

1. Shelf Life Extension: By providing real-time information on the freshness of the food, smart packaging can help extend the shelf life of packaged food. This can help prevent food waste by reducing the amount of food that is discarded due to spoilage.
2. Quality Control: Smart packaging can help improve quality control in the food supply chain by monitoring the temperature, humidity, and other environmental conditions that can affect the quality of food. This can help prevent food waste by ensuring that food is stored and transported under optimal conditions.
3. Inventory Management: Smart packaging can help improve inventory management by providing information on the quantity and condition of food in real-time. This can help prevent food waste by ensuring that food is consumed or sold before it spoils.

Produce Shelf-Life:

<https://extension.tennessee.edu/publications/Documents/SP768-F.pdf>

Links to existing labels: [Storage of Fresh Produce](#) (Where are examples of these labels?)

<https://www.bradyid.com/labels/temperature-indicating>

<https://www.omega.com/en-us/resources/temperature-labels>

“The labels allow you to quickly check if a product or area has been subjected to compromising temperatures, and so are sometimes used in where perishable or sensitive materials are stored. They are commonly found in pharmaceutical, food and medical applications.

What types of temperature sensitive labels are there?

Reversible - reversible temperature labels can change back and forth as needed to provide an indication of the present temperature. One advantage of the reversible labels is that they can be used over and over again.

Irreversible - irreversible self-adhesive temperature monitors consist of one or more heat sensitive indicators sealed under transparent, heat-resistant windows. The center of the indicator circles will turn black at the temperature ratings shown on the label, resulting in a one-time usage indication that the specified temperature has been reached.”

- <https://my.rs-online.com/web/c/automation-control-gear/sensors/temperature-sensitive-labels/>

Food Waste

A significant amount of food is wasted globally every year, contributing to environmental issues such as greenhouse gas emissions, unnecessary consumption of water and energy, and the inefficient use of agricultural land. Food waste occurs at various stages of the supply chain, from production and processing to distribution, retail, and household consumption.

Solution: Smart Packaging

Innovation in the form of smart packaging could play a crucial role in reducing food waste by extending the shelf life of perishable products and providing consumers with accurate information about food freshness. Smart packaging can include features such as:

4. **Active Packaging:** This type of packaging can interact with the food product or its environment to maintain or improve the quality of the food. For example, incorporating oxygen scavengers, antimicrobial agents, or moisture regulators can help prolong the shelf life of perishable items.
5. **Intelligent Packaging:** Intelligent packaging incorporates sensors, indicators and other communication devices that provide information about the condition of the food. For instance, freshness indicators can change color or display a message based on the product's current quality or safety level, allowing consumers to know if the food is still safe to consume.

Fruits and vegetables: Intelligent packaging can help maintain the freshness of fruits and vegetables by monitoring the respiration rate, ethylene production, or humidity levels. Modified atmosphere packaging (MAP) is one example of intelligent packaging that controls the atmosphere within the package to slow down the ripening process and extend shelf life.

Dairy products: Products such as milk, yogurt, and cheese can benefit from intelligent packaging that uses gas sensors or pH indicators to detect spoilage. These sensors

can monitor the level of freshness and provide consumers with an accurate assessment of the product's quality.

Smart packaging is a technology that involves embedding sensors or other technologies in packaging to monitor the quality and freshness of food in real-time. This technology can help prevent food waste by providing information on the condition of the food inside the package, allowing consumers and businesses to take appropriate action before the food spoils. Here are some ways smart packaging can help with the food waste problem:

1. **Real-time Monitoring:** Smart packaging can provide real-time information on the freshness of the food, allowing consumers and businesses to make informed decisions about whether to consume or discard the food. This can help prevent food waste by reducing the likelihood of consuming spoiled food.
2. **Shelf Life Extension:** By providing real-time information on the freshness of the food, smart packaging can help extend the shelf life of packaged food. This can help prevent food waste by reducing the amount of food that is discarded due to spoilage.
3. **Quality Control:** Smart packaging can help improve quality control in the food supply chain by monitoring the temperature, humidity, and other environmental conditions that can affect the quality of food. This can help prevent food waste by ensuring that food is stored and transported under optimal conditions.
4. **Inventory Management:** Smart packaging can help improve inventory management by providing information on the quantity and condition of food in

real-time. This can help prevent food waste by ensuring that food is consumed or sold before it spoils.

Temperature-Sensitive Labels

One innovative smart packaging solution for dairy products is the use of temperature-sensitive labels. These labels incorporate temperature-responsive materials that change color or display a message when the product has been exposed to temperatures outside its optimal storage range.

Temperature-sensitive labels can help ensure the freshness and safety of dairy products, such as milk, yogurt, and cheese, which are highly perishable and sensitive to temperature fluctuations. By alerting consumers and retailers when a dairy product has been exposed to unfavorable temperatures, these labels can help prevent the consumption of spoiled or unsafe products and minimize food waste.

For instance, the label could use thermochromic ink, which changes color when the temperature threshold is exceeded. When a dairy product is exposed to temperatures above its ideal storage range, the label would change color or display a message, indicating that the product may no longer be safe to consume. This provides an easy-to-understand visual cue for consumers and retailers, enabling them to make informed decisions about product safety and quality.

By adopting temperature-sensitive labels for dairy products, manufacturers and retailers can enhance food safety, reduce waste, and provide consumers with a reliable indicator of product freshness.

- Temperature sensitive labels should use thermochromic ink that is irreversible / permanent after exposure to certain temperatures
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Homework due Wednesday / Questions to answer (mostly about product viability):

- How does it work?
- Where in the manufacturing process can it be implemented? / Where does it fit in the manufacturing process?
- How does it benefit manufacturers to use this ink label instead of the labels currently used?
- What would be the price for manufacturers to use these labels?

- Introduce how the food is made and how it is manufactured
- What it costs to use the ink and the cost difference for manufacturers and consumers
- Introduce our product
- Who is this really helping?
- How are we supposed to know if the food tastes fresh based on its appearance?

Who is the audience / who is buying?

- Possible intro:

- Food waste is a significant global problem that contributes to a range of environmental issues such as greenhouse gas emissions, unnecessary consumption of water and energy, and inefficient use of agricultural land. According to estimates, a considerable amount of food is wasted worldwide every year due to various factors such as poor storage and handling practices, overproduction, and lack of infrastructure for food distribution. The problem of food waste is not only a moral concern but also an economic and environmental one. It affects the sustainability of our food systems and has implications for food security and social equity.

Benefits for retailers:

- Improved inventory management: Retailers can use temperature-sensitive labels to quickly identify items nearing their expiration date, allowing them to prioritize selling those products or take appropriate action to prevent spoilage.
- Enhanced customer trust: By providing a visual indicator of freshness, retailers can boost consumer confidence in the quality of their perishable products.
- Reduced waste: By better managing perishable inventory and providing information to customers about food freshness, retailers can ultimately reduce the amount of food waste in their stores.

Benefits for consumers

- Informed purchasing decisions: Temperature-sensitive labels help consumers make better choices by providing clear information about the freshness of the products they're considering.
- Improved food safety: By allowing consumers to identify potentially spoiled food, temperature-sensitive labels can help prevent foodborne illnesses.
- Reduced waste at home: By selecting fresher products, consumers can reduce the amount of food wasted at home, saving money and resources.

Wider environmental benefits:

- Reducing food waste has significant environmental benefits, as it conserves resources like water, energy, and land that would otherwise be used to produce, transport, and dispose of wasted food.
- By preventing the production of greenhouse gases associated with food waste decomposition, temperature-sensitive labels can contribute to the fight against climate change.

Overall, temperature-sensitive labels are a promising tool for addressing the global issue of food waste. By providing both retailers and consumers with a straightforward way to assess food freshness, these labels can lead to more responsible food management practices and contribute to a more sustainable food system.

1. How does it work?

Temperature-sensitive labels use thermochromic ink, which changes color or reveals a message when exposed to specific temperature thresholds. The ink contains

microencapsulated pigments that react to temperature changes, allowing the label to provide a visual indicator of the temperature exposure of a product over time. This helps both manufacturers and consumers to monitor the freshness or spoilage of perishable food items.

The temperature-sensitive labels will use irreversible thermochromic ink. This thermochromic ink will change color, and the color will be irreversible/permanent once exposed to certain temperature thresholds. For example, milk

2. Where in the manufacturing process can it be implemented? / Where does it fit in the manufacturing process?

Temperature-sensitive labels can be implemented at various stages of the manufacturing process, depending on the manufacturer's preference and the nature of the product. Some common points of integration include:

- During packaging: The labels can be applied directly to the product packaging (e.g., plastic wrap, boxes, or containers) after the food has been packaged and sealed.
- During labeling: If the product already uses labels for branding, nutritional information, or other purposes, the temperature-sensitive label can be integrated into the existing label design and applied simultaneously.
- Post-production: In some cases, it might be more suitable to apply the temperature-sensitive labels after the product has been produced and packaged, especially if the product needs to be shipped to a distribution center or retailer before the labels are applied.

3. How does it benefit manufacturers to use this ink label instead of the labels currently used?

Using temperature-sensitive labels can offer several advantages to manufacturers:

- Enhanced product quality monitoring: The labels provide a clear indicator of the product's temperature exposure, allowing manufacturers to monitor and maintain the quality of perishable items more effectively throughout the supply chain.
- Improved traceability: In case of a food safety issue, the labels can help manufacturers quickly identify affected products and take appropriate action.
- Increased consumer trust: By providing a visual

Stop generating

4. What would be the price for manufacturers to use these labels?

The price for manufacturers to use temperature-sensitive labels depends on several factors, including the label size and design, ink type, production volume, and manufacturing costs. As a rough estimate, the cost of a single label can range from \$0.01 to \$0.10 or more. It's essential to conduct a detailed cost analysis and consult with label suppliers or industry experts to get a more accurate understanding of the costs associated with implementing temperature-sensitive labels in your manufacturing process. Keep in mind that the potential benefits of using these labels, such as reduced waste and improved consumer trust, may outweigh the additional costs in the long run.

Regenerate response

Milk consumption in schools, off-flavored milks

Process of creating thermochromic paper:

Material selection - The paper base must be able to withstand the temperature range for which the paper is designed. Typically, high-quality paper grades such as bond, offset, or coated papers are used. The thermochromic coating must be chosen based on its sensitivity to temperature changes, compatibility with the paper base material, and desired color change properties.

Paper preparation - The paper base is prepared by coating it with a layer of thermochromic ink. The thermochromic ink is typically made up of microcapsules containing temperature-sensitive dyes, which rupture when exposed to the desired temperature. The ink can be applied to the paper base using various printing techniques such as flexography, gravure printing, or lithography.

Thermochromic coating application - The thermochromic coating is applied to the paper using a printing process. The ink is typically applied in a pattern or design to create the desired effect. The ink can be applied as a continuous coating, a series of dots or stripes, or in other configurations depending on the application.

Drying and finishing - The paper is allowed to dry; time will depend on the ink formulation and printing technique used. Once the paper is dry, it may be finished with additional coatings or laminates to improve durability, water resistance, or other properties.

Testing and verification: - The paper is tested to ensure that it responds appropriately to the desired temperature range and that it is durable enough to withstand handling and storage. Additionally, the paper must be tested for regulatory compliance, such as compliance with FDA regulations for food packaging.

Thermochromic labels have a similar process of creation. In terms of material, synthetic materials such as polyester or polypropylene are used for the label. The label base is then prepared by printing any required text or graphics onto it using conventional printing techniques, such as flexography or lithography. The label is then coated with a layer of thermochromic ink. This layer can be applied using screen printing, gravure printing, or other printing methods. The labels must be tested for regulatory compliance, such as compliance with FDA regulations for food packaging.

The process of creating thermochromic labels can differ depending on whether the pigment is irreversible or reversible. Irreversible thermochromic pigments change color permanently, while reversible thermochromic pigments can change back and forth between colors multiple times as the temperature changes. The process for irreversible and reversible pigments differs in terms of the testing process. For irreversible thermochromic labels, the labels are tested to ensure that they respond appropriately to the desired temperature range and that the color change is permanent. The reversible thermochromic labels are tested to ensure that they respond appropriately to the desired temperature range and that the color change is reversible. Both types of labels must be tested for regulatory compliance, such as compliance with FDA regulations for food packaging.

Questions to answer (mostly about manufacturing):

1. Where in the manufacturing process will these labels be implemented? (Keep in mind that they should not disturb the process for the company/companies.)
2. How much does it cost for manufacturers to make a regular label? How much will your label cost (it should cost less than the regular label so that they have a reason to use your label)?
3. List out the materials to make your label and the cost for each material.
- 4.

Due by Monday

- Have a "working draft"
 - MUST HAVE: technical description, cost
 - Also include:
 - What does it take to make the label/cost?
 - How do you make it?
 - What types of labels are they? (reversible/irreversible)
 - Since this is designed for consumable products, how does the consumer know the labels are safe for usage?

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- sticker
 - sold to manufacturers
 - sold as a roll
 - look up fda grade adhesive and specific materials WE will use also backing for said stickers

- present
- choosing these products because cost efficient and reliable
- types of printing methods used
- how they're tested to comply with fda regulations
- tasks schedule (duration of process)
- dimensions of sticker (1 in by 2 in)
- stickers have to be stored in a good place
- 200 per roll; comes in shipment of 10,000 (50 rolls)
- we provide the stickers to manufacturers and they apply them through a method of their choosing before being sent to retailers
- total costs include cost of materials being used, equipment, labor, renting a warehouse
 - Cost of product is result of all of these
- Beneficial to manufacturers (and indirectly retailers) so they don't lose money