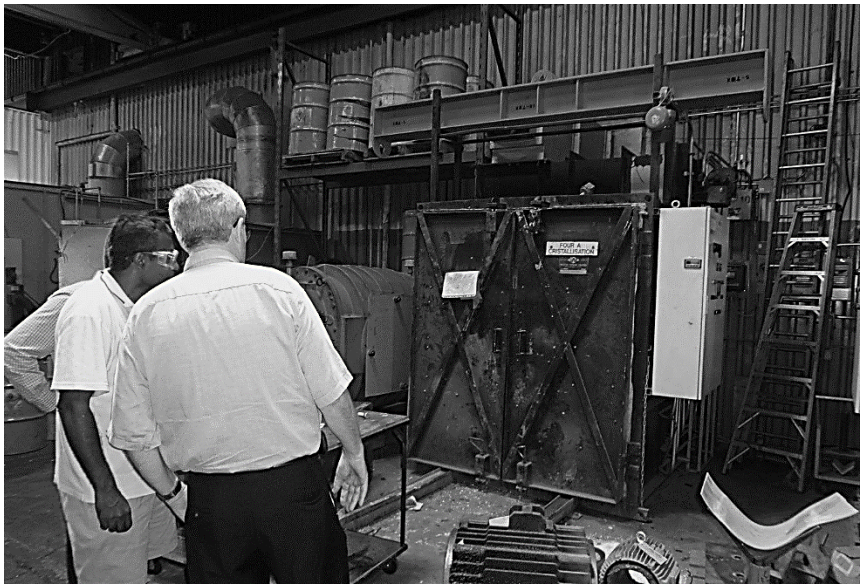
Proposed Methods

- All methods utilize data provided by Hydro-Québec and BC hydro.
- **Method 1** is a simple technique that needs DC test, nameplate details, and one no-load test at rated voltage. The method was validated by testing 196 motors.
- **Method 2** is designed based on IEEE Std 112 Efficiency Test Method F1-Equivalent Circuit. The parameters are extracted by using IEEE impedance test (method 3). IEEE procedure failed to test certain types of motors. A modification to the IEEE procedure was proposed and Method 2 was validated by testing 9 motors.
- Spreadsheets platform with Visual Basic coding were used to develop a user-friendly software to transfer both methods into a useful industrial tool that can be used in any electric motor workshop.
- The two methods and the software were approved by several Canadian power companies.
- **Method 3** is an in-situ algorithm for induction motors operating with balanced voltages.
- **Method 4** is also an in-situ technique for induction motors operating with unbalanced voltages.
- **Method 5** is another in-situ technique for induction motors operating with unbalanced distorted voltages.
- **Method 6** is a new stray-load loss formula that shows better accuracy when compared to the formulas of IEEE Std 112 and the IEC 60034-2-1 standards.



Technical visit to Moteurs Électriques Laval Ltée in Montréal region.
Photo courtesy of Moteurs Électriques Laval Ltée

The developed software shows testing results of a 150 hp machine.

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