# NON CONTACT INFRARED TEMPERATURE SENSORS IN CURING SYSTEMS

When using infrared temperature sensors (IRt/c) in curing systems there are three common challenges that you should consider:

1. During the curing process, the intense heat from the curing lamps conducted to the sensor area can cause the sensor to exceed its specified body temperature limit of 212°F, which, in turn, can cause the sensor to fail.
2. When power to the entire machine is shut off after it has been operating normally for some period, residual heat from the curing lamps and associated components is hot enough to cause the sensor to exceed its body temperature limit.
3. When curing lamps are positioned closely together, they may restrict the sensor's view of the target and may increase the probability of the sensor signal being influenced by a partial view of the hot lamps. The result is an excessively high temperature indication for a few seconds when the lamps are off and no target is in the view.

In order to achieve optimal ROI and operational efficiency in processes that require curing systems, it is ideal to employ a cost-effective IRt/c sensing system. These systems require no calibration, no operator attention, can withstand abuse in the field, and can be easily replaced if needed. Following are solutions to the three most common challenges that occur when employing an IRt/c sensor in a curing system.

**Solution to Problem 1: Sensor overheating during operation**

Sensors needs a constant flow of forced air (ambient air) guided along and around them for several reasons. First, the air helps ensure that the sensors remain close to the ambient temperature during operation. Secondly, if a small portion of the air is guided toward the sensing element, sufficient pressure is created to prevent dust from entering the sensor unit and landing on the sensing head, which can disturb the reading. An easy way to suply the air required for this purpose is to employ the fans that cool the whole system. When doing so, it is important to be sure that the guided air leaving the sensor does not blow on the fabric, creating a cool spot. (A good solution to this challenge is to mechanically guide the air -- after cooling the sensor body -- at a 90° angle away from the sensor). In order to determine if there is sufficient airflow to cool the sensor, we recommend employing an additional contact temperature sensor connected to the body of an IRt/c . If the contact sensor detects that the body temperature of the IRt/c is increasing, it is likely that the curing system's air filters are getting clogged and need cleaning. Clogged filters reduce the air flow used for cooling, and the increase in temperature can be directly measured at the IR sensor's body. The contact sensor embedded in the IR sensor provides an ideal tool with which to assess air filter conditions. This approach provides a simple and reliable method to prevent damage to both the sensor and other electrical components that can be caused by clogged air filters. Exergen can provide this configuration as a special build.

**Solution to Problem 2: Sensor overheating after power shut down**

While fans will normally help prevent overheating after the curing sytems has been shut down, if a power outage occurs (as often happens in countries like Mexico, Bangladesh and others), the sytem is at risk.
Exergen recommends the following solutions to avoid overheating during power outages:

1. A simple heat sink can be clamped to the sensor to absorb the conducted energy and help avoid raising


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the sensor temperature.

2. The heat sink should be made of aluminum. Since alumuminum is 12 times more thermally conductive than stainless steel and has more than twice the specific heat of stainless steel, it absorbs heat quickly and uniformly.
3. The heat sink should weigh >8 oz or so (>10 times the weight of the sensor), in order to reduce sensor temperature increases by a ratio of more than 20 to 1. For example, if the sensor temperature rose to 122°F at shutdown, the heat sink would reduce that increase by about 3°F or 6°F.
4. The heat sink can take the form of an "L" shaped bracket centered in the air flow path with the sensor mounted at one end and the bracket thermally insulated from the reflector plate. The air flow will keep the heat sink at about 158°F during normal operation. At shut down, the heat sink and sensor temperature will rise only a few degrees, thus protecting the sensor in a simple reliable manner.

Since there is effective and reliable cooling available at no cost via the cooling fans as described above, there is no benefit to deploying sensors that operate in temperatures of up to 356°F uncooled. Such sensors add about >$200 to the system cost when compared to standard 212°F sensors.

**Solution to Problem 3: Sensor signal effected from seeing hot parts after lamps are switched off**

The energy from the curing lamps and associated metal parts that is radiated after lamps are shut down can be in the vicinity of 1000°F, however, in our experience the effect of this heat on the sensor output signal is only about 70°F. This relatively small increase means that the field of view is too wide by only a few percent. In order to avoid employing narrow field-of-view optical systems (which carry significantly higher costs), the excess signal effect can be reduced or eliminated by shrouding the sensor's field of view with the same material used to create the reflector plate (referenced in solution #2).

The sensor recommended for this application is a standard IRt/c with an additional internal temperature sensor. If needed, the cables can terminate at a right angle to the sensor axis. Since there is ample air flow available around the sensor to keep it clean and cool, an internal air purge is not needed. We recommend a double-walled shroud be employed to insulate the inner surface from the intense heat of the lamp system. Since the shourd material has good reflective properties and is kept clean by the air flow, it can become both a part of the sensor's optical system and can also prevent any direct lamp energy from entering the sensor. We recommend a wider field of view (1:1), which is effectively funneled by the reflecting shroud, and serves to create a wide area measurement which is more desirable from a quality control perspective. The shroud can be either cylindrical or rectangular in shape, depending on fabrication ease. Its length should be to about the centerline of the lamps (~1 in), and diameter slightly larger than the sensor (~ 0.75 in). The sensor should be thermally mounted to the heat sink (described in solution #2), and thermally isolated from the shroud and hot reflector to the extent practical. A clear area around the sensor needs to be maintained to ensure air flow through the shroud. The sensor can be inserted below the reflector plate level to enable a convenient fit in the space available above the reflector plate.

An IRt/c.3X would also be suitable for the installation, and will have less dependence on the shroud as a reflector. However, the cost savings of using the IRt/c standard are well worth the additional attention that may be required to work out the best solution.



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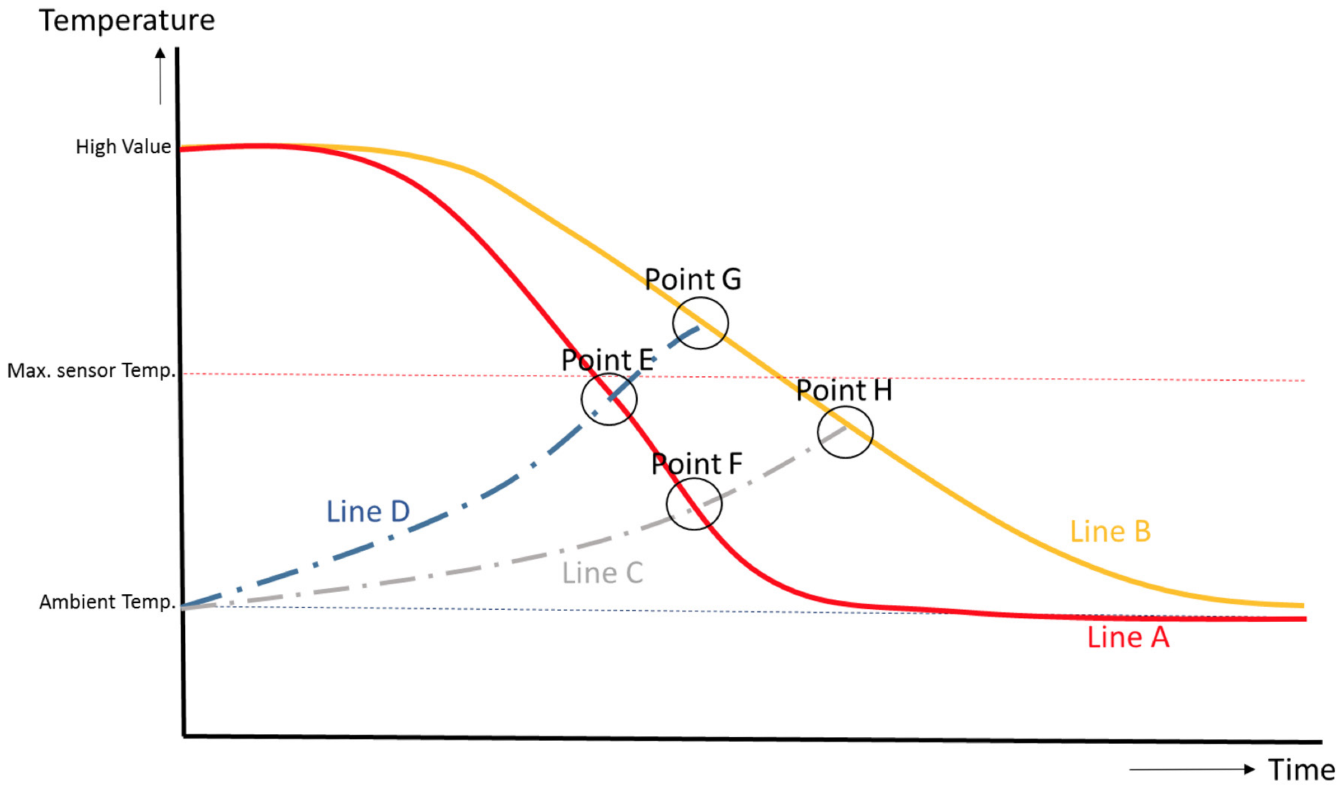
**Three solutions to common challenges encountered in curing systems explained in another way:**




During operation a curing system will “store” a lot of energy in the unit, shown in the graph as the “High Value”. The Max. sensor temp is the maximum temperature the sensor can handle before permanently breaking down (max 212°F for standard IRt/c’s). The Ambient temperature is the temperature of the air that is moved through the system by the ventilator.

Problem #1: Overheating during Normal Operation and its solution:
When the system temperature is at “High Value”, the sensor is cooled by the fans and remain in the range of the Ambient temperature. When the system is switched off, the ventilator is running and cooling the system down until it reaches the Ambient/air temperature (10-15 minutes). The sensor will not reach the Max. sensor temp level and will not be damaged.

Problem #2 Power Shutdown (No ventilation), no heat sink:
When a complete power shut down occurs, there is no cooling from the fans! So a natural cool down of the system will take place but will take time (Line B). The “stored energy” in the system will heat the sensor (line D) until it reaches point G, which is significantly higher than the maximum allowed sensor temperature, and the sensor will be destroyed. From that point, the sensor temperature will follow the

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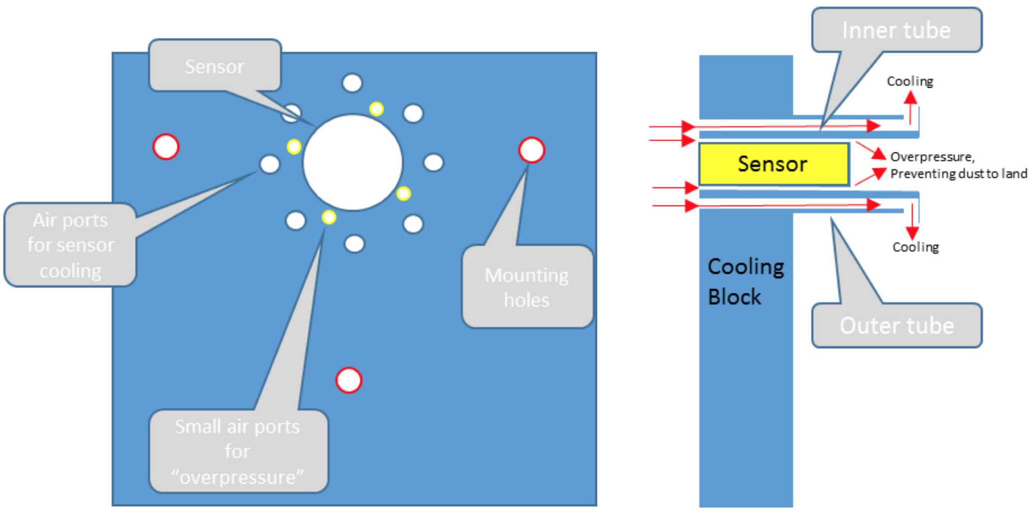
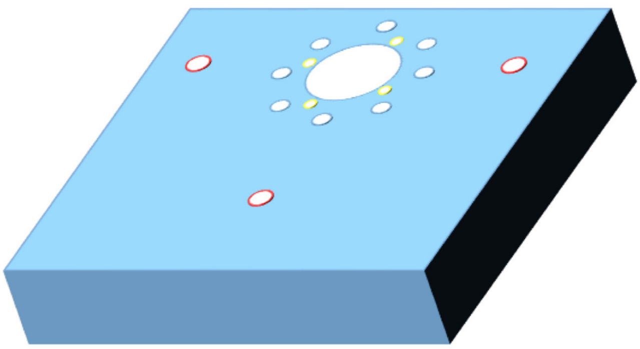
yellow line until it reaches the Ambient temperature.

Solution to Problem #2: Power Shutdown (No ventilation) WITH heat sink:
By installing a heat sink as mentioned earlier, the stored energy in the system will heat the sensor much more slowly (as the energy is spread out over the heat sink).
When a sudden power shut down occurs and a heat sink is in place, the system temperature will drop as in Line B. The sensor temperature will rise as shown in Line C. These 2 lines will cross at point H and from there the sensor temperature will follow Line B. Point H is still well below the maximum allowed sensor temperature, demonstrating that with the heat sink, the sensor will not be destroyed during a sudden power cut.

**Design suggestions:**



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