Predictive Technology in the Johnson&Johnson Power Transformer

Luiz B. S. Chacon (1)[1]

Murilo Armelin Toledo (2)[2]

Lucas Pavan Fritoli (3)[3]

Hirokazu T. B. Ito (4)[4]

ABSTRACT

Electric power is a fundamental input for the industrial production of the Johnson&Johnson plant in São José dos Campos-SP Keeping the park operating correctly has always been a priority for the maintenance teams.

The main substation, and specially the input transformer have always had a complete preventive maintenance program and their technology is constantly being updated for early flaw detection.

With the purpose to promote better plant reliability and availability, an online transformer monitoring system was installed between 2014 and 2015, composed of sensors and software, for daily monitoring of transformer operating status.

In this paper we describe the architecture and the solutions applied in the system, as well as the changes in maintenance routine, the assertiveness in the resolution of eventual problems and the operational security gains inside the complex.

KEYWORDS:

Substation Asset Management, Predictive Technology, Online Monitoring, Predictive Maintenance, Systems, Transformers.

[1] Johnson&Johnson, São José dos Campos-SP - Infrastructure Engineering
[2] Treetech Sistemas Digitais - SP - Project Engineering
[3] Treetech Sistemas Digitais - SP - Application Engineering
[4] Treetech Sistemas Digitais, Atibaia- SP - Application Engineering

1.0 - INTRODUCTION

Johnson&Johnson industrial plant, in São José dos Campos-SP is responsible for manufacturing hygiene and personal health products, in addition to a dedicated hospital product line. Inside the productive process, electric energy is an indispensable input and an eventual power failure compromises the programming and may cause huge company losses.

The plant's electric power is supplied by a 25 MVA installed power substation in the factory itself, which can be seen in figure 1, with only one 88kV transformer - a key piece of equipment to keep the production system up and running. In face of all this, all the corrective and preventive maintenance control is strict and done according to the standards and good practices of the sector.

The infrastructure engineering area is responsible for promoting technological innovation in the park therefore allowing ongoing reliable and safe plant expansion. In this context, the implementation of the predictive maintenance concepts was defined, aiming at improving processes and asset management.

This was allowed with the installation of a transformer online monitoring system to monitor the transformer's operation status. Involving sensors, software and change in maintenance plans, Johnson is innovating again and keeping the tradition of being a technological leader.

Fig. 01- 88 kV Substation

2.0 - ONLINE MONITORING FOR FAILURE PREDICTION

Online monitoring technology was chosen by taking into consideration the following criteria:

- The diagnosis of the transformer's current status in order to decide whether to keep it in operation or not - facility reliability;
- Early diagnosis of failure conditions in incipient evolution stages so equipment maintenance downtime can be programmed for corrective actions - plant availability;
- Equipment operating conditions are monitored along its whole service life to keep the aging process under control - full service life management.
- The use of the transformer in overload or risk conditions, but with total knowledge and control of the several variables involved, without incurring excessive risks - operational safety

3.0 - PHILOSOPHY IMPLEMENTED.

In order to meet the proposal technical and financial objectives, Johnson&Johnson adopted the following functionalities:

i. Variable Measurement through sensors in a decentralized architecture.

Specialist sensors to measure electrical, mechanical and chemical values of the power transformer, see Table 01 They are communicating via RS485 network through an open Modbus protocol with the monitoring software in the control room (architecture in Figure 02)

Table 01 - specialist functions installed in the transformer

Smart Sensor	Specialty	Goal
Temperature Monitor	Functions 26 and 49	Equipment protection
	Transformer thermal management	Get the most possible power with the least possible risk
	Ventilation system management	Guarantee the required conditions for more power in the grid
Voltage Regulation Relay	Function 90	Regulate voltage correctly according to the company's needs.
	Better power quality	Provide the best voltage range to meet the demand

		by the company.
	OLTC wear and tear management;	Predict if there is need for corrective interventions in the OLTC mechanism
Bushing Monitor	Capacitance monitoring	Predict catastrophic failure (explosion)
	Power factor monitoring	
	Leakage current monitoring	Obtain higher plant availability other than preventive maintenance offline tests
Gas and Humidity Monitor	Water in oil monitoring	Get the most possible power available for production Control the right time for corrective maintenance (oil treatment)
	Monitoring of H_2 in oil	Early identification of internal failure in equipment Back-up of the chromatographic preventive tests
Transformer ventilation system monitor	Transformer insulation maintenance.	Keep the humidity at allowed levels in the conservator tank

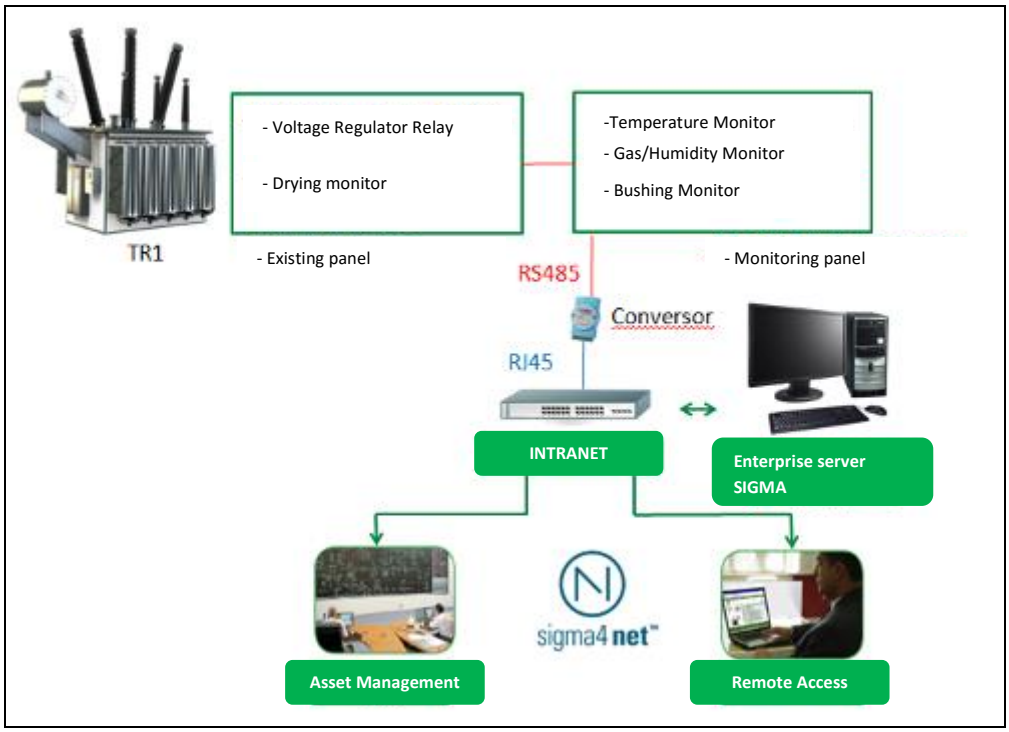

Fig. 02 Implemented Architecture

ii. Measurement storage

Measurements by intelligent sensors installed in the transformer are taken to a data server installed in the substation control room (as shown in Figure 03).

Fig. 03 - Data server with the online monitoring software;

Everything that is measured is recorded in historic data bases through any resources deemed necessary to ensure information availability (backups, disc mirroring, etc.) Therefore, the whole transformer service life behavior can be monitored.

The analysis of this behavior along time shall allow Johnson&Johnson's engineering team to identify standards and trends and therefore to define more assertive actions.

iii. Information processing

The monitoring system provides information beyond the "raw" data acquired from measuring equipment, shown in Figures 04 to 07.

Fig. 04 - Monitoring panel

Fig. 05 - Temperature Monitors and Bushings

Fig. 06 - Voltage Regulator and Paralleling Supervisor

Fig. 07 - Gas and Humidity Monitor

The use of digital computer processing capacity (Specialist Systems) through mathematical and logical models provides transformer operation status diagnosis and prognosis. This translates engineering knowledge about the machine into a software able to emulate certain aspects of its behavior. Therefore the monitoring system contributes for the prediction of adverse conditions and knowledge maintenance, which does not depend only on human agents involved any more.

The models used in the São José dos Campos- SP plant were:

A. Insulation aging calculation

Insulation aging through pyrolisis and hydrolisis (NBR5416, IEC60076 e IEEE/ANSI C57.91)

- Remaining service life percentage control, loss of daily average life and remaining service life time prediction.

B. Water in oil content calculation

Water in oil content, with evolution trend and temperature for free water formation

- Loading restrictions control

C. Water on paper content calculation

Water on paper percentage, with an estimate of service life loss acceleration through hydrolysis and bubble formation temperature calculation;

- Loading restrictions control

D. Cooling system efficiency calculation

Comparison between calculated top oil temperature and the same measured temperature.

- Preservation of the transformer supporting all loading requirements.

E. Future temperature calculation

Prediction of future temperatures, with indication of remaining times to reach alarm and disconnection levels, as needed.

- Power cut planning without changing the plant production plan

F. Chromatographic and physicochemical offline calculation

History record and offline analysis of oil gas chromatography tests and physicochemical tests

- Test organization and early identification of internal failures

iv. Information availability

Using the potentiality of the automatic monitoring system, information is made available to all interested sectors of the company (maintenance, operation, automation...) in simultaneous and unlimited access - transformer information democratization.

1. Local access - from the server itself in the control room.

2. Remote access through the Internet - from any remote computer connected to the company's intranet.

In the concept of "exception" the system is responsible for alerting against computer behavior abnormalities, and this means there is no need to have someone dedicated 24/7 to the system. This assists the maintenance team work in planning and performing their jobs, by sending information - via alarms and e-mails - about any critical situations which must be addressed. In Figure 08, the identification screen shows the occurrence in a graphic and friendly way.

Fig. 08 - Monitoring software screen with the transformer failure graphic identification system.

4.0 - CONCLUSION

Quality requirements and the respect for consumers drive Johnson&Johnson to constantly seek innovations to make the production process more efficient and reliable.

The electric and plant modernization continuity and the use of the online monitoring directly adhere to the predictive maintenance adopted as standard.

This tool as an accessory to decision making has already changed the maintenance processes as well as the relationship between technical needs and plant production requirements. Based on the analysis of the supervised evolution of significant parameters of power transformer deterioration, the new routine allows better planning of corrective interventions.

In fact, the teams who are responsible for keeping all system energized have what they need to take faster action, be more assertive and lower intervention costs.

5.0 - REFERENCES

[1] ELECTRA, "An International Survey on Failures in Large Power Transformers in Service", Paris, CIGRE, Ref. number 88 1983

[2] Ammon, Jorge Alves, Marcos, Vita, Andrew, Kastrup Filho, Oscar Ribeiro, Adolfo, et. al., "Sistema de Diagnósticos para o Monitoramento de Subestações de Alta Tensão e o Gerenciamento das Atividades de Manutenção: Integração e Aplicações" ("Diagnostic System for High Voltage Substation Monitoring and Maintenance Activity Management: Maintenance Management Activities: Integration and Applications ", X ERLAC - Latin American Regional Meeting of CIGRÉ, Puerto Iguazu, Argentina, 2003.

[3] Melo, Marcos A.C., Alves, Marcos, "Experiência com Monitoração On-Line de Capacitância e Tangente Delta de Buchas Condensivas" ("Experience with On-Line Monitoring and Tangent Delta Condensive Bushings"), XIX SNPTEE - National Seminar on Production and Transmission of Electric Power. Rio de Janeiro, Brazil, 2007.

[4] Alves, Marcos, Silva, Gilson, "Experiência de Campo com Monitoração On-Line de um Transformador 343MVA 230kV, com 2 Comutadores sob Carga" "Experience in the Field with Online Monitoring of a 343 MVA 230kV Transformer with two OLTCs", IV Workspot – Workshop on Power Transformers, Recife, Brazil, 2005.

[5] Alves, Marcos, Vasconcellos, Vagner, "Monitoramento da Umidade no Óleo Isolante de Transformadores de Potência Visando o Aumento da Confiabilidade Operativa" ("Monitoring the Moisture in the Insulating Oil of Power Transformers to Increase the Operating Reliability"), V Workspot – Workshop on Power Transformers, Belém, Brazil, 2008.

[6] IEEE Guide for the Application of On-Line Monitoring to Liquid-Immersed Transformers – Draft 11

[7] Brazil (2014). Treetech Sistemas Digitais; SIGMA - Sistema Integrado de Gestão e Monitoramento de Ativos [Asset Monitoring and Management Integrated System]