Two distinct flame detection families

There are two distinct flame detection families:

1. **Radiation flame detectors**
   - consisting Ultraviolet, Single Frequency Infrared, Combination UV/IR, and Multiple Frequency Infrared

2. **Visual Flame Detectors**

Radiation-type flame detectors collect radiation from the area under surveillance, sum the total radiation within the field of view, analyzing the total intensity of the radiation and any flicker frequency that exists.

The second family, Visual Flame Detectors, are based on a CCTV camera with processing built into the detector the fire decision is made by the detector. This type of detector analyzes each area of interest within the field of view to determine if each area meets the criteria for fire. The radiation from each potential fire source is analyzed individually.

Radiation-type, such as **UltraViolet (UV)** detectors are good general-purpose fire detectors; virtually all fires emit UV radiation. However it is well known for its false alarm susceptibility to arc welding, X-raying and Lightning but methods of causing the device to fail to detect a fire are seldom discussed. Hydrocarbon films caused by oil lube sprays from gas turbines or diesel fuel on the windows of the device render the detector blind and even solvents in the atmosphere inhibit the device from responding.

**Infrared (IR)** detectors were introduced to solve the problems associated with UV detectors. They operated by detecting the heat element of a fire analyzing amplitude and flicker frequency. IR flame detectors solve a number of the false alarm problems associated with UV detection and are not affected by hydrocarbon films, however black body radiation becomes a false alarm issue, water on the optical surfaces absorbs and scatters the heat energy from a fire decreasing the overall sensitivity of the device. The vast majority of IR devices use the CO2 emissions from a fire resulting in the device only being sensitive to Hydrocarbon fires.

The **UV/IR combination** devices normally require both sensors to respond to a fire before an alarm signal is generated, this increases their false alarm immunity removing the effects of each of the false alarms that generally upset IR and UV detectors individually. However not only are the advantages of both technologies realized but also the disadvantages. They will only detect hydrocarbon fires and are blinded by water, ice, oil films and airborne solvents. Water, ice and oil films in an out door environment cause many optical faults to such an extent that in time the faults are just ignored. This is dangerous as the fault indicates that the device is blind.

With the advent of **Multi-Frequency detectors**, guard bands were added to the 4.4uM IR sensor to reduce false alarms and increase the sensitivity. The signals from the sensors are correlated at either two or three optical wavelengths. This technique has not reduced unwanted alarms; in addition, the increase in sensitivity of these devices has generated another set of problems. They have detected the reflected radiation from flares; the hot CO2 emissions from gas turbine exhausts; and even responded to the welding rod flux burning during arc welding operations. Black body radiation emitted by hot engines will not cause the detectors to false alarm. However, the black body radiation affects the ratio between the sensors causing the devices to desensitize and in some cases become totally blind. Reflected sun radiation off water has had a similar effect. Additionally, partial obscuration of one of the sensors, due to water contamination, can result in the fire being missed.
Flame detector family type 2, Visual Flame Detectors, employ a video imaging based technique utilizing CCTV and advanced algorithms. The advanced algorithms process the live video image from the CCTV array and interpret flame characteristics.

By the very nature of the device looking for bright images within its field of view it can be seen that black body radiation and hot CO2 emissions will have no effect. Water is less of a problem as the detectors are not looking for the heat energy, and light is easily transported through water. The main disadvantage of this approach is that the device will only respond to bright fires. However the level of information received easily compensates with live video in the control room.

The output from a visual flame detector provides not only an indication of a fire it also provides a visual indication in the control room of the incident. The system provides a live video image in the control providing the operators with all the facts allowing them to make the correct decisions with out endangering personnel.

The sensitivity of the Visual Flame Detector is 44 meters to a 10Kw fire (1sq pan fire of gasoline) under absolute ideal conditions. The difference between this technology and conventional detection is that at 45 degrees the off axis the sensitivity is not reduced by 50% but remains at 100% of the on axis sensitivity this increases the coverage per point by up to 20% which must mean fewer detectors.

False alarm immunity is assured to Hot CO2 Emissions. The emission of exhaust gases from gas turbines emit very strongly at 4.4um the prime detection wave length for IR detectors causing them to false alarms. As the Visual Flame detector looks for bright images it totally ignores the emission. Flare Radiation Reflections the device was designed specifically to ignore this form of false alarm. Black body Radiation emits radiation at 4.4um but again it is not bright so the visual flame detector totally ignores it. Arc Welding is bright but does form an image that is fire shape therefore no false alarms

With the Visual flame detection direct view of friendly fires are excluded by simply masking. A box is drawn around the fire and down loaded to the detector. This facility may also be used to create very accurate fire zoning. For instants the fire protection of boiler fronts the opening that operators use for viewing into the boiler may be masked so that when an operator views the flames a false alarm is not generated However the area requiring protection the gas ring is fully monitored.

Intelligent heated optics are heaters they are controlled by the temperature sensor just above the camera lens. The heaters are normally set to maintain a temperature of +16 degrees centigrade this stops ice and snow forming on the optics.

As with any flame detection technology, it has its limitations and they must be understood to allow the detector to be applied correctly. This type of technology will not respond to invisible fires such as: Methanol or Hydrogen fires.
Flame Detection Strengths and Limitations

**LIMITATIONS**

- False alarm to arc welding, X-raying, and lightning
- Blinded/Inhibited by: Hydrocarbon films, and solvents in the atmosphere

<table>
<thead>
<tr>
<th>UV</th>
<th>IR</th>
<th>UV/IR</th>
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<tbody>
<tr>
<td>False alarm to black body radiation</td>
<td>Inhibited by: water on optics (can decrease sensitivity)</td>
<td>Typically, only detect hydrocarbon fires</td>
</tr>
<tr>
<td>Inhibited by: water, ice, oil films and airborne solvents.</td>
<td>Blinded/Inhibited by: water, ice, oil films and airborne solvents.</td>
<td>Increased sensitivity</td>
</tr>
<tr>
<td>Live video image in the control providing the operators with all the facts allowing them to make the correct decisions - thus compensating for slightly slower response time (typically 10 seconds)</td>
<td>Immune to black body radiation</td>
<td>Response to black body radiation “de-sensitivity”</td>
</tr>
<tr>
<td>New problems with unwanted alarms from increase in sensitivity (ie: detect reflected radiation from flares; from hot CO2 emissions; from gas turbine exhausts).</td>
<td>Respond to welding</td>
<td>Some cases of blindness.</td>
</tr>
<tr>
<td>Will not respond to invisible fires such as Methanol or Hydrogen fires</td>
<td>Response time is normally slightly slower (typically 10 seconds)</td>
<td>Can be partially obscured by water.</td>
</tr>
<tr>
<td>Some devices are only sensitive to Hydro Carbon fires.</td>
<td>Responds to bright fires only</td>
<td></td>
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**STRENGTHS**

- Good, general - purpose flame detector
- Solve a number of UV false alarm problems
- Not affected by hydrocarbon films
- Combined response increased reliability by increasing false (unwanted) alarm immunity
- Increased sensitivity
- Immune to black body radiation
- Live video image in the control providing the operators with all the facts allowing them to make the correct decisions - thus compensating for slightly slower response time (typically 10 seconds)
- Will not alarm to black body radiation or hot CO2 emissions
- Water is less of a problem
- Response to bright fires, thus avoids false (unwanted) alarmd from flare radiation, hot CO2 emmissions
- Will not alarm to arc welding

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The Progression of Flame Detection Development
Advanced Optical Verification

The device is intelligent enough to know if objects are placed directly in front of the detector affecting primary detection capability. If a scaffolding plank is placed directly in front of the device or it is covered due to painting operations the detector will send a warning. The Field of view can be manually checked from control room ensuring correct alignment of the detector.

Therefore to summarize the Visual flame detector has Superior false alarm immunity reducing the number of unwanted shutdowns.

Live video display the operators can see the hazard develop. The surveillance aspect of the detector eliminates the need to dispatch operators to investigate alarms as the live video images are viewed directly in the control room. This reduces the risk of injury to operators and improves response time. Un-manned installations can be remotely monitored allowing suitable action to be taken before personnel access the area thereby minimising the risk to operators.

Video recording of events Visual flame detection systems are fitted with a video recorder all alarms are automatically recorded for post event analysis and used to assist with future accident prevention. It takes the guesswork out of what caused the alarm.

Advanced Optical Verification. A simple check from the control room can verify that the device is protecting the correct area and that it has not been knocked and is now pointed in completely wrong direction.

The Masking of friendly fires and Accurate Fire Zoning in areas where the quantities of firewater is restricted ensuring only the correct areas are drenched.

Heated optics to ensure the detector is not blinded by snow or ice.

The MICROPACK Visual Flame Detector is complimented by a number of software tools that allow the site operator (together with MICROPACK technical advisors) to set performance targets for the flame detection system and then lay out the detectors. The software tools take into consideration the shadowing effect the process plant has on coverage allowing us to maximize the coverage using the minimum number of detectors.

The tools also produce drawings indicating the design criteria for the detection system and the way in which the design was achieved showing detector positions and their coverage. Many operators use this study as part of their safety case for the regulatory authorities.