MASSY ENERGY

A MASSY GROUP
COMPANY

MASSY GROUP
IN LATIN AMERICA & CARIBBEAN

MASSY GROUP
CORPORATE VALUES

Growth & Continous Improvement		Honesty & Integrity		Responsibility
	Love & Care		Collaboration	

MASSY PURPOSE

WE ARE A FORCE FOR GOOD

CREATING VALUE, TRANSFORMING LIFE

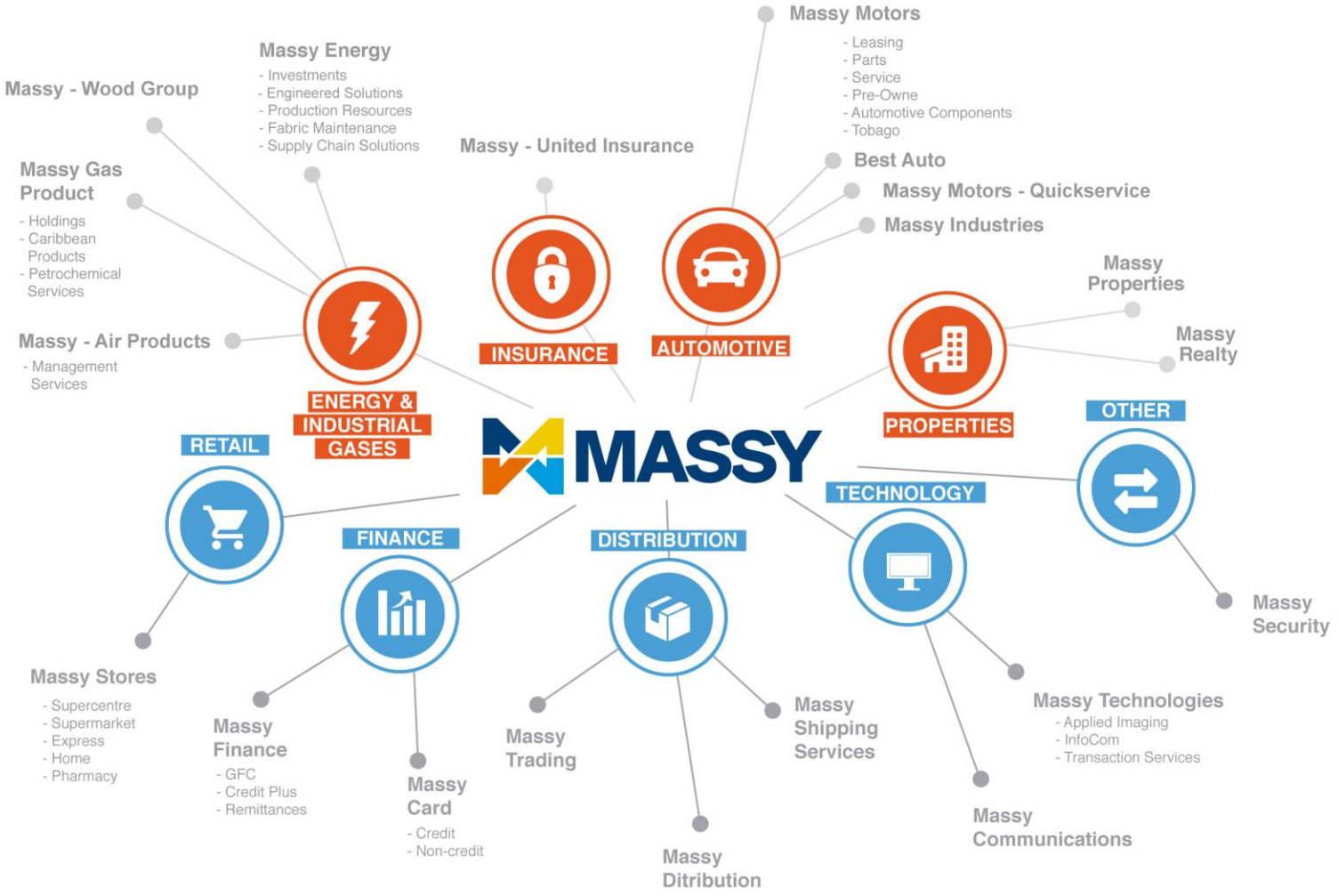
MASSY GROUP
IN NUMBERS

USD $1,6 Bn	+11.000	35
Annual Sales	Employees	Offshore Platforms

+75	10
Business	Countries

BUSINESS TO BUSINESS

BUSINESS UNITS



BUSINESS TO CONSUMER

MASSY ENERGY COLOMBIA
A MASSY GROUP COMPANY

MISSION

*We are a company that provides services, through a **culture of innovation** with a committed staff. We operate with efficient processes aligned to the needs of our clients, ensuring the quality, integrity, safety, health and environment in all our operations.*

VISION

*Be recognized for **being ahead of the needs of the industry** based on the competence of our people, permanent innovation and our values as the center of everything we do, achieving sustainable development.*

MASSY ENERGY
COLOMBIA

- Industrial
- Oil & Gas
- Petrochemical
- Biofuels
- Energetic
- Minning
- Siderurgical
- Infraestructure

MASSY ENERGY COLOMBIA
BUSINESS LINES

MASSY ENERGY COLOMBIA
BUSINESS LINES

MASSY ENERGY

CBM TECHNIQUES

TECHNOLOGY AND INFORMATION TAILOR-MADE

WHAT WE DO

We offer predictive maintenance techniques to perform diagnostics of rotative equipment and issue technical recommendations to correct anomalies detected. Besides, we consult and advise clients on solving problems to their equipments.

WHAT ARE
OUR GOALS?

- **Ensure availability and reliability** dof customer´s equipments by reducing unplanned failures.
- **Reduce operating costs** by detecting timely posible failures that may have an impact on production losses, emergency Works and increased consumption of spare parts.

WE PROVIDE SOLUTIONS IN:

MECHANICAL CBM

- Vibration Analysis
- Infrared Thermography Analysis
- Oil Analysis
- Reciprocant Equipment Analysis
- Ultraosonic Analysis

ELECTRICAL CBM

- Infrared Thermography Analysis
- Electric Motors and Generator Analysis (offline and online testing)
- Power Quality Analysis
- Ultrasonic Analysis
- Transformer Oil Analysis

SPECIALIZED CBM TECHNIQUES

- Pump's Energy Efficiency Analysis
- Rotordynamic Analysis
- Structural Vibration Analysis
- Pulse Analysis
- Remote Visual Inspection (Boroscopy)
- Balancing and Alignment

MACHINERY CONDITION ADMINISTRATION

- CBM Web (Asset Condition Management Tool in a Web Platform).
- Defining Condition Based Maintenance Models.

MECHANICAL CBM

MECHANICAL CBM
VIBRATION ANALYSIS

¿What is it?

It's a predictive maintenance technique to determine the inner status of and equipment and thus prevent unexpected and costly failures.
It's based on the movement study of structures and its relationship to a good condition of internal components.

¿What can be detected?

- Mechanical Unbalance - Misalignment
- Mechanical Ease - Wear
- Bearing deterioration
- Cavitation - Recirculation
- Bent Shaft - Resonance
- Electrical Issues
- Poor Lubrication

Benefits

- Increased remaining lifetime of an equipment and its components..
- Increased planned maintenance and hence reduce corrective maintenance.
- Cost reduction by preventing lubrication, bearings and misalignment typical faults.
- Ensure quality of repairs and reduce amount of faults during the startup of new equipments.
- Optimize preventive maintenance and enable condition based maintenance plans.

MECHANICAL CBM
IR TERMOGRAPHIC ANALYSIS

¿What is it?
Infrared thermographic analysis detects those systems or components having abnormal temperatura values that may cause a failure to a mechanical and/or electrical system.

Tehnology at your service
We have several termal imaging cameras with the following features::

- High-definition infrared detector.
- Bluetooth voice recording technology.
- Real-time radiometric video recording and JPEG storage.
- Automatic indication of hot spots
- High speed data transfer via USB port.

These above advantages may allow the thermographer to perform his work with extraordinary efficiency and productivity.

Benefits

- **Improved service** quality.
- Provide security to people, environment and equipments.
- Prevent unexpected failures.
- Achive efficient scheduling of maintenance resources.
- Reduce repair time by accurate fault location.
- Reduce maintenance costs.
- Process optimization.

MECHANICAL CBM
OIL ANALYSIS

¿What is it?

This predictive technique evaluates the type of wear experienced by an equipment in operation, performing oil testing such as physico-chemical properties analysis, wear metals analysis and contamination.

¿What can be detected?

- Degradation level of lubricating oil physico-chemical properties (Oxidation/Nitration/Viscosity)
- Lubricating oil cleanliness level.
- Presence of metal particles contamination associated to wear of components such as rings, camisas, bancadas, asientos.
- Water, silicon, soot contamination.
- Wear additives

Benefits

- Increased remaining lifetime of an equipment.
- Increased lubricating oil change periods.
- Early fault detection.
- Energy cost reduction, and increased useful life of mechanical components.

MECHANICAL CBM
RECIPROCATING ENGINE AND COMPRESSOR ANALYSIS

¿What is it?

This predictive analysis evaluates both the performance and mechanical condition of a machine through specialized techniques to analyze parameters such as pressure, temperature, ignition time, vibrations and rotational speed (RPM), in order to identify issues and potential failures, and take promptly maintenance actions.

¿What can be detected?

Engine failures such as:

- Injection and synchronization system problems.
- Uncalibrated valves.
- Excesive wear on valves, impellers or camshaft.
- Piston and liner problems.

Compressor failures such as:

- Volume pocket operations
- Valve leaks
- **Piston rod loads**

Benefits

- Reduced maintenance costs.
- Increased preventive maintenance intervals.
- Production losses reduction.
- Identify beforehand the spare parts to replace.
- Increased lifetime of internal components.
- Avoid unnecessary outages for components inspection.
- Prevent unexpected outages due to internal components failures

MECHANICAL CBM
ULTRASONIC ANALYSIS

¿What is it?

By applying this technique, statistical data and trends of an equipment can be registered, allowing more assertive assessments about equipment condition and reducing potential failures.

Technology at your service

The Ultraprobe 10000 is the equipment used for ultrasonic testing.

This equipment enables to perform non instrusive testing, ranging from simple leak detection to extremely sophisticated mechanical analysis methods, allowing inspection and monitoring components, mechanisms and systems operating in a plant.

Sound waves analyzed in ultrasonic testing are waves with frequencies higher than upper audible limit of human hearing, for which special hard hat compatible headphones are used.

Benefits

- Uninterruptible operations.
- Versatility in plant applications.
- Energy savings.
- Plant reliability.
- Reduced operating costs.
- Non intrusive maintenance activities.

ELECTRICAL CBM

ELECTRICAL CBM

ELECTRIC MOTOR AND GENERATOR ANALYSIS (OFFLINE & ONLINE TESTING)

¿What is it?

It's a non destructive technique that provides a complete analysis of an electric motor and/or generator set, by applying both offline (MCE) and online (Emax) testing, to evaluate the condition of the equipment using the six fault zones (rotor, stator, power circuit, airgap, insulation and power quality).

¿What can be detected?

- Motor circuit faults.
- Poor insulation quality
- Eccentricity
- Moisture/ Contamination
- Harmonic distortion
- Rotor and stator issues

Benefits

- Power circuit condition provided from the point at which the testing starts through to the connections at the motor, including breakers, fuses, contactors. etc.
- Ensuring integrity of electric motors and/or generator sets.
- Increased reliability and availability of electric motors.
- Motor circuit condition is provided.
- Mitigation of potential catastrophic failures
- Increased mean time between failures (MTBF).
- Reduced maintenance costs

ELECTRICAL CBM
POWER QUALITY ANALYSIS

¿What is it?

This technique evaluates electric power systems to determine electrical issues associated to equipment failure or malfunctioning, such as voltage fluctuation (flicker), harmonic content in the network, transient voltages and currents, load imbalance, that may cause premature failures to electrical systems and its components, penalties imposed by utilities due to harmonic pollution caused by non linear loads connected to the network and electrical system losses.

Dranetz Power Xplorer PX5 is the power quality analyzer used to perform power quality surveys.

¿What can be detected?

- Votlage and current harmonics
- Sags/Swells
- Voltage and current imbalance
- Frequency variations

Benefits

- Power quality analysis of the supply network.
- Electrical failures identification in starting systems and power system protection coordination.
- Understanding of electrical power systems behavior due to power load variations.
- Conduct Energy efficiency studies
- Compliance verification of electrical standards and regulations.

ELECTRICAL CBM
ULTRASONIC ANALYSIS

¿What is it?

By applying this technique, statistical data and trends of an equipment can be registered, allowing more assertive assessments about equipment condition and reducing potential failures.

This technique may be perform to power transformers, power lines, MCCs, switchgears, protection relays, insulators,, switches.

¿What faults can be detected?

- Partial discharges
- Corona discharge
- Tracking
- Arcing

Benefits

- Uninterruptible operations.
- Electrical failures detection to critical equipments and systems such as power transformers or electrical substations
- Increased remaining lifetime of an equipment.
- Reduced operating costs.

ELECTRICAL CBM
TRANSFORMER OIL ANALYSIS

¿What is it?

It's a predictive technique to analyze and test insulating oil in power transformers, performing laboratories testing such as physico-chemical analysis and gas chromatography to determine oil condition, detect electrical faults within a transformer and oil insulated components, in order to increased lifetime of Transformers and check presence of oxidation, moisture, contaminating agents and metails in insulating oil.

¿What can be detected?

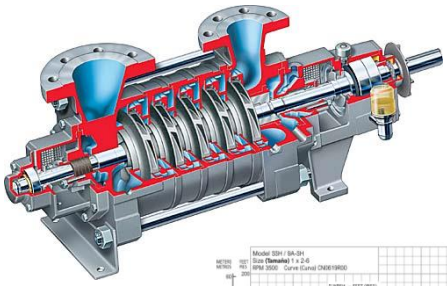
- Degradation level of insulating oil (oxidation/contamination).
- Loss of dielectric strength (dielectric breakdown voltage).
- Loss of insulating oil properties.
- Acid and sludge formation in oil.
- Partial discharge.
- Corona discharge.
- Cellulose/Insulating oil overheating.

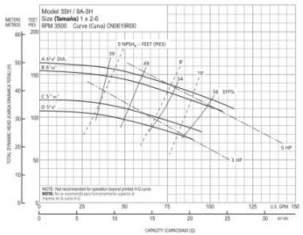
Benefits

- Monitoring overall condition of Transformers to predict and prevent failures.
- Increased remaining lifetime of transformers.
- Latent failures mitigation by implementation of maintenance strategies.
- According to local laboratories Alliance, it may be posible to check online test results and historical data.
- Lab tests accreditation to ensure high reliability results.

SPECIALIZED CBM TECHNIQUES

SPECIALIZED CBM TECHNIQUES
ENERGY EFFIECIENCY ANALYSIS





¿What is it?

It's a technique to evaluate the Energy efficiency of industrial equipment such as electric motors, reciprocating engines and pumps.

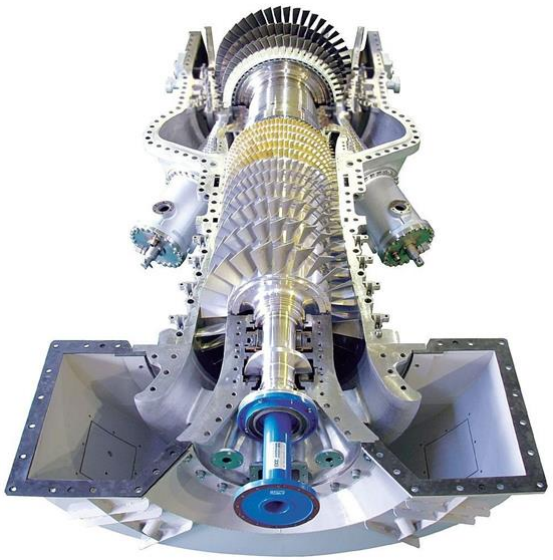
¿What can be detected?

- Hydraulic mechanical and electric power consumption.
- Power losses.
- Flux issues.

Benefits

- Provide accurate information to improve pumping system performance.
- Verify capacity of operating systems.
- Reduce unnecessary energy consumption.
- Identify hydraulic issues.
- Minimize power losses.

SPECIALIZED CBM TECHNIQUES
ROTORDYNAMIC ANALYSIS



¿What is it?

It's a predictive technique that allows to diagnose condition of major equipments such as turbines, pumps and compressors, to prevent failures that may cause high impact costs. This technique is based on the study of shaft movement inside equipments and its correlation to potential failures.

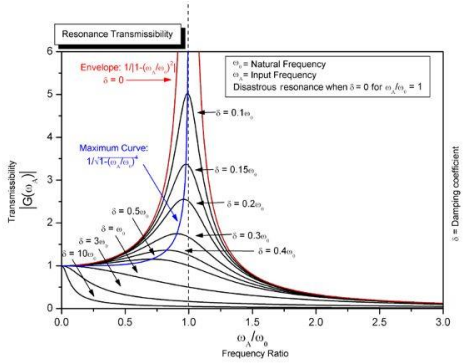
¿What can be detected?

- Mechanical Unbalance - Misalignment
- Mechanical Preload
- Shaft positioning in bearings
- Rotating Stall
- Thermal Bowl
- Axial positioning
- Critical Speeds

Benefits

- Ensure reliability in major rotating equipment.
- Major overhaul planning.
- Optimize overhaul timing.
- Reducing costs by preventing high impact failures.
- Ensure quality of reparis and failures reduction during startup, steady state and outages.

SPECIALIZED CBM TECHNIQUES
STRUCTURAL VIBRATION TESTING



$$F_R = \frac{1}{2\pi\sqrt{LC}}$$

¿What is it?

It's a predictive technique that allows to identify if the vibration that occurs in an structure is the result of a phenomenon called resonance, in which a vibrating system drives another system to oscillate with a greater amplitude at a specific preferential frequency.

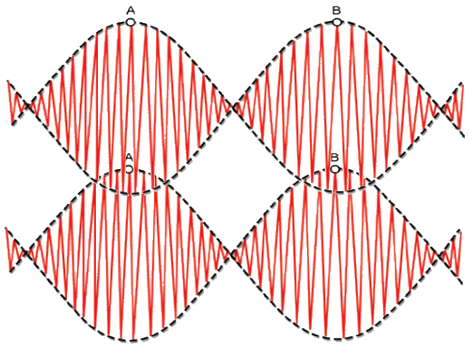
¿What can be detected?

- Resonance
- Lack of stiffness
- Lack of mechanical support
- Structural Vibration
- Inappropiate designs
- Faulty corrections
- Incorrect material selection

Benefits

- Increased remaining lifetime of equipment and its components.
- Prevent fatigue failure, breakage or unexpected failures.
- Cost reduction by preventing fatigue failures.
- Removal of unnecessary vibration.
- Different test scenarios, not affecting equipment integrity.
- Prevent contamination due to product leakage.

SPECIALIZED CBM TECHIQUES
PULSATION ANALYSIS



What is it?

It's a predictive technique that evaluates severe pulsation caused by positive displacement machines (pumps, compressors), while increasing fluid pressure.

¿What can be detected?

- Pulsation
- Buffer tank issues
- Absence of damping
- Absence of orifice plates

Benefits

- Remove abnormal noise and vibration in piping, scrubbers, vessels.
- Prevent costly piping repairs
- Prevent accidents caused by mechanical forces.
- Detection of buffle bottles issues

SPECIALIZED CBM TECHNIQUES
BORESCOPE INSPECTION

¿What is it?

It's a predictive technique, non-destructive test, to visually inspect a machine where the area to be inspected is anaccessible by other means, in order to evaluate internal machinery condition by capturing video and images.

¿What can be detected?

- Cracking
- Wear
- Internal component degradation
- Erosion
- Abrasion
- Leakage

Benefits

- Machines intervention in an appropiate time.
- Increased remaining lifetime of an equipment and its components
- Increase planned maintenance and hence reduce corrective maintenance.
- High costs savings in order to minimize outages of critical equipments.

SPECIALIZED CBM TECHNIQUES
ALIGNMENT & BALANCING OF INDUSTRIAL EQUIPMENT

¿What is it?

This technique is part of an assurance process based in equipment condition, avoiding maintenance cost overrun. This technique is vital to develop maintenance programs in order to ensure lifetime of equipments.

¿What can be detected?

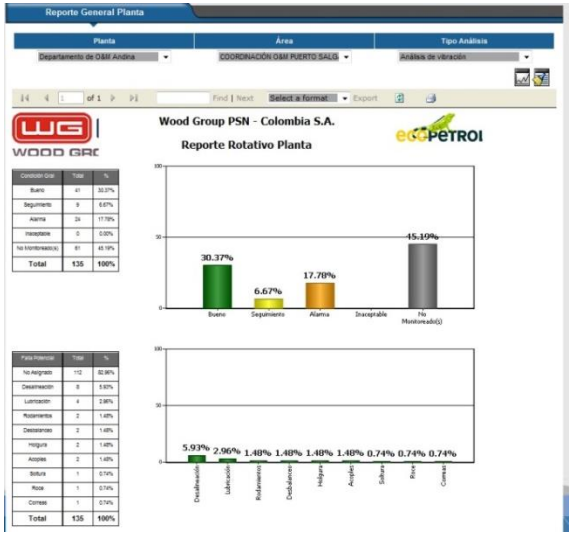
- Mechanical Looseness
- Grouting issues
- Housing deformation
- Flange misalignment
- Angular, parallel, vertical and horizontal misalignment

Benefits

- Extended lifetime of bearings, seals, shafts and couplings.
- Optimize lifetime of internal components.
- Reduced maintenance costs and production losses.
- Mitigation of unnecesary outages.
- Optimize machine performance.

CONDITION MONITORING MANAGEMENT

CONDITION MONITORING MANAGEMENT
MACHINERY CONDITION- CBM WEB



¿What is it?

It's an own web based database to document, manage and evaluate condition of equipments in a facility, integrating every predictive techniques used.

¿What fort?

One of the current issues of any CBM program is to track, analyze and manage asset information, due to high amount of collected data, reports are stored in personal computers or folders and lack of integration in applied technologies. Web CBM manage asset's historical data and condition allowing a customer to agile decision-making.

Benefits

- Easing information management of a condition monitoring program.
- Check equipment condition from any computer with internet Access.
- Track historical data of equipments in a facility.
- Easily Access (no software to be installed), in order to check and track historical data of equipments.

CONDITION MONITORING MANAGEMENT
MACHINERY CONDITION – CBM PROGRAMS

Types of CBM programs

- **In-House CBM**

Condition Monitoring specialized group located in a plant or facility, full-time dedicated to develop and manage a CBM program

- **Hybrid CBM**

Condition monittoring management program executed by In-house maintenance personnel and outsoourcing.

- **CBM by services**

Condition monittoring management program by outsourcing services.

Requirements

- CMMS Implementation.
- Predictive maintenance programs.
- Highly trained and skilled workers.
- Condition Monitoring Tool, which is easily accesible and interpretation for remote users.
- Use of technologies that enable communication to remote locations.
- Find the appropiate means to display periodic results benefits and its evolution

SOME OF OUR EXPERIENCE

OUR EXPERIENCE
IR THERMOGRAPHY ANALYSIS

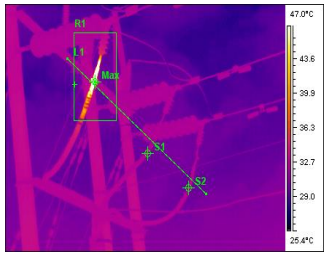
Timely Fault Diagnosis of a 34.5 kV Power Distribution Line.

Challenge

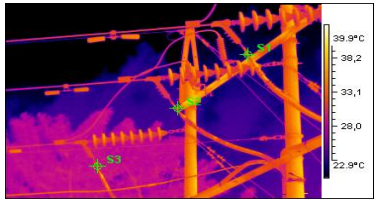
- Continuing with the predtivie maintenance philosophy, in terms of avoiding catastrophic failures and plant outages, that may have cause high economic losses.
- Through a semi-anual infrared inspection in OCENSA's Coveñas pumping station, a hot spot was found in a power line that feeds the maritime terminals.

Results

- Timely detection allowed to schedule corresponding maintenance.
- In order to meet the pumping Schedule, a high availability of the system is achieved.
- Significant savings were achieved by maintaining operation of the maritime terminals in Coveñas (OCENSA, ODL & ODC pipelines)



Object parameter	Values
Máx.	287.0°C
L1: Temp. Máx.	206.4°C
L1:Temp. Min	27.4°C
R1: Temp. Promedio	33.8°C
R1:Temp. Max	293.8°C
R1:Temp. Min	27.4°C



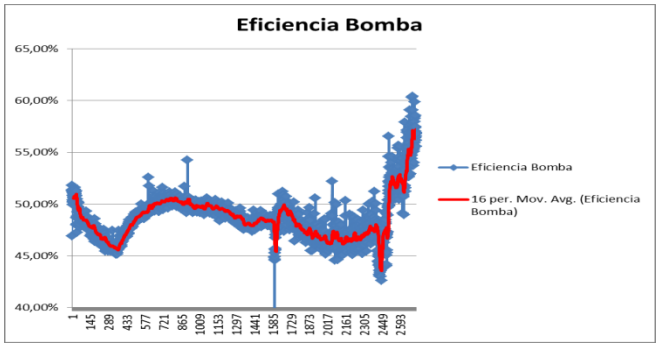
Object parameter	Values
S1	33,6°C
S2	33,3°C
S3	32,9°C

OUR EXPERIENCE
ENERGY EFFICIENCY ANALYSIS

Evaluating Energy Efficiency in Pumping Systems

Challenge

- It's been identified the need to evaluate energy efficiency in pumping systems along the oil pipeline stations, in order to reach the national's daily production goal of 1 million oil barrels transported to loading terminals.
- In order to identify pumping energy costs, as well as pumping units deficiencies, the necessity to develop a methodology to measure pump efficiency was considered.



Results

- MASSY ENERGY has developed a methodology to measure energy efficiency in pumping systems by combining existing technologies that derive from real and non-theorical data.
- The performed testing in ECOPETROL's pumping systems have allowed the validation of expected results by identifying efficiency values, costs and system inefficiencies.

Pump Efficiency	
Mean	48,66%
Standard Error	0,00
Median	0,49
Standard Deviation	2,19%
Sample Variance	0,00
Kurtosis	3,89
Skewness	1,19
Range	0,24
Minimum	36,40%
Maximum	60,43%
Sum	1322,55
Count	2718,00
Confidence Level(95,0%)	0,00
Variation	4,51%

OUR EXPERIENCE
THERMAL IMAGING ANALYSIS

Mechanical and Electrical Equipment

Challenge

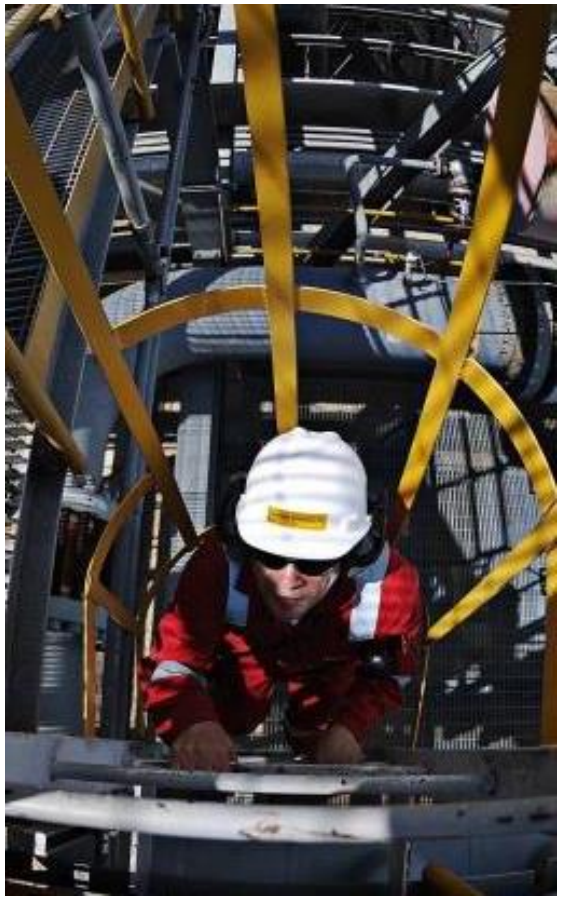
- Detecting issues in electrical contacts, electric circuits, breakers, switches, power Transformers and mechanical heat transfer systems.
- Perform activities to customer satisfaction in terms of quality, effectiveness and diagnoses agility

Results

Money savings in correcting faults detected to Transformers that could have cause economic and human losses.

Avoiding unexpected stops at a very high cost (Pastas Doria, AMSA & ECOPETROL.)

WHY WE ARE THE BEST OPTION
TO YOUR BUSINESS?



- Ease and **quick adaptation to your requirements** and needs.
- **Accompaniment** to provide a solution to your problems, by first hand communication of findings and recommendations.
- **More than 15 years** of local and international experience, which has allowed us developing a wide KNOW HOW at your disposal.
- **Certified personnel** in predictive maintenance techniques such as vibration analysis, IR thermography analysis, electrical testing, reciprocating analysis. Every certifications are accredited by international standards.
- Integrating **predictive maintenance techniques** in order to analyze and duly detect equipment failures.
- Cutting-edge technology and a condition monitoring management tool in **a web platform** (Web CBM).

MASSY ENERGY

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