WHITE PAPER: THERMAL IMAGING CAMERA SYSTEM

Fixed Thermal Imaging Camera Systems for Process Measurement & Control

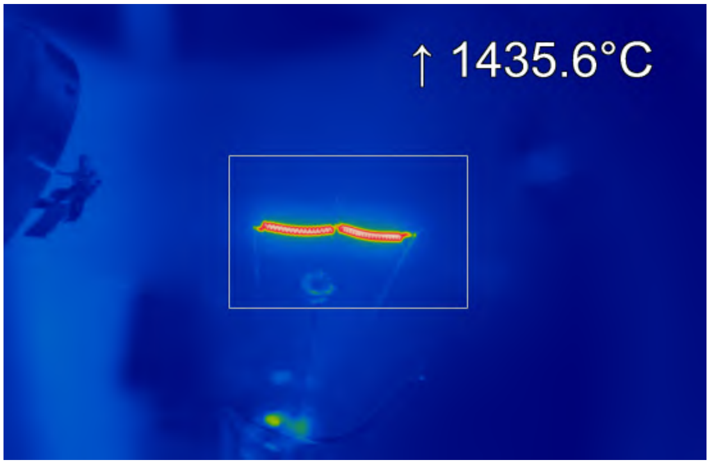
Abstract

Non-contact temperature measurement has long been used for industrial process monitoring and control. Although thermal imagers can provide more detailed information, their use in fixed process monitoring was limited due to high cost and technological limitations. Recent advances combined with lower cost have made the use of fixed, high resolution thermal imaging systems a viable solution for a wide variety of process monitoring and control applications. This paper will address the use of thermal imaging for process monitoring and control, the state of current technology, installation considerations, and several application solutions.

INTRODUCTION

The emergence of new industrial process applications has surfaced for fixed process thermal imaging camera systems that historically were not practical, due to the high cost and technological limitations of a thermal imaging camera's detector array. Greater demand for thermal imaging detectors has accelerated research in developing new technologies for supplying a variety of detector array types.

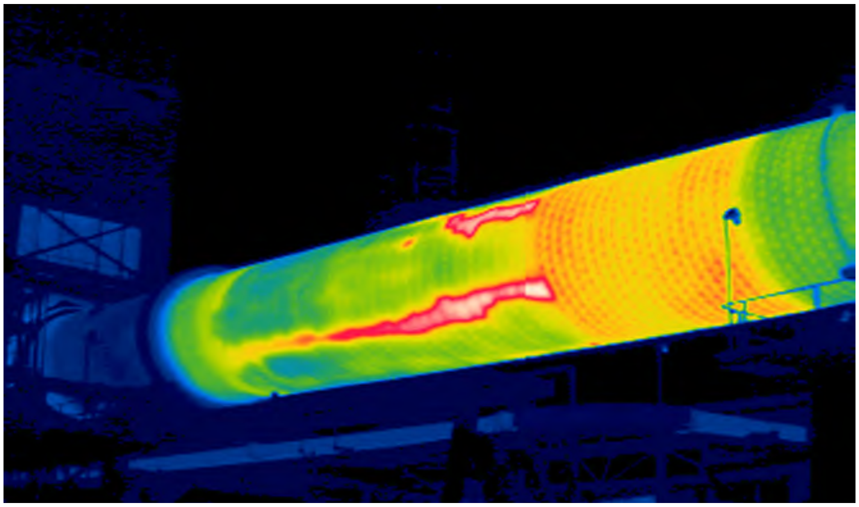
The combination of higher demand and advancements in technology has fueled the increase in the number of detector array manufacturing companies worldwide. Fierce competition in this marketplace has resulted in reduced costs for these detectors, making it affordable to use thermal imaging camera systems in industrial process applications.



THERMAL IMAGING SYSTEMS

Historically, it has been the prime domain of single point, non-contact infrared temperature sensors as the standard for use in industrial process temperature measurement applications. However, they posed many limitations and challenges in addressing the need to measure multiple spots to profile temperature over a large area.

It would take 76,800 individual infrared temperature point sensors to measure the same area as one thermal imaging detector (UFPA) with an array size of 320 x 240 elements.



Realistically, it would take 8,533 single point IR sensors to make a comparable measurement to that of the aforementioned detector array, since a 3 x 3 pixel area or a total of 9 pixels is needed to make an actual temperature measurement of an individual spot, due to the extremely small size of each pixel. Most cameras use a detector chip with a rectangular FOV (field of view), wider than it is in height.

The clear advantage of a thermal imaging camera system is that it can monitor and measure the temperature profile over a wide area and be used for measurement and control of selected single points or user selected and defined areas, or regions of interest (ROI's) in assigning an average, peak or minimum temperature within each ROI over the entire thermal imaging viewing area.

The components of such systems include a thermal imaging camera, a variety of lens choices, protective hardware, comprehensive software / integrated I/O modules for communication and control for direct interface to HMI & DCS systems. Additionally, they provide discrete 4-20mA, 0-10VDC analog outputs and relays for alarms.

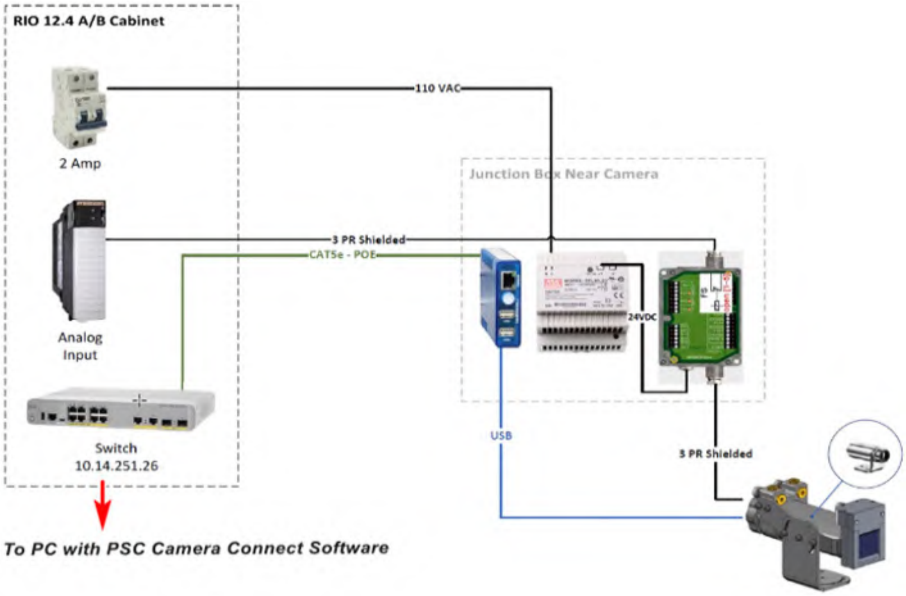


Illustration of a basic configuration for a fixed thermal imaging camera

One major component of a thermal imaging camera is the eye or UFPA detector that consists of thousands of tiny detector elements onto a small semiconductor chip. The resolution of the detector array with lens combination determines the minimum measurable spot sizes and the overall imaging viewing area.

Common UFPA detectors are offered in array sizes such as 160 x 120, 320 x 240 or 640 x 480 and are continually progressing to higher resolution levels.

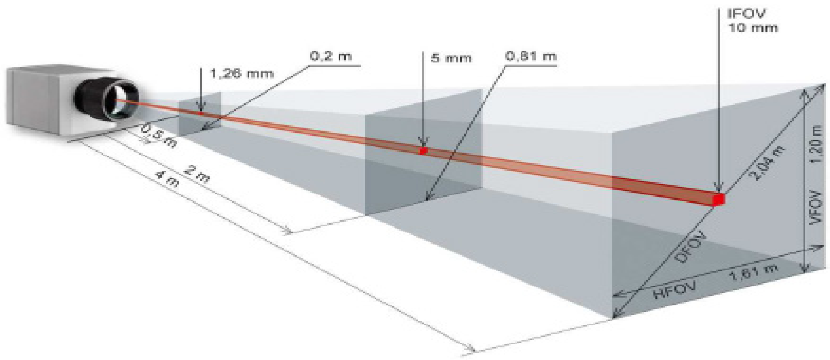
Use of a telephoto, close focus, or a standard lens assembly/attachments facilitate the angle of measurement or observed area (in degrees or radians) and is based on the type of detector resolution needed to resolve the minimum measurable spot within the overall observed field of view.

Prominent industries for use of thermal imaging camera systems include:

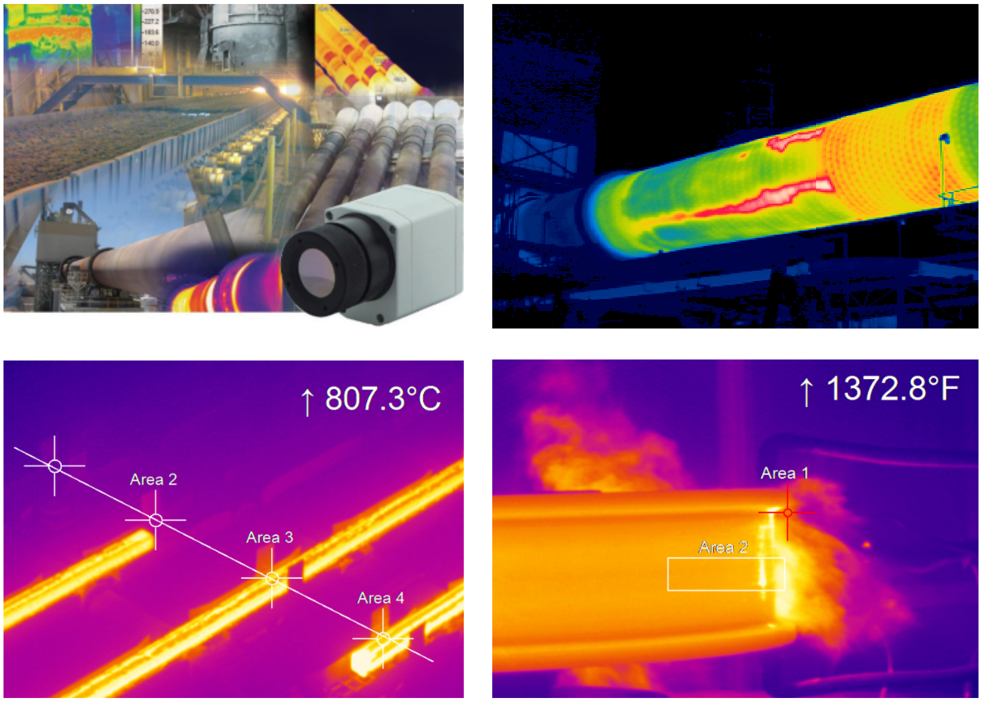
Steel, forging, glass, thermoforming, cement, paper, power, petrochemical, plastics injection molding, ceramics, food and many more.

Typical thermal imaging applications include:

- Metals: Steel Slabs in continuous casting operations Molten Metal pouring streams, Fire Prevention Areas, Heat Treating, Ladle and Torpedo car shells
- Furnaces / Ovens / Dryers / Heaters
- Semiconductor: Crystal Growth, Wafers, Graphite heaters, crucibles, susceptors
- Kilns: Cement and Lime- product and kiln shell
- Furnace walls / Reactor shells for refractory degradation
- Pulp & Paper: Paper, recovery boilers, roller bearings / equipment
- Power Boilers: Water walls
- Glass: Molten Glass, glass gobs, metal molds and tungsten filaments
- Plastics Industry: Thermoforming Operations / Webs / Injection Molding
- Critical Process Equipment: Large expensive motors / drives / piping / bearings
- Flares: Petrochemical / Chemical Industry
- E-beam & Vacuum Melting Furnaces
- Research & Development



Measurement field of the Surveyor Series Thermal Imaging Camera representing a 23 degree x 17 degree lens



Thermal Images of Steel Billets, Kiln Shell and Forging Applications

As with any non-contact temperature measurement application, basic infrared guidelines must be followed to provide a unique and rock-solid solution. This resides on the shoulders of an experienced IR Application Sales Engineer.

The bottom line in providing the best solution is to listen carefully and attentively to the customer about their requirements and most importantly, identify what their objective is to accomplish the task at hand.

Being able to physically see the operation of the process application is extremely beneficial to correctly understand the application.

Based on infrared theory, visible light and infrared behave very similarly; each are reflected, absorbed, and transmitted. These components collectively contribute to what is termed as a product's emissivity, a degree of the emission of infrared energy. The higher a product's emissivity, the more infrared energy it emits.

Conclusion

Review of an application can uncover many problems, such as seeing reflected high temperature IR energy (in the form of light) impinging on the target from an unwanted background source. The use of mechanical hardware, shielding or sighting techniques can be employed to eliminate erroneous temperature readings that can be caused by background reflections.

Also, considerations regarding the appropriate installation location can be determined based on the correct sighting angle and ambient temperature. In the case where ambient temperature exceeds the camera's specification, the use of a water-cooling jacket and air purge to keep the lens clean from debris is required.

Not until an application has been fully analyzed and the definition of the customer's objective is realized, can a comprehensive solution be provided.

As manufacturing costs of detector arrays have substantially decreased, thermal imaging camera systems have become more affordable, therefore much of the well-established single temperature point pyrometers will transition to legacy products.

Authored by: Scott Nagle, Sales Manager & Application Specialist for Process Sensors IR products

KPM Analytics | **Process Sensors IR**
787 Susquehanna Avenue | Franklin Lakes, NJ 07417 USA
Phone: +1.774.399.0461
www.processsensorsir.com | irtemp@kpmanalytics.com