INDUCTION MOTOR PERFORMANCE ANALYZER

Introduction:

Induction motors are considered to be the major users of Electrical Energy. They are used in a wide range of Industrial and commercial applications, including Compressors, Fans, Pumps, Conveyors, Winders, Mills, Elevators, Transports and Home applications. Normally the energy consumption of motors is around 50-60% of the total plant consumption. There is a scope for 5-10% energy conservation as majority of the motors are not operated at their best operating points. Hence it is necessary to find the operating characteristics of the motors in order to operate them very efficiently to conserve energy.

Development of IMPA:

Industrial controls and drives (India) Pvt. Ltd. has developed the Induction Motor Performance Analyzer (IMPA) with technology support from CSIR-CSIO Chennai Centre.

Simple test tool to easily analyze the electrical and mechanical performance of Induction Motors:

The new ICD Induction Motor Performance Analyzer has the capability to measure Electrical parameters like Voltage, Current, Frequency, Power, Harmonics, and Unbalance along with mechanical parameters like Efficiency, Torque, Output Power and Total losses of the motors without the need of any mechanical sensors. Further it has additional optional feature to measure the Vibration and Temperature of the motor. The IMPA is an ideal test tool which can provide necessary electrical and mechanical information needed to effectively evaluate the performance of Induction Motor.

Key Measurements:

- Electrical parameters such as Voltage, Current, Frequency, Apparent Power, Active Power ,Reactive Power ,Power Factor, Harmonics and Unbalance.
- Mechanical Parameters such as Speed in rpm, Slip, Output Power, Torque, Motor Efficiency, Total Losses, Vibration in mm/s and Temperature.
- All the parameters are measured instantly on line with one second update rate.

Principle of Operation:

The Induction Motor Performance Analyzer computes all the parameters using three phase voltage, current waveforms and shaft speed. The Voltage is measured directly in case of LT motors or through PT in case of HT Motors. The current is measured either through inbuilt CT (Inline IMPA) or through Clamp on CT (Portable IMPA). The shaft speed is measured through non contact reflective type sensor. The vibration and temperature are measured through dedicated vibration and temperature sensors.

The equivalent circuit method of motor provides the basis for the measurement. The stator resistance of the motor is measured through milli ohmmeter and is fed as input to the IMPA. Then using proprietary algorithms the equivalent circuit of the motor is estimated. The electrical parameters are computed from the input voltage and current waveforms. The equivalent circuit is used to compute the losses happening in the motor. From the Loss calculations, the output power, torque, efficiency are calculated. Mechanical sensors and No load test, Blocked rotor test are not required, making this method faster to analyze the overall performance of the electric motors.

Features:

- Suitable for conducting on-site energy audits of existing motors which provides scientific data to replace or refurbish the existing motor to conserve energy.

- Motor performance can be analyzed without disconnecting the motor from the load. (On Site, On Line and In Situ)

- Mechanical sensors, No load testing or blocked rotor testing are not required.

- Electrical parameters and mechanical parameters are shown in a single instrument.

Benefits:

The motor performance analyzer helps in identifying the motors for,

- Refurbishment
- Replacement with new motor
- Checking the performance and efficiency after rewinding
- Operating the motor around at its best efficiency point (BOP)
- Known benchmarks and performance trends can be created for informed preventive maintenance.

Electrical Motor Analysis:

The motor performance analyzer provides complete measurement of electrical and mechanical parameters. The measured parameters are grouped and shown on the user screen as various dashboards.

In motor analysis dashboard, on line measured parameters are estimated for full load conditions and shown along with recommended or rated values taken from either name plate of the motor or according to NEMA guidelines.

The data analysis is provided with three level color severity scales for easy understanding. The electrical parameters like kW, PF, Unbalance, Harmonics and mechanical parameters like Output power, Torque, Efficiency, Vibration are related to the rated or recommended values.

The motor analysis features is very useful in analyzing the performance of the motor during different operating conditions. Known benchmarks and performance trends can be created by frequently performing these tests over a period of time. The results thus obtained can be very useful to take planned maintenance investment decisions.

Accessories

ICD Node IMPA 2005

The ICD Node IMPA 2005 is a standalone system, which is capable of monitoring the motor performance continously. The node IMPA 2005 is most suitable for monitoring the performance of the motors used in critical applications. The unit was built around arm controller and precision energy measurement circuits.

The Node IMPA is connected to the motor permanently. The node IMPA is designed to operate with both LT and HT motors. The voltage inputs are field selectable either 415V directly for LT motors or 110V from HT PT's for HT motors. The current inputs are also field selectable either 5A/1A from external CT's.

The speed sensor, vibration sensor and temperature sensor are mounted on appropriate locations on the motor and are connected to the IMPA unit through external cable. The stator resistance is measured through Milli ohm meter and is fed into the IMPA unit for calculations.

Hardware Features
- Large 7" TFT Display is provided to display various electrical and mechanical parameters.
- Motor parameters are configured through touch panel.
- The system has built in RTC.
- RS485 port supporting Modbus-RTU protocol is provided.

Networking of IMPA Node

The Node IMPA system is designed for monitoring multiple motor performances in the industries. The IMPA nodes are provided with RS485 connectivity supporting MODBUS-RTU protocol. Multiple IMPA nodes can be networked using twisted pair RS485 cable and data can be collected in a centralized server. The IM2S (Induction Motor Monitoring System) software is used to collect and process the data in the server.

Web Enabled IMPA Node

The IMPA Node can be made Web Enabled by connecting a GPRS Modem to the RS485 port of IMPA node. The GPRS Modem transmits the data to the remote cloud server at pre defined intervals. The IM2SW (Induction Motor Management System Web) software running in the cloud server collects the data, processes the data and hosts them in user friendly WEB pages. The user can use standard internet browser to log on to the system and can view the performance of the motors from remote locations anywhere in the world.

Software Package

The IM2S (Induction Motor Monitoring System) software is used to collect the data from IMPA 2005. The collected data is stored in the MYSQL data base and various analyses with respect to the performance of the motors are done.

IM2S / IM2SW Features
- Collects the data from IMPA nodes continuously and stores them in the data base at predefined intervals.
- Online data representation and graphical representation.
- Displays instant data in real time trends.
- Processing of stored data.
- Facility to plot various graphs like Load Vs Efficiency and Speed Vs Torque etc.
- Facility to compare performance of various machines.
- Analysis of losses through Pie chart.
- Analysis of vital parameters through multi color severity indicators (Rated Vs Actual).
- Report generation and printing of reports.
- Facility to export the data in excel spread sheet.

Accessories

In its standard configuration, the IMPA 2005 is supplied in a industrial grade aluminum enclosure along with the following accessories,
- Industrial grade terminals for connecting voltage and current inputs.
- Hansford Model No: HS-420SRT Vibration and temperature sensor.
- Diffused Reflective type speed sensor.
- Magnetic stand for holding speed sensor.
- Milli ohm meter for measuring stator resistance

Note 1 : Hansford Model No: HS-420RT is required for analyzing vibration and temperature. If vibration and temperature analysis are not required, this option can be removed while ordering.

Optional Accessories:
- RS485 cables and IM2S software package for networked IMPA Node.
- GPRS Modem and IM2SW software package for web enabled IMPA node.

ICD Portable IMPA-2000

The ICD Portable IMPA 2000 is a Portable instrument, with which one can perform spot analysis or continuous analysis on the test motor. This instrument is best suitable for conducting on-site energy Audits. The unit was built around Arm controller and precision energy measurement circuits.

The IMPA is designed to work for both LT and HT Motors. In LT motors, the motor terminal voltages are measured directly (440VLL rms) by clipping on the motor terminals and the motor current is measured by using Clamp-ON current Transformers (CT).

In the case of HT motors, the motor terminal voltages are measured by connecting the IMPA unit to the secondary of potential transformers (PT) used in the HT panels (110VLL rms) and the motor current is measured using clamp-ON current transformer (CT) connected in the secondary of the HT CT's installed in the HT panel (5A or 1A).

The speed sensor, vibration sensor and temperature sensor are mounted on appropriate locations on the motor and are connected to the IMPA unit through external cable. The stator resistance is measured through milli ohm meter and is fed into the IMPA unit for calculations.

Hardware Features:
- The system has a built in RTC and mass storage card for data logging.
- 3*4 matrix keypad available to configure the motor parameters and mode of operation.
- Large 3.5" or 5" or 7" TFT display is provided to display various electrical and mechanical parameters.
- USB connectivity is provided to download the logged data into PC.

Modes of Operation:

There are two modes of operation available in IMPA. They are,
- Spot Analysis Mode (SAM)
- Continuous Analysis Mode (CAM)

Spot Analysis Mode:

In spot analysis mode, the system operates in interactive mode. The user has the provision to perform Load Vs Efficiency, Torque Vs Speed Characteristics. At every point of the load conditions, an average of 10 sets of readings are taken and stored on the SD card with time stamp. After completing the test operation the data stored in the IMPA can be downloaded into the PC and detailed analysis on the performance of the motor can be done.

Continuous Analysis Mode:

In the continuous analysis mode, the IMPA has the provision to record all the Electrical and mechanical parameters of the motor at any predefined interval. The data is stored on the SD card. The system can accommodate maximum of 4GB SD card, which provides data logging for more than a year even with 1 minute storage interval. The test can be performed on numbers of motors and data is stored under different file names. After completing the test operation the data stored in the IMPA can be downloaded into the PC and detailed analysis on the performance of the motor can be done.

Software:

The data stored in the IMPA 2000 can be processed with MPVIEW Software. The IMPA2000 is connected to the PC via USB link.

Software Features:
- Directly access to the data recorded in the instrument
- Facility to save the data and retrieve them in future for analysis
- Processing of recorded data
- Facility to plot various graphs like Load Vs Efficiency, Speed Vs Torque etc.
- Analysis of losses through Pie chart
- Analysis of vital parameters through multi color severity Indicators   (Rated Vs Actual)
- Report generation and printing of Reports
- Facility to export the data in excel spread sheet

Minimum Operating System Requirements:

Windows XP, Windows Vista, Window 2000

Accessories:

In its standard configuration, the IMPA 2000 is supplied in an industrial grade protective suitcase along with following accessories,
- Voltage measurement leads with crocodile clips.
- Hioki Model No: 9661, 500A clamp on CT 3 No's (LT Motors).
- Hioki model No: 9694, 5A clamp on CT 3 No's (HT motors).
- Hansford Model No: HS-420SRT Vibration and temperature sensor.
- Diffused reflective type speed sensor
- Magnetic stand for holding speed sensor
- Meco Model No:7002 Milli ohm meter for measuring stator resistance
- Power cable, PC connection cable and processing software CD

Note-1: The Hioki model No: 9694, 5A clamps are necessary for analyzing HT motors. If HT motors are not to be analyzed, this option can be removed while ordering.

Note-2: Hansford Model No: HS-420SRT is required for analyzing vibration and temperature. If vibration and temperature analysis are not required, this option can be removed while ordering.

DESCRIPTION / PARAMETERS	SPECIFICATION			
Model	IMPA 2005	Node Type	IMPA 2000	Portable Type
ELECTRICAL POWER MEASUREMENT				
Input Connection Type	3-Phase Star/Delta Connected			
Input Voltage (LT)	415 Vrms (L-L) (-40% to +20%)			
Input Current (LT)	5A/1A (Panel CT class 1or class 0.5 Accuracy is preferred)		500A (clamp on CT)	
Input Voltage (HT)	110 Vrms (L-L) (-40% to +20%) (Panel PTs with Class 1 or Class 0.5 Accuracy is preferred)			
Input Current (HT)	5A/1A (Panel CT class 1or class 0.5 Accuracy is preferred)		5A (clamp on CT) (Panel CT class 1or class 0.5	
Accuracy is preferred)				
Power Measurement Accuracy	Class 0.5 (as per IEC62053-11)			
Program Mode Selection	LT/HT , 5A/1A, star/Delta		LT/HT , 500A/5A, star/Delta	
Safety Protections	Protection against high Voltage surge, Transients, EMI, ESD, etc.			
	SPEED MEASUREMENT			
Measurement Type	Non-Contact Reflective Type Sensor			
Speed Range	0-6000 RPM			
Accuracy	1 RPM (as per IEC 60034-2-1)			
	VIBRATION AND TEMPERATURE MEASUREMENT (Optional)			
Vibration Sensor Type	Accelerometer Measuring Velocity			
Vibration Velocity Range	0-10 mm / sec			
Accuracy	0.5% OFS			
Temperature Sensor Type	RTD-PT100			

Temperature Range	0-200 degC
Accuracy	0.2% OFS
COMPUTATION PROCESS	
Motor Performance Analysis	By Equivalent Circuit Computation Method
Computation Algorithm	Proprietary Algorithm with less than 1% error on Equivalent circuit
	parameter Optimization
Analysis Mode	Spot Analysis Mode and Continuous Analysis Mode
HARDWARE FEATURES	
Controller	ARM Cortex-M4 Core running at 168 MHz
Display	3.5" or 5" or 7 " TFT Display
Programming Interface	3X4 Matrix Keypad/ Through Touch panel
Communication to PC	RS 485 Interface (MODBUS – RTU)USB Interface
PARAMETERS DISPLAYED	
Electrical Parameters	Voltage, Current, Power, Energy, Unbalance and Harmonics
Speed Parameters	Speed and Slip
Mechanical Parameters	Efficiency, Output Power, Torque, Vibration and Temperature
Loss Parameters	Stator Copper Loss, Rotor Copper Loss, Iron Loss,
	Windage Loss and Stray Loss
AUXILIARY POWER SUPPLY	
Supply Input	140-270V AC
Power Consumption	Max 5W with AC Fuse Protection