MOSYCOUSIS Report Summary

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Final Report Summary - MOSYCOUSIS (Intelligent Monitoring System based on Acoustic Emissions Sensing for Plant Condition Monitoring and Preventative Maintenance)

Executive Summary:
An acoustic emission self-powered wireless sensor is one of the main objectives achieved at the end of the project. The sensor measures relating frequency as opposed to time which is advancement from the state of the art. Thus MOSYCOUSIS create a smart AE sensor incorporating on-board data acquisition, conditioning and data processing system capable of storing data for pre-processing and threshold comparisons. Sizeable solution is sought with a separate stackable module, allowing to place “each function” (signal processing, wireless and energy harvesting) into a single global enclosure. Specific algorithms have been developed based on signal processing and acoustic emission theory for translating the condition of acoustic emissions from the mechanics to faults in the machinery (system), and to perform machine prognosis and calculate life expectancy. From the sensor’s hardware point of view, two important features have been developed: an acoustic emission conditioning module which allows up to three-channels management and specific conditioning to emphasize the acoustic emission fault characteristics defined analysed by the fault detection algorithm, and the power supply module, which allows a regular 24Vdc supply, but also up to three harvesting modes (vibration, photovoltaic and thermal) which can be combined depending on the application.

The MOSYCOUSIS system is complemented by an Expert System software which runs remotely. The Expert System allows the monitoring of the sensor’s network, and is the responsible of interpret the information in order to give the maintenance support to the operator. The Expert System allows the comparison, visualization history analysis and data export, as well as wired and wireless communications with the MOSYCOUSIS sensors.

The MOSYCOUSIS project has result in a high-performance condition monitoring product that, although it has been dedicated to mechanical degradation detection in rotating machinery, the system can be adapted to a wide range of industrial monitoring applications related with structures, materials and mechanics.

Project Context and Objectives:
With the increasing adoption of electronics in today’s industrial systems, increasing reliability is often let down by mechanical components. Reliability is a major issue in today’s highly competitive market place; the costs associated with unexpected machine failure can have a drastic effect on a company. Unexpected failure does not only cost in the replacement of parts and labour, but downtime cost as well in that it may take several days before the replacements arrive. During this time the machine is inoperable and the loss of several days of production may have a negative impact on the income for the company.

In an attempt to reduce downtime costs, large enterprises and indeed most companies keep an on-site inventory of replacement parts or they build redundant systems for all their vital machines, especially gearboxes and other rotational couplings. However, both these solutions tie up a substantial amount of capital and do not necessarily solve the downtime issue as it takes a significant amount of time to repair major failures. Small and Medium sized Enterprises (SMEs) often suffer disproportionate financial hardship more than Large Enterprises (LEs) in this type of situation because often they are unable to afford the services of condition monitoring operatives and their cash resources are often stretched with downtimes due to plant failure. A preventative method often adopted by most SMEs is to have maintenance operatives go around the plant...
periodically listening to and analysing the machines for any sign of malfunction while others implement a pre-programmed
downtime and substitution of the critical machine parts, within a well defined operating lifetime to minimise the fault risks and
costs of sudden shutdown. There are two issues with these approaches:

• The first method is subjective and relies on highly skilled and highly experienced maintenance operatives. In addition this
method may not be appropriate for systems that are remote as is often the case in a lot of processing (including chemical
processing industries) plants.

• The second may prevent unplanned down time, it does not eliminate the cost of down time and it increases the maintenance
cost of the machine since parts are substituted before the end of their natural life. Significantly, most of the signal acquisition
system relies on vibration monitoring, which means that component parts have already started to degrade by the time the
vibration has been detected.

In order to have a machine that functions well it is imperative to ensure that there is good predictive maintenance. Historically,
predictive maintenance was applied mainly by LEs but they are usually complex, expensive because handmade, mostly
monitoring vibration and usually offered as an additional service to large enterprises by a wide range of companies usually an
SME. These systems and services are very often beyond the affordability of SMEs. An intelligent system and devices able to
detect the fault in its early stage is then convenient. The most common failures in industrial machines are those related to the
power transmission systems. Therefore, there is a need for a low cost means of non-subjective on-line, pre-vibration
monitoring system for detecting malfunctions in gearboxes, rotating shafts, bearings and similar systems. For instance, gear
related failures account for 60% of faults in gearboxes, and 24% of gearbox failures are caused by ineffective maintenance
action. It is for this reason that gearbox condition monitoring is of significant importance to reduce failures and to assure the
continuity of operations. Both the early detection of a potential mechanics failure and the remaining life of the damaged
mechanics are useful information for equipment users, and the examination of operating state monitoring and fault diagnosis
in machines without disassembly has become one of the most important research areas. A wide range of research has been
carried out considering vibration. Nevertheless, most of this research has been limited to using conventional methods such as
time domain and frequency domain techniques, or instead new time-frequency transformations, as well as signal
demodulation techniques. Acoustic Emissions (AE) is the latest approach in detecting and identifying faults in bearings,
gearboxes and mechanical couplings. The principal advantage of the AE detection against traditional vibration detection is
that it has a much better signal to noise ratio (SNR) at very low frequencies, and in this way it is possible to detect the
beginning of a possible failure at a very early phase. In addition AE frequencies do not depend on the machine speed.

Acoustic Emission (AE) is the phenomenon of transient elastic wave generation in materials under stress. When the material is
subjected to stress at a certain level, a rapid release of strain energy takes place in the form of an elastic wave which can be
detected by transducers placed on it. Plastic deformation and growth of cracks are among the main sources of AE in metals.
Though AE can come from any system under movement, the main source is doubtlessly rotating machinery. Sources of AE in
rotating machinery include impact, cyclic fatigue cracks, friction, turbulence, material loss, cavitations, leakage, etc. In most
cases the SMEs machine owner would be satisfied with a simple affordable device that is able to warn them of impending
failure of critical equipment. In most cases vibrations in rotary systems appear after the fault has impacted in performance,
this project is targeted at developing a rotary system monitoring device for predictive maintenance of gear boxes, bearings
and mechanical shafts based on acoustic emissions.

With AE it is possible to monitor 100 % of a relatively large surface area with a small number of sensors. It is not necessary to
move the acoustic sensors above the surface to locate a defect. The AE analysis “listens” to the defects right at the moment
of their occurrence, and therefore - in real-time. Due to this real-time monitoring, the AE testing method can be used as a
warning system to avoid a failure of the system with possibly disastrous consequences for testing objects.

Recent developments in sensing technology, microprocessors, and miniaturised radio transceivers has enabled a new
generation of Wireless Sensors Modules (WSM). The dream of the future is that ubiquitous sensing nodes will autonomously
report on operating conditions, and that these data will be used to facilitate structural health monitoring, embedded test &
evaluation, and condition based maintenance of critical industrial rotating machinery without the use of expensive cabling. Such WSMs will also be able to monitor machine efficiency and compare against expected norms. In order to provide sensing networks which are truly autonomous, chemical batteries must be eliminated from the sensor and some kind of energy harvesting has to be foreseen. Piezoelectric materials have demonstrated their ability to convert vibration energy from vibrating machinery and rotating structures into electrical energy for powering WSMs. Hence, an acoustic emission self-powered wireless sensor module is one of the main objectives to be achieved in this project.

The proposed sensor will be required to meet the following operational goals:

- A smart AE sensor incorporating on-board data acquisition, conditioning and data processing system capable of storing up to 1Mb of data for pre-processing and threshold comparisons. First pre-diagnostic output should be stored in a local non volatile memory. Local feature extraction to send only extracted feature to the network is foreseen.

- Low cost – low power consumptions electronics that must be very sensitive to EMI problems and robust against usual electrostatic discharges.

- Sizeable solution with a separate stackable module, allowing to place “each function” (signal processing, wireless and energy harvesting) into a single global enclosure for hermeticity away from the sensor.

- A local wireless network communication system suitable for hazardous conditions and capable of transmitting processed signal in less than 60 seconds with a reliability of 98% without cross talk (between sensors) or spurious sensing due to external electromagnetic. Built in antenna is better for hermeticity.

- Mesh networks

- A local power harvesting able to supply at least 100mJ of energy every 60 seconds.

- Algorithms based on artificial intelligence for translating the condition of acoustic emissions from the mechanics to faults in the machinery (system).

Three main advantages of this type of sensor are:

- As the sensor is attached to the machine it contains neither complex algorithms nor specific input/output ports, it results in a cheaper and more compact solution compared to the available commercial products.

- Signal processing at the sensor level is simple and fast and then they do need neither large memory nor powerful CPU. Only extracted feature are sent to the network and messages send to central CPU are short and sporadic, only in case of threshold event will it maintain the RF link. Therefore, power requirements are low and AE sensors can be supplied by a parasitic power supply, which is a novelty in the market.

- Complex diagnosis and prognosis algorithms run in a low cost PC hardware, and RF network that is not expensive. Hence, every plant can be covered by sensors to apply predictive maintenance.

Project Results:

Introduction

Unexpected failure in an industrial production chain does not only involve the costs of failed parts replacement and the
associated man-hour labour, but downtime costs have also be considered. To keep a machine functioning well it is a must to have good predictive maintenance, as it helps to reduce operating risk, avoids plant failures, provides reliable equipment, reduces operating costs, eliminates defects in operating plant and maximises production. Acoustic Emission (AE) is a phenomenon of transient elastic wave generation in materials under stress. When the material is subjected to stress at a certain level, a rapid release of strain energy takes place in the form of elastic wave which can be detected by transducers placed on it. Plastic deformation and growth of cracks are among the main sources of AE in metals. Though AE can be produced from any system under movement, the main source is doubtlessly from rotating machinery. Sources of AE in rotating machinery include impacting, cyclic fatigue cracks, friction, turbulence, material loss, cavitation, leakage, etc. In most cases the SMEs machine owner would be satisfied with a simple affordable device that is able to warn them from critical equipment failure. Recent developments in sensing technology, microprocessors, and miniaturised radio transceivers has enabled a new generation of Wireless Sensors Networks. The future of these sensors is to have ubiquitous sensing nodes that will autonomously report on operating conditions, and that this data will be used to facilitate structural health monitoring, embedded test & evaluation, and condition based maintenance of critical industrial rotating machinery without the use of expensive cabling. In addition, in order to provide sensing networks which are truly autonomous, chemical batteries must be eliminated from the sensor and some kind of energy harvesting has to be foreseen. Piezoelectric materials have demonstrated their ability to convert vibration energy from vibrating machinery and rotating structures into electrical energy for powering a wireless sensing node. Hence, an acoustic emission self-powered wireless sensor is one of the main achievements in this project.

2. Scientific and Technological results

2.1 Fault Condition Characterisation algorithms

Traditionally, predictive maintenance of industrial machinery is carried out using vibration monitoring systems. These are designed either as a continuous monitoring (on-line or LAN based), in that the measurements are centrally processed or discontinuous monitoring (off-line or hand held), whereby a qualified technician carries out periodic revisions of vibration state. Although continuous monitoring systems offer better maintenance, their high cost leads to the companies to resort to discontinuous monitoring services, which represents the majority (more than 70%) of vibration monitoring solutions. These methods are costly, because they either need a permanent monitoring system that results in a costly system (600-800€ for the vibration sensor unit alone), which deters many companies from installing the technology. Moreover, slow rotational speeds result in reduced energy loss rates from damage related processes and under these conditions Condition Monitoring Techniques that detect energy loss, tend to be more difficult to apply. Despite their costs, these methods tend to discover faults only when it is serious. They are not able to discover problems at the initial stage before its starts to progress. Surprisingly, AE is well suited to detect very small energy release rates, and as a result AE is able to detect subtle defect related activity from machinery. Even when it is rotating very slowly and the defect is in the earliest state. These characteristics make AE a suitable tool for Predictive Based Maintenance (PBM), although the application of AE in prognosis has yet to be fully explored and exploited. Additional research has to be done to interpret and fully understand the “sounds of AE” from rotating machines.

A number of signal processing methods have been used on the time domain to diagnose failures by AE measurements in machinery. Although these methods are quite simple to apply, it is apparent that they involve a significant expertise in the interpretation of the output. As a conclusion, and despite lubrication and some faults are detectable in the time domain analysis, to benefit most from the high sensitivity of AE to defects filtering and reconstruction from time and frequency processing are proposed in this project, as a way to diagnose the bursts and apply time and frequency analysis to perform the feature extraction and characterise the faults. If mean or overall AE parameters obtained from characterisation are considered as fault detection parameters, they can be most suited as a trending parameter where its current value is to be compared to previous ones under similar operational conditions.

This additional research has been carried out under the MOSYCOUSIS project. The characterization of the failure event and the associated acoustic signal response has been approached in four stages during the analysis of the mechanical
materials/components: the first one based on the characterization of metallographic samples and its mechanical behaviour under different loading conditions, the second one focused on the characterization of gear failures under finite element modelling and, finally, the third and fourth approaches by rotating machinery under laboratory and industrial conditions respectively. The observed AE patterns during the signal analysis approaches, taking into consideration time, frequency and time-frequency domains, which represents and advancement in regard with the actual methodologies, are listed next:

(i) Two main kinds of AE signals can be acquired: continuous and discrete signals. Discrete AE signals are usual in electromechanical systems based on gears. However, the complexity of the mechanical components, or the increase of the speed will leads to the generation of a continuous AE composed by continuous AE bursts.

(ii) In general, the AE acquired signal shows a continuous noise level (in continuous and discrete signals). The fault apparition or the speed increase modulates the AE bursts amplitude significantly, but not the AE noise level.

(iii) The mechanical degradation implies a displacement of the AE spectral content to higher frequencies. Two main characteristic fault frequency bands have been detected. The analysis of the spectral contents around these frequencies represents the most reliable approach for fault detection and degradation quantification.

(iv) The AE point of measurement affects the amplitude of the frequency components, but not the AE pattern. The same effect is observed under mechanical speed variations. In this sense, the spectral contents around the characteristic fault frequency bands must be analysed in comparison with previous acquisitions to observe the evolution.

(v) The characterization of the processed AE signal (time-envelope and pass-band filters), by statistical-time features can provide enough information about the regular levels (healthy cases), and the frequency analysis allows the quantification of the severity.

This analysis level is considerably advanced in comparison with the current approaches based on characteristic time threshold. Traditionally, the most commonly measured AE parameters for diagnosis are amplitude, rms, energy, kurtosis, crest factor, counts and events. Observations of the frequency spectrum, whilst informative for traditional non-destructive evaluation, have only found limited success in machinery monitoring. This is primarily due to the broad frequencies associated with the sources of generation of AE in rotating machinery. The algorithm fault detection performance has been compared with similar products in the market, and the results shows that the proposed methodology is able to detect smaller degradation levels of the materials, which allows an earlier detection of the mechanical status and the corresponding tracking of the degradation evolution.

Smart AE sensors such as the Holroyd Instruments give an overall view of the levels of AE activity from a machine. MHC cabled-sensors from Holroyd record the AE signal, analyze the time signature, and monitor the events. Total energy, peaks of singular defects and dB level are parameters used as fault detectors. Other suppliers, like MARPOSS, supply a wide range of acoustic sensors for alternating, rotating or grinding machines, together specific software to manage the time signal processing and sensor configuration. However, no information in frequency space is considered in the sensor, and no further process to analyze trends, life expectancy or sudden fault probability are included in these equipments. There are a few other handheld devices but these types of equipments are used as diagnostic aids by qualified technicians. Therefore the equipment is only as good as the interpretation of the user.

In order to manage the condition monitoring information, two specific algorithms have been developed, which are combined at different scale in the sensor and expert system algorithms.

The Mosytron algorithm takes advantage of the fact that the Acoustic Emission activity will increase with the presence of failure and its related spectral content will be displaced to specific higher bands during the degradation process of the component under analysis. Accordingly, three different frequency bands related to the severity of the failure in the system were defined which have specific meanings: Healthy condition or initial degradation signs, degradation process initiated and presence of failure in the system. In order to simplify the machine’s condition information given to the user, the algorithm tries to summarize all the information related to the energy content in each frequency band to a final numeric fault indicator. The Mosytron calculation algorithm, first of all, searches for relevant spectral content in the acquired AE signal, and it returns the information of high AE relative energy. The algorithm searches iteratively the frequency spectrum. Finally, a specific ratio
has been defined for computing the fault indicator. All these fault indicators are stored in a historic inside the sensor. The machine health indicator (Mosytron), is calculated as a weighted mean of this historic.

In order to complement this information, the chromatic algorithm has been applied to represent the energy variation in the AE critical areas of the frequency spectrum. The procedure to apply the chromatic monitoring is detailed in the project deliverables, as well as the calculation of the Mosytron values. Three frequency bands are isolated in time domain by means of three digital filters which are applied to the original time domain AE signal. Then the chromatic index is calculated.

A significant characteristic of the defined algorithm which represents also a difference with similar products is the programming of an automatic calibration process. The obtained characteristic fault indicators are adapted to a normalized scale independent from the machine under monitoring.

2.2 Acoustic emission transducer and conditioning

AE was originally developed for non-destructive testing of static structures; however, over the last 30 years its application has been extended to health monitoring of rotating machines, including bearings, gearboxes, pumps, etc. It offers the advantage of earlier defect/failure detection in comparison to vibration analysis due to the increased sensitivity offered by AE. However, limitations in the successful application of the AE technique for monitoring the performance of a wide range of rotating machinery in industry have been partly due to the difficulty in processing, interpreting, and classifying the intelligent information from the acquired data in the sensor. The main drawback with the application of the AE technique is the attenuation of the signal, and as such the AE sensor has to be close to its source. However, this is not always possible and AE signal originating from the defective component will suffer severe attenuation, and reflections, before reaching the sensor. Although ultrasonic AE covers a wide frequency range (20 kHz to 1MHz), in practical use the frequencies are limited to 50 kHz to 500 kHz. Time domain waveforms associated with AE are of two types: burst and continuous. A continuous-type AE refers to a waveform where transient bursts are not discernible. On rotating machinery, typical background operational noise is of a continuous type.

A high-performance set of transducer and electronics has been defined during the project. The low-cost transducers have been selected to increase the diagnosis algorithm capabilities by means its characteristic AE curve. The electronics allows the conditioning up to three channels and the attenuation of the non-significant bands. Most of the similar products in the market allows only one AE channel, which reduces the multiple points monitoring possibilities to increase the diagnosis reliability.

2.3 Self – Powered Sensors

Energy-harvesting techniques, which extract ambient energy from the local environment around the WSM, offer a potential solution to prolong the lifetime of a sensor and therefore gaining real autonomy and minimising/eliminating the need for servicing.

At present several piezoelectric and electromagnetic transducers which convert mechanical vibrations of 50Hz/60Hz from rotating machinery into electrical energy with enough efficiency to achieve several mWatts of power have been demonstrated. These transducers produce sufficient power to operate the WSM reliably, i.e. maintain the sensor reading, wireless processing data functions etc. Energy storage devices such as supercapacitors enjoy reasonably high energy density and store sufficient energy to ride through short term downtimes and periods where the harvested energy is low.

An energy harvesting strategy has been successfully demonstrated in the project, in which vibration, thermal and photovoltaic energies have been considered. In case of significant variations to the operating frequency/amplitude of the harvesting source, it is proposed to devise a ‘combinational EH device’ comprising the addition of other types of EH devices. This comprises adding other harvesting transducers at the same time considering cumulative harvested energy approach. Thermal harvesting sources are likely to generate power of the order of 100-200 µW, which is sufficient to charge the supercap, in case of drop in the harvested power, so it can complement the energy generation scheme.
2.4 Expert systems

Different interface software are available in the market to manage sensor networks. However, most of them are based on a basic visualization of the corresponding characteristic fault parameters. In the MOSYCOUSIS project, the expert system allows not only the management of sensors (status monitoring, enable/disable, calibration and sensor functionalities configuration), and visualization of data, but also the obtention of maintenance recommendations after the automatic interpretation of the characteristic fault parameters received. This fact, represents an important difference in regard with similar current products.

Expert system main role in monitoring Acoustic Emissions is collecting data being acquired by Wireless Sensor Network nodes, saving it, processing it and identifying sources of signals detected into the channel as a way to identify faults in rotating and reciprocating machinery in its very early state using. Analysis core is based on advanced signal processing tools and knowledge obtained from analyzing machinery in different operation modes and scenarios. Results from data analysis are saved and exposed to user for their visualization. The functional blocks are:

Data acquisition and database.
Nodes acquired data is transmitted to expert system via wireless sensor network or physical connection to the sensor attached to the failing machinery. Expert system saves data received in to the database.

Data analysis.
Analysis is done using signal processing with following inputs:
- Data acquired. Data acquired from wireless sensor network nodes while system running
- Knowledge database. Model data obtained from previous analysis of correctly working and failing scenarios in different operation modes.

Results display.
Results previously saved to the database are available to the user via different frontends considering specific functionalities and user requirements.

Potential Impact:
The MOSYCOUSIS integrated system could have near infinite future technological applications, from environmental monitoring, compressed air monitoring, structural monitoring, process monitoring and machine condition monitoring. However recognising the strengths of this consortium and the biggest market sector the MOSYCOUSIS sensor system will initially focus on machine condition based monitoring processes such as pumps, gear boxes, electric motors, machining processes, fans, blowers and compressors etc. for parameters such as: wear; bearing deterioration; mechanical seal rubbing; lubricant contamination and loss of lubricant; severe misalignment; mounting faults and process monitoring including leakage etc. The MOSYCOUSIS system determines the state of the machine when no evident vibration or change on standard condition can be perceived or sensed by the existing condition monitoring technology, thereby providing pre-warning of machine degradation at its onset which will bring significant benefits to the end – users. The benefit of the MOSYCOUSIS condition monitoring system is not only in the reduction of repairs and down time as mentioned above, but in the efficient running of machines by reducing damage to machines and minimising maintenance costs, optimise energy consumption, improve quality and avoiding waste (production quality may degrade as a machine starts to fail before the problem is identified with the conventional monitoring systems) and reducing unscheduled machine breakdowns. The cost of the existing method of predictive maintenance, as practiced by Large Enterprises (LEs) remains proportionally prohibitive for the SMEs that currently compete with them. Therefore the MOSYCOUSIS system will lead to reduced operational costs, improved efficiency, and reduction in capital expenditure on repair and replacement of plants thereby improving the competitiveness of SME’s, especially against the LEs and Non-European competitors who have favourable labour advantage. Furthermore, prevention of catastrophic failure can avoid disasters that
could potentially bankrupt or weaken the financial positions of the SME. The proposed platform provides a cost-effective solution to SME’s who have been unable to access the use of existing machinery monitoring systems, due to the excessive costs. Moreover, MOSYCOUSIS goes beyond the performance of conventional systems used by LEs due to its novel technology in terms of sensing, integration and the advanced predictive model. This means that MOSYCOUSIS can not only be used by SMEs but also LEs, which enhances the potential exploitation of this technology in the market.

The main environmental impact that the MOSYCOUSIS system will impart is the reliability of key industrial processes and installations. Timely notification from the MOSYCOUSIS system, of impending process failures will afford manufacturing and household goods industry enough time to plan shut downs and avoid needless increases in energy which would result in an increase in CO2. In the food, pharmaceutical and medical industries, where project partner Wirelite (now, Endeco Technologies), has many clients, one of the major issues is the failure of process and refrigeration equipment which results in the loss of millions of Euros of products each year and unnecessary waste going to landfill. The MOSYCOUSIS system, used for these machines can prevent these types of negative environmental impacts from occurring in the first place. The energy saving gained from the elimination of industrial process interruptions for continuous production lines in the manufacturing industry such as household goods production from Electroarges or from the food processing and pharmaceutical industries, as in the case of Wirelites clients, can be in the order of 25% as the power consumption for restart and the return to normal operating conditions requires a heavy initial power load. Thus the MOSYCOUSIS system can prevent unplanned shut downs quicker than current technologies across many industries in Europe which in turn can save a vast amount of CO2 being released to the atmosphere. For example an SME industrial or processing company using 10KWh of energy per month through using the MOSYCOUSIS system will produce 1.5Kg less CO2. As a machine starts to fail the quality of products it produces may start to deteriorate, by being able to easily identify the machine problem the MOSYCOUSIS system assists in reducing production wastage which results from machines that are not within normal tolerance ranges. In addition the wireless application of the MOSYCOUSIS system will also result in the elimination of wires, conduit and cable trays which results in a saving of raw materials, such as Cu, Al and Sn, which are needed to manufacture these parts. Energy Harvesting of the MOSYCOUSIS system means that batteries will be eliminated which means that environmentally harmful battery components are not sent to landfill and the raw materials required for battery manufacture are all together eliminated. Thus an overall positive environmental impact is certain from the production and installation of the MOSYCOUSIS system.

The MOSYCOUSIS system will increase safety in the work place for all Europeans. As an early warning system, earlier than what is currently on the market, the MOSYCOUSIS system permits safer working environments as catastrophic plant and industrial failures can be avoided. As stated above, the MOSYCOUSIS system will also be able to prevent a number of environmental disasters and reduce unwanted environmentally destructive waste from entering water ways and reduce CO2 emissions which in turn will benefit all Europeans which will thereby better the social aspects of the lives of Europeans. The development of the MOSYCOUSIS system will also result in increased employment and jobs in Europe. The MOSYCOUSIS system will positioned in Europe in the Acoustic Emission field, not only in the application but also in the development of technology, which will bring the creation of new jobs not only in companies but also in Research Organisations. Each SME is expected to receive a substantial benefit and return on their initial investment from the production of the MOSYCOUSIS system. During these difficult economic times that faces the global economy, unemployment in Europe is particularly high, therefore the introduction of a new system on the European economy would result in increased employment.

List of Websites:
http://mosycousis.ctm.com.es

Related information

| Result In Brief | Acoustic emissions announce machine stress |