# REAL TIME MONITORING SYSTEM FOR INDUCTION HARDENING MACHINE

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*Abstract :*In today's competitive world, manufacturers have realized that they need automation as a key for their success. However, the impact of automation is concerned with the effectiveness of process monitoring and control system. There is a need for close loop supervisory system, which integrates and coordinates individual process modules for real time adjustment, conflict resolution and priority assignment. Monitoring and control of multiple process modules will result in higher productivity, better quality and prognostics (in future) for near-zero breakdown performance.
As there is a need for making real time monitoring in the practical application of the given process which can be achieved by using TCP/IP Protocol and applicationpackages like MATLAB.
The key words of this approach are data accusations and analysis, process monitoring and analysis, and feedback during the manufacturing process, acquisition and decision making.

## I. INTRODUCTION

In today's competitive world automation has been playing a very important role for manufacturers. These automations can be supervised with the help of RTM (Real Time Monitoring) systems. The customer need accurate and quality products, there is no room for error. This can be achieved by using RTM system.
As there is improvement in technology with the use of automation, there is a need for RTM systems to monitor, control, and rectify the errors, etc. during the process being performed on the machine. RTM System helps in monitoring and managing the data for the real time processing operations and decision making. Typically, an RTM system provides the data to the operating administrator with the visual insights of the operation which is undergoing real time processing operation.
RTM system is a process through which an administrator can review, evaluate and modify the addition ,deletion, modification the overall process and functions performed on data in real time, or as it happens, through graphical charts and bars on a central interface.
These RTM systems continuously monitors the variables in machines and analyses the performance of the machine during the process and compares it with the reference data. If the data is not matching with the reference data then it give alarm or indications to the operator of the machine so that he can take necessary actions to over-come the errors.
These RTM systems other than in induction hardening machine can also be used in other various fields like for administrative purpose or health monitoring systems or checking for the quality of the water, etc.

## II. Literature Survey

Alwyn Goodloe and Lee Pike [1] used Real time monitoring system for increasing the reliability of safety-critical systems. They observed the behaviour of the system and detects the defects if it consistent with a specification. By using RTM, the monitoring of the safety system in aircrafts or space-crafts helps in reducing the risk of damage or disaster going to be caused.

Lihui Wang, Peter Orban, Andrew Cunningham, Sherman Lang [2] made Real time monitoring system to bring traditional CNC machine tools on-line with combined monitoring and control capability. By using this method the user not only can feel largely reduced network traffic by real-time interactions, but also can obtain more flexible control of the real shop equipment.

Sir Atluru, Amit Deshpande, Dr. Samuel Huang, Dr. John P. Snyder [3] used Smart Machine Supervisory System which consists of RTM. In this process the supervisory system integrates and coordinates individual process monitoring and control modules such that a real-time globally optimal machining solution is delivered for maximum productivity.

Snatkin A, Karjust K, Eiskop T [4] applied the idea of using Real time production monitoring system in SME (support manufacturing engg). The main objective is to analyze real time production monitoring systems (PMS) and to offer better solutions for small and medium sized production companies. PMS is the alternative to manual data collection and should capture most of the required production data without human intervention. The real time PMS systems enable to continuously acquire data from the shop floor with regard to efficiency, malfunctions and productivity. This leads to improved production capacity and cost efficiency, helps to achieve desired production goals.

Przemyslaw Oborski [5] implemented the idea of Integrated Monitoring System of Production Processes. The integrated monitoring system was built on the base of multi-agent technology to assure high flexibility and openness on applying intelligent algorithms for data processing. Development of IT systems, machine control and advance monitoring applications gives new opportunities for integration of production level with management systems.

Mahmoud A. Alahmad, Patrick G. Wheeler, Avery Schwer, Joshua Eiden, and Adam Brumbaugh [6] used Real Time Monitoring system to monitor the Residential rate of Energy consumption. The implementation of real time energy monitoring has an impact on the residential rate of energy consumption in a metropolitan area with relatively low electricity rates. Real time monitors reduce the energy consumption as a result the actual power consumption data collected from the devices are reduced.

Theofanis P. Lambrou, Christos G. Panayiotou, Christos C. Anastasiou [7] saw that there was a need for making use of Real time monitoring for checking the water quality assessment at consumer sites. The real time monitoring system is used to check the water quality at consumer's site and gives the details based on the contaminants present in the water and it also indicated whether the water is suitable for drinking purpose or not.

S. Geetha and S. Gouthami [8] made used of technology by using Internet of things enabled real time monitoring for checking water quality. IOT is used for testing water samples and the data uploaded over the internet are analyzed. The system provides an alert to a remote user, when there is a deviation of water quality parameters from the pre-defined set of standard values.

Iryna Kuklina and Antinin Kouba and Pavel Kozak [9] used Real-Time monitoring of checking the water quality by using fish and crayfish as bio-indicators/inputs. Real time biomonitoring is use to incorporate living organisms into the system to serve as biosensors. This method is used for water treatment plants and water supply stations for prevention of hazardous toxicological events, and for aquaculture in ponds, lakes and aquariums for monitoring growth, population size and behavior traits.

Rajvardhini Katake, Bhagyashree Kute, Sharmili Ranjane, Shubham C. Jaiswal [10] made use of RTM system for health monitoring through internet of things. The RTM with the help of IOT can be used in medical fields like for monitoring the patient's heart rate, body temperature, respiration rate, etc. By using this method doctors can provide medications depending on the health parameters through IOT.

## III. Task of Real Time Monitoring System

The real time monitoring system in manufacturing industries enables both the management and the production team to continuously monitor the real time production status with regards to reliability, accessibility and maintainability of the equipment. Information of the production process must be collected every time whenever the operator performs the operation.
The ability of the real time monitoring system is to collect the production data information on real time basis and it enables the production team to respond, in timely manner, to solve any production related issues that may arise.
The task of RTM is to suggest or indicate the production team to produce their best within the available resources / information. Other than this RTM system also helps in improving quality and production process of the product.
This system should proactively detect and react to the defects, by informing the relevant personnel in the departments so that necessary action could be taken place. The Data collected is used for analysis i.e., it is used for comparing the obtained data with the predefined data stored in the system and necessary action should be taken place so that there will be no repeated errors occurred in future.
We have used RTM system for monitoring the process consistency of the product undergoing induction hardening process. These RTM system records the process parameters during hardening process. The data collected will be helpful in field analysis if failure occurs. By doing so the quality and the production speed of the part will be improved and increased.

## IV. Requirements of RTM systems

To make a RTM system we have used Siemens PLC. We have used Potentiometer for simulation of the sensor used for measuring process parameters. We have used Siemens Step 7 for the communication purpose and application software like MATLab for obtaining the required output graph. With the help of these we can monitor the process without the requirement for human intervention during the hardening process. In case of any error occurred the RTM system will give signal to the operator to take necessary actions against the error occurred.
A PLC (Programmable Logic Controller) consists of power supply, control program, memories, input / output circuits and control unit. PLC is a control system which continuously monitors the input device and makes decision based upon custom program to control the state of output device.
The sensor reads the production process and then sends it to the PLC which acts as input. The input obtained by the PLC will be checked and stored in the memory and the required output will be transferred to output module of PLC. The output data obtained will be verified and stored in the PLC memory. The output data obtained will be communicated to MATLab through TCP/IP Protocol.
PLC communicates with the external devices like PC. We use Siemens Step7 to make a connection between PLC and MATLab. The program used for making communication between PLC and MATLab is usually written in Ladder. After the programmer completes writing the code he then compiles and downloads it to CPU.
Using the Siemens Step7, the programmer can access the code online with the PLC and makes online modification. This means that the code being downloaded can be modified or changed without stopping the operation being performed.
The program downloaded in PLC is then transferred to MATLab using TCP/IP protocol. The data sent from PLC to MATLab is been scaled down in the Siemens Step7. The required output data sent to MATLab is displayed in the form of graph where it make the operator to understand the operation undergoing the process easily.
The data obtained in MATLab are stored in the memory of RTM System which would be helpful during the analysis of the field failure if occurred. The data displayed in the form of graph in MATLab are on the bases of real time occurrence of the production operation. The input and output takes place in the modules of the PLC and the required data is been visually displayed on the screen.

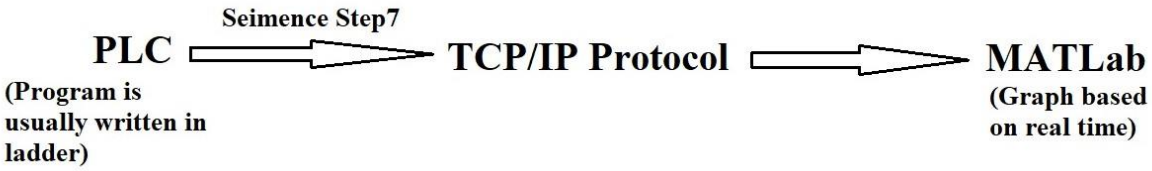


Fig 1: Link between PLC and MATLab

4.1 Technical Requirements of RTM System

An automated machine needs a supervisory system to monitor the communication between the process control and monitoring system of the machine. The RTM system can have various inputs and, subsequent output must be obtained on real time bases. The RTM system should deliver the data on real time so that the operator can perform his operations accordingly to the output obtained during the production operation. To perform these operations the system should consists of flexibility, modular, scalability, online connection.

- Flexibility: It has the ability to change the design and fluctuations in the product, which is undergoing the production process.
- Modular: Modular approach is an approach which enables us to plug and play with the system components without any requirement for re-engineering.
- Scalability: It is used to scale the values to make sure the values are shown are within the required range.
- Online connection: It is used to connect the communication between the system and the application software for obtaining the data on real time bases.

## V. How is real time monitoring system useful?

Real time monitoring is a system that has the ability to respond to the data so quickly that the response takes place as the event is occurring i.e., it gives out the output data for every 50ms. The data output obtained produces the result in real time bases.
These Real Time Monitoring system gives us the accurate real time visibility during the production process of the part undergoing the hardening process. RTM System helps the operator to track the operations and also record the performance of the operation automatically.
The benefits of using a real time monitoring system is to provide effective and efficient real time data immediately on screen based on production related information.

5.1 How does RTM help Operators?

The purpose of RTM is to assist the operator to perform the operations required during the alerts displayed on the screen. The operator must take necessary actions against these errors occurred and make sure that these sort of error don't repeat on future. The RTM system is used to maintain a consistent pace throughout the operation and this will result in a better process of the work among the employees. With the implementation of the RTM the process of the work becomes faster and quality of the work also improves.
This system also empowers the operator to recognize faults and react to the system by alerting the respective departments to solve problems as they occur as shown in fig1.

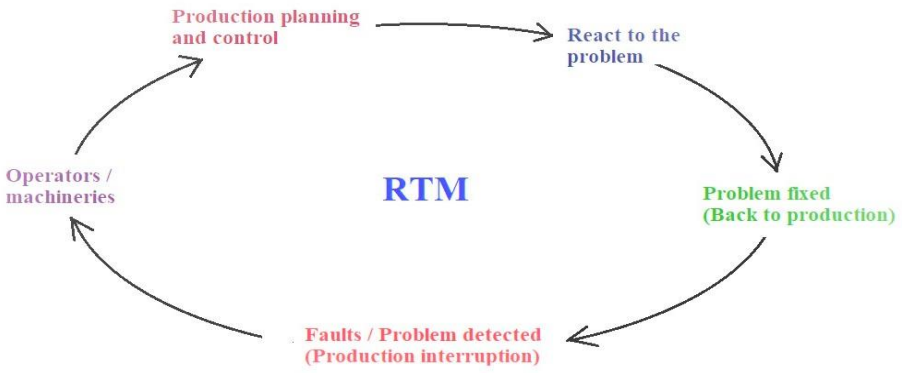


Fig 2: The process cycle to problem solve faults at work station with the help of RTM system

5.2 How does RTM be useful for Production Team

The purpose of RTM is to help the production team to ensure production goals are established and are monitored carefully. Apart from this the RTM also helps to increase production at controlled production costs, within the set targets and enable continuous improvement of line balancing (bottle neck). RTM helps in displaying the results on the screen and also create awareness when work is not flowing.

5.3 Use of RTM in the development of manufacturing systems

The RTM system is developed based on the advances in the production process, machines, materials and control devices. It is also required for effective management of more and more complex and sophisticated systems which requires to be monitored. This

RTM is applicable in business process, production process, assembly process and so on. Applying RTM to monitor the machines and process is one of the most important directions of modern manufacturing systems development.

The implementation of RTM systems in manufacturing field plays a very important role in improving the production process. One of the most difficult problem in the production area is gathering the information of the production process on real time bases. These difficulties can be overcome with the help on RTM system.

The Controlling and monitoring the production process of the machine is very difficult by manual method, this could be overcome by using RTM system because RTM system reads the data on time. The data collected by RTM is very accurate and precise.

The information transfer of data takes place through online process. It gives the information of machining process of the parts being manufactured and these information is stored in the memory. Information from machining process and machine parameters, like tool condition, temperature, distance travelled, part geometrical dimensions, etc. should be accessible on request or during the error rectification cases. The online access to the production data would allow for much more efficient management of all production process. Recording of such data will be helpful in keeping a history of a particular product and its parts being manufactured. Such history would allow us to easily fulfilment the requirements of quality and also for more efficient life cycle management of products and its parts.

## VI. Advantages of implementing RTM system in manufacturing field

- Improve on-time delivery
- Solve the problems in real time
- Saves production hours
- It gives instant notification
- RTM decreases manufacturing down time
- Cutting down waste(cost)
- Higher quality of the product.
- We collect more data more accurately when compared to manual data collection.
- Less human intervention.

## Results and Discussion

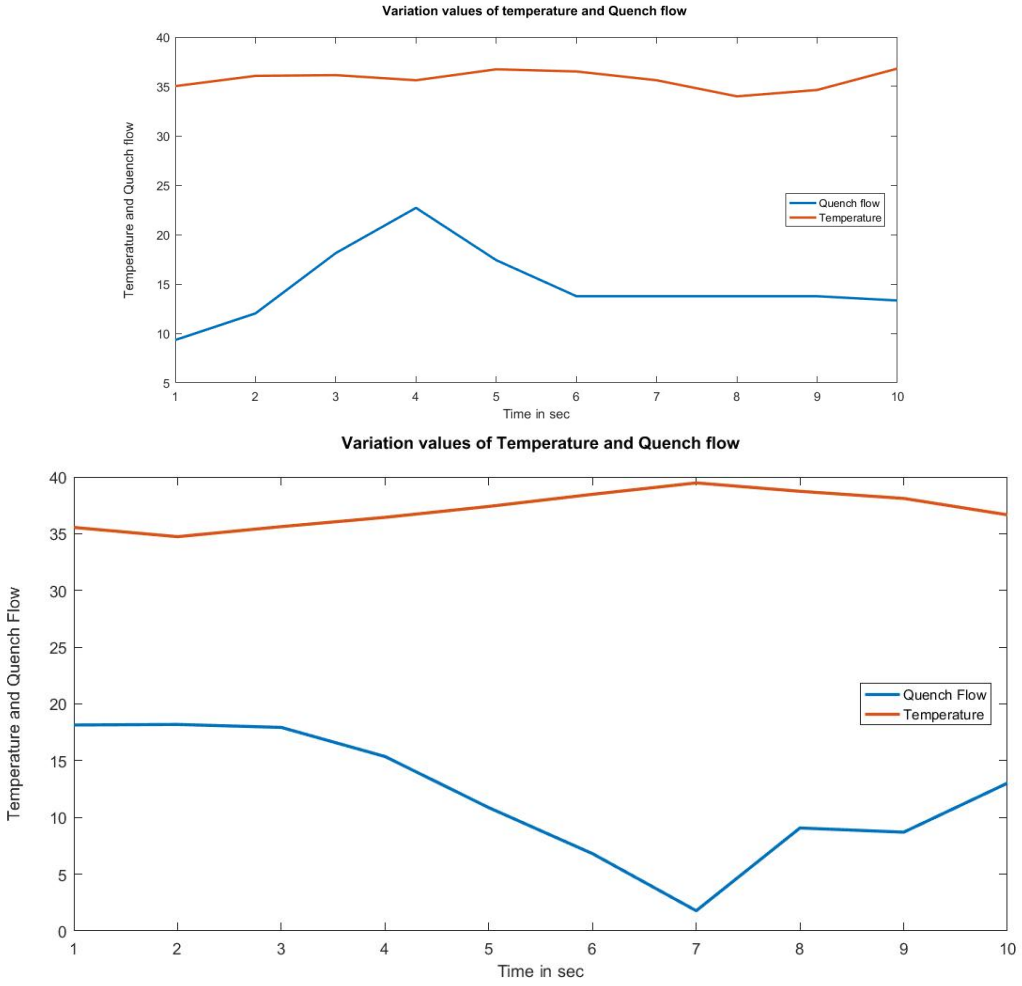


Fig 3: Variation of temperature and quench flow

The above graph is the simulated sensor results of temperature and quench flow. The above graph shows the process consistency of the component undergoing induction hardening process. It gives the details of the temperature and quench flow values which is being processed on the components. From the above graph we can see that the range of temperature remains almost constant during the heating process on the component. And when the quenching of the component takes place initially the pressure flow of the liquid will be high on the component and gradually remains constant through the process. The overall time taken by the component for heating and quenching takes place within 10 sec.

As we can see in the above graph that the x-axis indicates time in seconds and y-axis indicates the values of temperature and quench flow variation values with respect to time. Almost all the variation of the quench flow is between 100lp to 250lp and the range of temperature varies between 300℃ to 900℃. The obtained result is scaled downed in the Siemens S7 and the scaled downed values is plotted by using MATLab.

The graph shown above is obtained from the application software i.e., MATLab. The required output data is scaled downed and the scaled down data is transmitted to the MATLab where the output data is plotted in the form of graph in the MATLab for particular analysis.

## Conclusion

Taking the input and giving the output of the production information at all levels and time along the production process is very essential and this can be achieved by using RTM system. RTM system make sure that it collects the data on timely bases i.e., every 50ms to maintain the accuracy of the products and the quality of the product also increases.

The result displayed on the screen by the RTM system helps us to keep track on the processing parameters like temperature, pressure, distance, etc. on timely bases and the displayed data will be compared with the pre-stored data for checking the errors if obtained. If there is any difference between the obtained data and the pre-stored data then the RTM system helps us to rectify the error so that there will be no repetition of the error in future. By doing so the time required for rectification of the errors will be less and the production process rate will be faster. Thus quality of the product will be improved.

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