

Moving to electronic temperature monitoring

In response to the increased demands for 'last-mile' cold chain monitoring, electronic temperature indicators have emerged over the past decade as viable alternatives to their chemical counterparts, explains Jeff Hawkins, strategic marketing manager at **Sensitech Inc.**

Temperature indicators based on the thermal properties of chemical compounds (chemical indicators) have been commercially available for many years, providing accept/reject information for perishable goods within the food supply chain. While many believe chemical indicators may fall short of compliance with global regulations and industry best practices, these devices have, over time, migrated to last-mile cold chain applications in the life science market.

In response to the increased demands for last-mile monitoring, electronic temperature indicators have emerged over the past decade as viable alternatives to chemical indicators, providing superior performance and functionality. In addition, manufacturing costs of electronic devices have dropped substantially, enabling cost-effective deployments in a wide variety of applications.

Considerations for temperature indicator usage include:

Time and Temperature Accuracy. Typical temperature accuracies for chemical indicators are $\pm 1\text{-}2^\circ\text{C}$, as opposed to electronic devices providing accuracies of $\pm 0.5\text{-}1^\circ\text{C}$. Time accuracy specifications for chemical indicators vary widely with specifications such as threshold indication after 'a minimum of 30 minutes' or 'within 15 minutes' of exposure above/below set-point temperature. For electronic indicators, typical time accuracies are of the order of $\pm 0.01\%$ of elapsed time (less than a five-minute error per month of operation). Some chemical time-temperature indicators (TTIs) provide evidence of the accumulated effects of temperature exposure. The dynamic temperature response of TTIs is governed by the Arrhenius equation, more specifically the activation energy (E_A) of the temperature-sensitive material. TTI manufacturers strive to emulate the dynamic temperature effects of the monitored product via matching E_A values within the indicator. In practice, this matching is often sub-optimal, leading to substantial inaccuracies.

Device validation. Electronic indicators can be validated prior to activation and deployment. The technology enables every indicator to be tested for accurate operation during the manufacturing process, thereby establishing the veracity of the measurement for 100% of device production. Chemical indicators cannot be validated in this fashion as validation or testing at operational time/temperature thresholds would be destructive. In addition, electronic indicators can typically be post-use validated by the manufacturer. Chemical indicators cannot be reset and tested after initial activation and use.

Custom threshold alarm settings. Most electronic indicators can be customised to fit unique transport conditions dictated by product storage requirements, packaging/pack out parameters and transportation route variability. Chemical indicators are generally offered in a limited number of time-temperature threshold or activation energy variants. Furthermore, most electronic devices can be programmed with several independent time-temperature alarm conditions. As a result, a single device can be deployed to monitor both high and low temperature limits, eliminating the need to procure, stock, and deploy multiple indicator devices for each shipment.

Interface ambiguity. Chemical-based TTIs incorporate user interfaces that are dependent on colour-matching of the reactive material or the determination of a 'migration' distance of the reactive material relative to a graded time scale, necessitating subjective interpretations of the results. In contrast, electronic indicators integrate user interfaces and displays that offer clear, unequivocal results of time-temperature alarm conditions.

Pre-deployment storage and shipment environment. Many chemical indicators must be stored and shipped within controlled conditions prior to deployment. In comparison, electronic indicators offer broad storage and shipment temperature ranges prior to deployment since they are commonly supplied inactivated and are therefore unaffected by temperature conditions prior to start. In addition to these onerous storage and shipping conditions, some chemical indicators require specific temperature pre-conditioning protocols to ensure proper operation.

In summary, these attributes highlight many of the advantages of electronic temperature indicator technology for 'last-mile' cold chain monitoring applications. Viewed holistically, electronic indicators offer effective, accurate, and cost-efficient temperature monitoring in support of global regulatory requirements. ■

Further information

Sensitech
Website: www.sensitech.com
Email: jhawkins@sensitech.com

