9.
Infrared Thermography as a Reliability Tool

◈ 9.1 INTRODUCTION : Even a few years back, maintenance and operation people did quite queer things in the factory. It was a common sight that a productive machine broke down and none had any idea as to why and when such breakdowns would happen. As and when such a breakdown took place, people ran all over the place fighting to put things back in order and as quickly as possible. The bosses would stand around the affected machine and literally breathe down the neck of the repairmen urging them to speed up as if they were driving a car. Sooner or later the machine would be up and running and the repairmen had a broad smile on their faces and a pride in their hearts thinking that their jobs will stay as long as the company stays. Such smiles were however short-lived since within some time the same type of scene would follow.

But such type of thinking and action has started to change. Managers now understand that proper management of equipment is the heart of Productivity. When equipment breaks down frequently it is not possible to produce. When equipment functions abnormally, quality of product is affected. And safety is also compromised. Under such circumstances operational costs increase leading to loss of profitability.

In order to prevent such loss of profitability it is important to enhance the reliability of operation and equipment. How does one do that? We may then start by understanding the basic reasons as to why any equipment would fail. One of the most important reasons is Temperature. For example, an electrical connection fails due to temperature. So does a bearing. And a furnace or boiler becomes inefficient due to temperature changes taking place within it.

But the question that may come to your mind is “Are we not measuring temperature at different places in different ways?” Yes, but most often that does not give the indication of a failure. Why? Simply because a spot temperature measurement may not give us proper or sufficient information as to why and when a machine or component of a machine is going to fail. In most cases we would need to know the temperature distribution of a particular place. This in technical parlance is known as the temperature profile something like a CAT scan, which many of us are familiar with.

However, by simply knowing when a failure would take place we would not be in a position to improve reliability of the equipment. If there were some imperfection then that component or machine would again fail even after being repaired thoroughly. Improving reliability would mean improving the life of the component or machine. That may only be done if the root imperfection is understood properly.

Therefore, Infra-red Thermal imaging (non-contact measurement of temperature) is the only temperature tool that can not only predict a failure effectively but also understand the root imperfections properly. Once the root imperfection is understood and eliminated reliability is improved. We need to do it once to gain ongoing benefit. In this manner, we would be able to improve productivity, quality and reduce operating cost to obtain higher profitability.

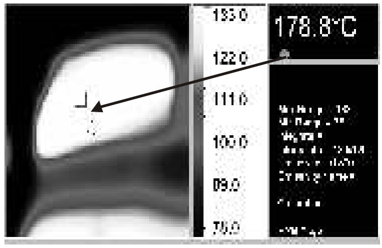
The following cases show how Infrared thermal imaging is useful to achieve these objectives. However the application of this technique is limitless. It is only limited by human imagination.

◈ 9.2 CASES

1. Productivity and Quality depends on Refractory health
2. Finding the root imperfection of anti-friction bearing
3. Finding an electrical unbalanced load
4. Finding the condition of Transformer
5. Finding out the suitability of commutator brush material
6. Improving the life of bearing and gears in a highly loaded gearbox
7. Finding the condition of Slip ring
8. Finding the insulation condition of motor
9. Finding the condition of cable joints
10. Total impact on reduction of electrical failures
11. Total impact on reduction of motor failures

9.2.1 PRODUCTIVITY AND QUALITY DEPENDS ON REFRACTORY HEALTH

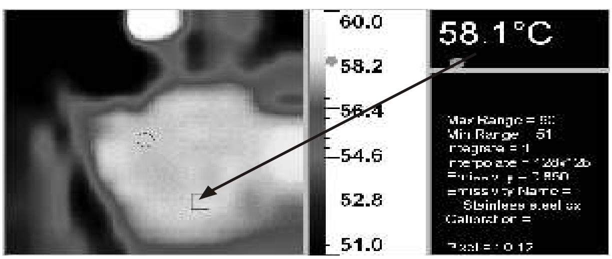
This thermogram (heat picture) shows a portion of refractory wall. Since it is almost impossible to stop furnaces and kilns to measure refractory thickness thermal imaging offers the only viable technique to do so. By measuring the temperature on the shell it is possible to estimate the amount of wear that has taken place inside. It is also possible to estimate the amount of loss of radiant heat from an area. If the loss is too much then cost goes up in terms of extra fuel or energy that is needed to achieve process parameters. Moreover, quality of the product becomes inconsistent. In this particular case, the loss of radiant heat was almost 4 times the normal and the quality was inconsistent. It meant that for every unit of energy added to the system only 25% could be utilized for the process the balance 75% was sheer wastage.



Similar application may be done to find out the effectiveness of Boiler insulation. Thanks to Infrared thermal imaging which made such estimation and calculations possible.

9.2.2 FINDING THE ROOT IMPERFECTION OF ANTI-FRICTION BEARING

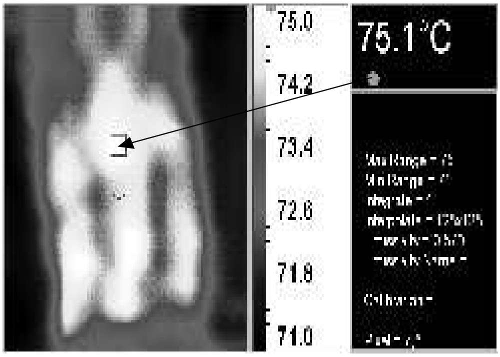
This thermogram shows the end view of an ID fan Non-drive end bearing in a Plummer block. There was noise from the bearing but vibration analysis was unable to detect the cause.



The thermogram clearly shows that the rollers were rubbing against the cages. The only reason could be that the bearing was skewed in its housing. It was found that the housing was 14 years old. The last bearing also gave similar symptoms and failed within 3 months. Had it not been for thermography this root imperfection would have remained undetected and the bearings would have kept on failing one after the other.

9.2.3 FINDING AN ELECTRICAL UNBALANCED LOAD

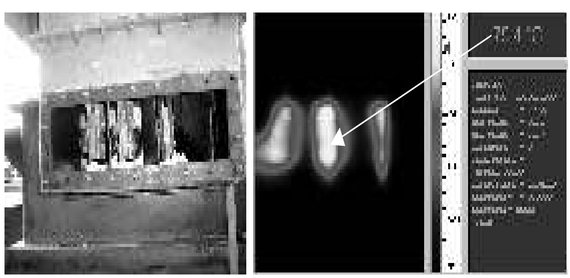
This thermogram shows the thermogram of an electrical connection. Though the temperature may be said to be just outside the normal range an unusual phenomenon was observed. In most panels the Y phase was



found hot. This led to the conclusion that the electrical load was unbalanced. Had the situation continued it would have led to a series of failures of electrical connections thus disrupting production? It may be noted that other than infrared thermography (always non-contact) it would not have been possible to find the problem in electrical circuits in any other way. Moreover, this method is the only safe method to observe abnormalities in electrical installations.

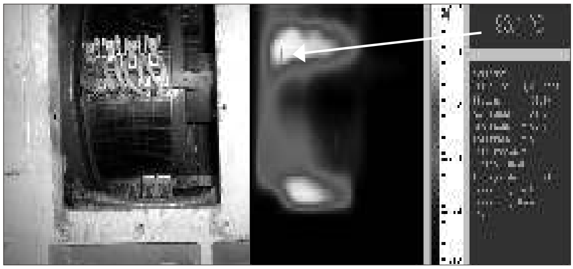
9.2.4 FINDING THE CONDITION OF TRANSFORMER

This thermogram shows all the contacts of the transformer as shown to have higher temperature, especially the Y phase. The analysis showed that the problem is not connected to load. It is a local transformer problem. The contacts are to be cleaned and re-tightened. The gas in oil is also high. The transformer oil is to be checked for moisture content and di-electric strength. Condition the oil or change oil as per findings.



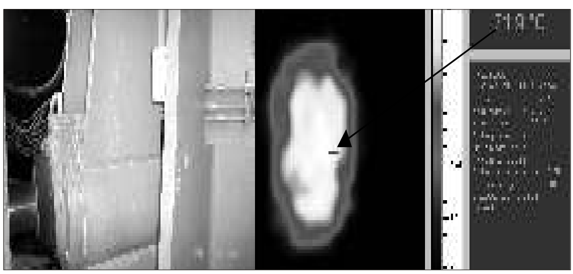
If the oil were not taken care of the contacts would again develop higher temperature. So temperature pattern or distribution reveals a lot of details, which may not be possible to do otherwise.

9.2.5 FINDING OUT THE SUITABILITY OF COMMUTATOR BRUSH MATERIAL



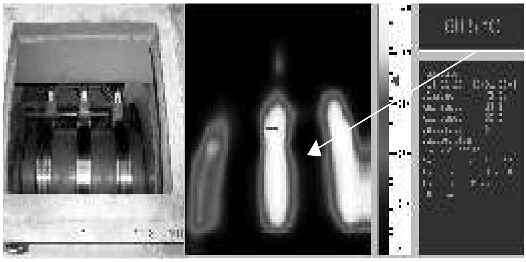
This thermogram reveals two distinct temperature patterns for the two different types of brush materials used in this motor. There would be no other method to understand the comparative performance of two materials other than the time taken for each brush material to fail. With thermography one would easily find out which material is inferior to the other. The material on the upper holder is inferior to the material on the lower holder.

9.2.6 IMPROVING THE LIFE OF BEARING AND GEARS IN A HIGHLY LOADED GEARBOX



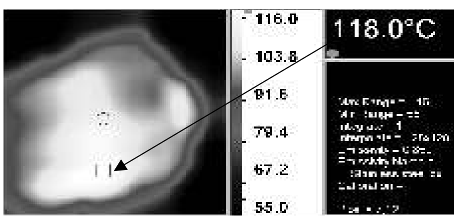
This thermogram was taken for a highly loaded gearbox. The bearing, gearbox in general was found running hot and in a distress condition. The root cause of the heat generated was inadequate lubrication. At the temperature of around 72 degree Centigrade, the oil would get oxidized and lose its effectiveness in lubricating the gears. As a result, the bearing would not run to full life and the gears may also develop fatigue over time. It may manifest as pitting or breakage. Hence it was recommended to control the oil temperature. As a short term measure the existing heat exchanger may be cleaned. As an improvement measure, the efficiency and effectiveness of the heat exchanger may be done by several means. Such analysis of root design imperfection would not have been possible with any other techniques but infrared thermal imaging.

9.2.7 FINDING THE CONDITION OF SLIP RING



This thermogram was taken to find out the condition of the slip rings. It was found that the R phase (the extreme left hand side contact in the thermogram) slip ring interface shows less temperature than optimum temperature level. It meant that the spring has lost tension. Hence this contact/spring may be replaced at the next opportunity. Had it continued in this manner there would have been a possibility of an early failure. Such failures could be very easily avoided by the use of thermal imaging technique. It is more useful since the technique could be applied online.

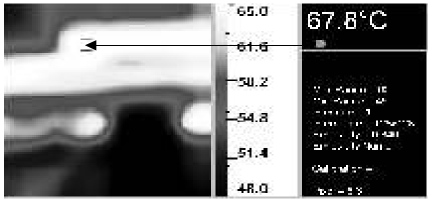
9.2.8 FINDING THE INSULATION CONDITION OF MOTOR



This thermogram shows heat generation at the bottom of an induction motor. And the temperature is quite high for 'B' class insulation. Obviously this motor would fail. However, the thermogram shows a weak insulation at that area. Matters could probably be improved by revarnishing the insulation. It would not have been possible to detect this abnormality so quickly by other means while the motor was running. Thanks to thermal imaging that it also possible to check motors in operation.

9.2.9 FINDING THE CONDITION OF CABLE JOINTS

This thermogram shows the condition of a cable joint. It shows that there is a problem with the joint and the joint would fail over time. A timely



action is warranted. With thermal imaging it is possible to check condition of such cable joint quickly and effectively even in difficult to access places.

9.2.10 TOTAL IMPACT ON REDUCTION OF ELECTRICAL FAILURES

One major cement plant had around 12 cases of electrical panel failures a year. Regular monitoring with thermal imaging reduced the failures to ZERO within one year of operation. The cost of burn out of one panel was Rs. 12 to 15 Lakhs. You may well calculate the savings and the return on investment by application of thermal imaging was more than 1: 100. Regular thermal imaging of electrical connections and joints help improve the reliability of electrical systems.

9.2.11 TOTAL IMPACT ON REDUCTION OF MOTOR FAILURES

Another major paper plant had around 350 motor failures a year. On regular application of Infrared Thermal imaging the various root design imperfections were found out and were being corrected in a gradual manner. However, in the first year itself the number of failures reduced to only 70 motor failures, which again gradually reduced over the years. Needless to say that it helped improved productivity of the plant greatly. Thermal imaging was the right tool to enhance productivity for this plant.

◈ *9.3 A NOTE ABOUT TAKING GOOD THERMAL IMAGES*

Unlike other temperature measurement techniques, infrared imaging provides the means to scan the infrared emission of complete machines, processes or equipment in a very short time. The user can view the thermal emission profile of a wide area simply by looking through the instrument's optics.

However, there are three golden rules to take effective Thermal Images. These are the following:

1. What am I looking at?
2. Why am I looking at this, what I expect from this images?
3. What additional data I need to analyze the thermogram and find the root imperfection?