**Smoke Detector Sensors**

The two most commonly used types of sensors for used in domestic and commercial smoke detectors are Photoelectric Smoke Detection Sensors and Ionization Detection Sensors. These sensors may be used individually in commercially sold smoke detectors, used in combination with each other, and also in combination with Carbon Monoxide Sensors or Heat Sensors.

**Photoelectric Sensors**

The Photoelectric Sensor, is often considered to work as an “eye” due to the nature of how it detects smoke. The sensor typically consists of a using a light source that emits infra-red light, an LED is commonly used, a lens for directing the light and a photoelectric receiver, such as a photodiode, that is the target of the infra-red light. These are placed in a chamber that is open to the air, and when smoke is present, will be filled with smoke particles. Smoke particles will cause the light to scatter and affect the amount of light that comes in contact with the photoelectric receiver. This will then result in a drop in current across this sensor, which is sensed by the circuit attached and the alarm is activated accordingly. This type of sensor is typically placed on or near the ceiling of a room, as smoke tends to rise and this allows for a better reaction time in case of a fire. This alarm is also less sensitive to false alarms that result from minor smoke from candles, steam or cooking. This type of sensor is also known to react more quickly to smoldering fires, as these fires tend to produce larger combustion particles that interact well with the sensor, however it still has a good detection time for flaming fires. (Bukowski XXV).

**Ionization Sensors**

The Ionization Sensor is considered a cheaper alternative to using a Photoelectric Sensor. Like a Photoelectric Sensor it can also sense smoke particles in the air that are generally not big enough to see with the naked eye. This sensor is comprised of two ionization chambers that create a current using the potential difference across two electrodes contained inside. A reference chamber has no particle entry while the other chamber is open to the air and would potentially allow for smoke particles to enter. Both chambers contain a small amount of Americium-241, a radioactive material that emits “alpha particles” which result in positively charged ions and negatively charged electrons when they collide with air particles. The electric charge of the ions creates a potential difference across the pair of electrodes and allows a current to flow across the sensor. The expected current should be the same in both chambers, as they are both facing identical conditions including air pressure, temperature and aging of the Americium. If any smoke particles enter the test chamber, ions will begin attaching to those particles and the current will not be carried across the chamber. Thus, the circuit attached will detect the current difference between the test and reference chambers and activate the alarm (Cote 249). Once this smoke clears, the ions will begin to flow between the electrodes again and current should return to the reference level. The current draw of an Ionization Sensor is low, therefore a small battery is sufficient for powering this circuit long term. Ionization Sensors are known to quickly detect small amounts of smoke, generally produced by flaming fires fueled by paper and flammable liquids and thus is prone to false alarms (Alt).

**Carbon Monoxide Sensors**

Carbon Monoxide Sensors are generally intended to sense deadly levels of carbon monoxide, and alert those present, usually sleeping, of the presence of the gas, so that they may escape or clear the air. These tend to respond to all scenarios of fires, and has a faster response time for flaming fires in comparison to smoldering fires, however it greatly increases response time for smoldering fires when compared to both smoke sensors. This would be ideal if used in combination with the Photoelectric or Ionization sensor, however not essential or entirely reliable as a sole sensor, due to not all fires producing large amounts of carbon monoxide (Bukowski 246).

**Heat Sensors**

Heat sensors feature a detecting element, such as thermistors, that activate when a predetermined temperature or a previously specified temperature increase occurs in the sensor ("Types of Smoke Detectors and Alarms."). The best applications for using these sensors are “small confined spaces where rapidly burning, high heat fires are expected” ("Types of Smoke Detectors and Alarms."). These tend to have low false alarm rates, however due to the slow detection time for both smoldering and flaming fires (Bukowski 246) it is not very effective in residential fires.

**Dual Sensor Technology**

Commercially sold smoke alarms may also contain a dual sensor technology, that while it may be more expensive, the use of both photoelectric and ionization sensors allows for a functionality that quickly detects flaming and smoldering fires. However, the IAFF announced at their 2008 conference that they officially recommend photoelectric sensor alarms and stating dual sensors are no longer acceptable as the technology in ionization sensors tends to lead to a delay in sensing smoldering fires, in addition to having difficulties to high airflow environment, which would lead to an even greater delay ("International Association of Fire Fighters (IAFF).").The Ionization sensor’s susceptibility to false alarms is also problematic when creating a smoke detector and alarm system that the users can trust.

**Conclusion**

Due to the recommendation by the IAFF of using solely Photoelectric Sensors in a smoke alarm due to its fast response time to smoldering, over using Ionization Sensors or dual sensors, as well as the common use of Photoelectric sensors in public areas fit for large domains and the sensors simplicity, the Photoelectric Sensor will be implemented in the S.M.A.R.T Alarm system. Ionization Sensors may provide the fastest response time for more noticeable flaming fires, but the average response time of a Photoelectric Sensor is comparable according to the NIST study (Bukowski 234). The use of Carbon Monoxide sensors will also not be implemented, while it may increase response time for smoldering fires, the use of a Photoelectric Sensor is sufficient for targeting this type of fire. Heat sensors will also not be implemented in the S.M.A.R.T. Alarm due to slow detection time, it would not add much to the system while increasing cost.

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