

# TEMPO™

Accelerated Shelf Life Modeling

## A Winning Formula

That Reduces Shelf Life Testing Time for Pet Food Products, While Increasing Your Speed of Innovation and Speed to Market





## ACCELERATED SHELF LIFE MODELING: WHO SAYS YOU CAN'T TEACH AN OLD DOG — OR CAT — NEW TRICKS?

In a fast-growing and increasingly competitive global marketplace, increasing your speed to market can mean the difference between success and failure. And in a highly competitive market like pet food and pet treats, time is of the essence. That's why efficient shelf life testing is so crucial. To make the most of physical shelf life testing for dry or semi-moist pet foods, mathematically modeling shelf life is a fast, cost-effective method to determine the unique barrier needs of a particular product in various environments — and it can reduce shelf life testing time by as much as 80%. It's useful when you're changing packaging formats, working on a new product or product formulation, or even altering your distribution environment.

Ultimately, shelf life modeling can help you determine the optimal packaging barrier for your product, predict likely shelf life in various environments, and identify packaging optimization opportunities. All to maximize development efficiency and minimize packaging costs.

While traditional, full-length physical shelf life studies depend on fewer assumptions than rapid shelf life modeling, they account for a great deal of time in the product development cycle — valuable time that could be better used elsewhere. Using software to model shelf life as a screening tool significantly enhances your chances of setting up a representative shelf life study on the first try, minimizing the trial-and-error process and maximizing your speed of innovation and speed to market.



## INTRODUCING TEMPO™ ACCELERATED SHELF LIFE MODELING

As everyone knows, traditional shelf life testing accrues a significant time delay. If you skip testing, you risk product failure on the shelf and damage to your brand if anything goes wrong. If you do test, you could risk missing important opportunities that may have small windows for capitalization. Our new accelerated shelf life modeling technique, called Tempo™, helps eliminate both risks by identifying barrier needs and optimal packaging trials at the front end of the shelf life testing process.

Tempo allows us to deliver a highly optimized and customized solution based on the ideal packaging format for your product by identifying the most effective and cost-efficient barrier properties for your specific needs.

## THE POWER OF INFORMATION LEADS TO POWERFUL OPTIMIZATION



Now you can have speed to market without sacrificing product integrity. Taste, texture, appearance and even oxidative spoilage are dependent on the amount of water available in the package. Our Tempo modeling technique is more than a simple permeation calculator — it allows us to combine experimental analysis with mathematical modeling to quickly evaluate the critical variables contributing to moisture ingress or egress, including food chemistry and storage conditions.

Today, the industry is limited in its ability to design in the optimal barrier properties, and as a result companies often overdesign the packaging barrier — subsequently inflating packaging costs waste. The Tempo tool allows for package barrier optimization, meaning your product is protected while structure efficiency is maximized.

Using the Tempo tool, Sonoco can identify failure points based on factors like appearance, color and hardness, and then determine optimal barrier properties for a range of shelf lives. The necessary barrier properties are then designed into packaging specifications for a variety of packaging options, including paperboard containers, clear and opaque rigid plastic packaging and flexible pouches. Once we've identified the best packaging solutions using Tempo modeling, we can set up a full shelf life study to confirm packaging performance. Ultimately, you receive a variety of proven packaging options that support your brand while protecting your product.

## HOW DOES TEMPO WORK?

Tempo shelf life modeling is a process that allows for quick, accurate estimates of how a package will perform under various conditions with a given product type.

The first step in the Tempo process is to select and identify test products, package options, and expected storage conditions. We can then set up an accelerated experimental analysis that allows us to determine product moisture loss or gain and correlate that to physical characteristics (visual, color, texture, etc.). Equipped with this raw data, we are able to mathematically model a moisture sorption isotherm to estimate the failure points for that specific product and condition.

We can then use our proprietary software to simulate physical shelf life testing for a variety of package formats, barrier materials and storage conditions very quickly and accurately. We are able to accomplish this by analyzing a wide range of data related to the product, the package environment. We can then use composition and proprietary software to simulate physical shelf life testing.

# THE POWER OF THE PROCESS:

## Insight?

SELECT product, packaging options and expected storage conditions

## EXPERIMENTAL ANALYSIS

- **DETERMINE** moisture absorption/loss
- **CORRELATE** water activity data to physical properties of product

## WHAT TEMPO MODELING CAN DO:

- Determine moisture absorption/loss of product
- Estimate product failure points based on moisture content
- Predict product freshness
- Model the shelf life of a product for a variety of packaging formats, sizes and barriers
- Screen out variables prior to physical shelf life testing
- Aid in the effective design of physical shelf life tests
- Design for optimal product protection and packaging barrier
- Reduce product development costs and increase speed to market

## MATHEMATICAL MODELING

INPUT water activity curve, product information, package information and storage conditions into the Tempo software

## DESIGN

for optimal product protection and packaging barrier

## WHAT TEMPO MODELING DOES NOT DO:

- Gauge packaging requirements for processed/retorted, refrigerated or frozen foods
- Determine packaging needs for items with an active ingredient (such as pharmaceuticals)
- Correct OTR for RH impact to moisture-sensitive barrier materials such as EVOH, PVOH or nylon

# TEMPO™

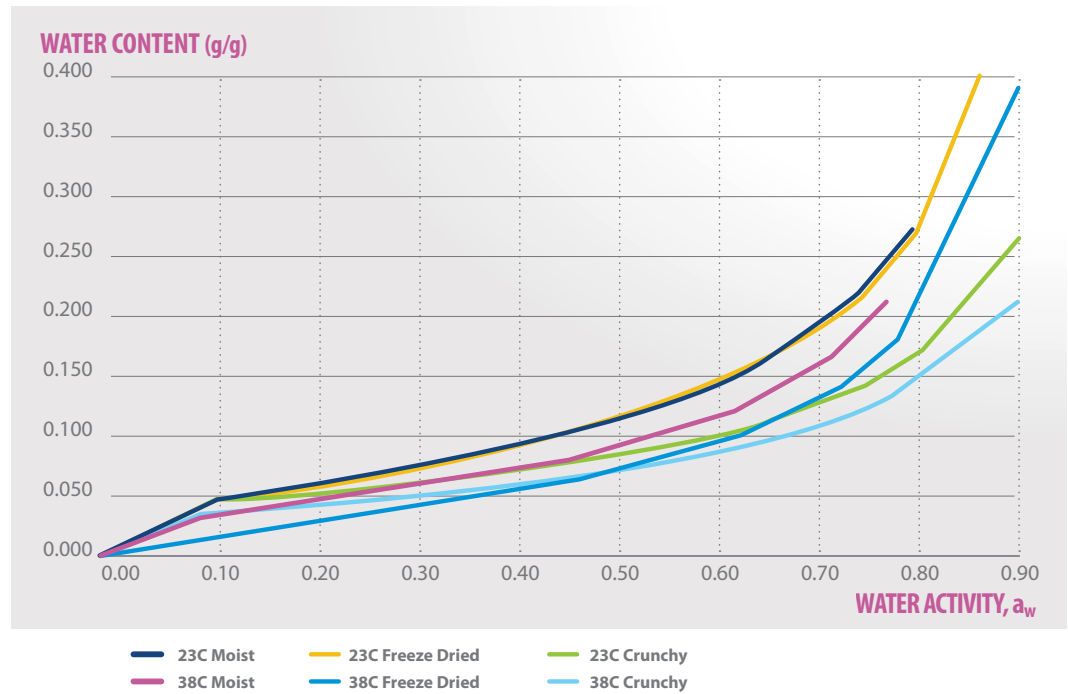
Accelerated Shelf Life Modeling



## THE PROOF IS IN THE PUDDING, OR IN THIS CASE, THE PET TREAT

Sonoco invested in a research project to establish moisture sorption isotherms for three popular pet treat formats: crunchy, moist and freeze dried. These treats represent a wide range of initial moisture content and environmental sensitivity. The objective of this project was to ultimately use the Tempo modeling tool to estimate the shelf life of the three treat types for various packaging types, formats and barrier properties.

The first step was to calculate the water activity for each treat type at various environmental conditions. We selected ambient (23°C) and elevated (38°C) temperatures as these were representative of real-world conditions and would result in a clear effect of temperature change on the shelf life of the products. The resulting moisture sorption isotherms, as seen in Figure 1, are a useful tool for characterizing the food stability of the products. The relationship between water activity and food stability has been well-researched and well-documented before. It has been shown that water activity plays a critical role in lipid oxidation, Maillard reactions, enzymatic activities, vitamin degradation, color and texture changes and microorganism growth. By knowing a specific pet treat's water activity curve, we can then later select an appropriately engineered package to deliver the desired shelf life.



**Figure 1.** Moisture sorption isotherm of various pet treats at 23°C and 38°C temperatures.

In addition to modeling the moisture sorption isotherm and identifying the water activity of the product, we also evaluated the products for visual and textural changes at various humidities (Figure 2). Using this water activity data, mathematical calculations, and information from published journals, we were then able to calculate the critical moisture content level and failure point for the various cat treats.



**Figure 2.** Color change of moist cat treat product stored at various humidities.

Equipped with this information, the next step was to analyze a number of cat treat packages found in the marketplace to calculate barrier values of current packages. We found that a number of flexible pouches use either aluminum oxide, metallization or polyvinylidene chloride (PVdC) coated polyesters as their primary barrier to oxygen and water vapor permeation. A few identified samples relied on the thickness of the sealant layer, polyethylene (PE), to deliver a moderate water vapor barrier in cases where oxygen transmission was of little concern. In addition to flexible packages, we selected representative package structures for rigid plastic and paper containers for inclusion in the shelf life analysis.

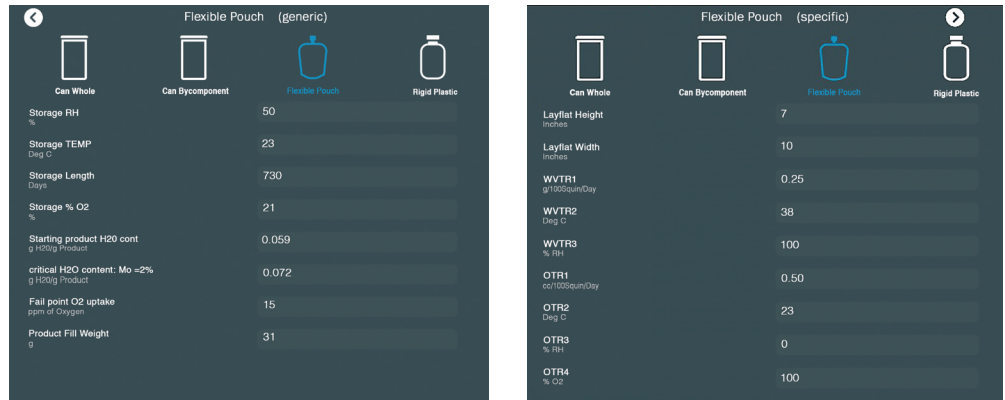
**Table 1.** Tested structures and barrier properties used for shelf life modeling.

<b>FORMAT</b>	<b>STRUCTURE</b>	<b>WVTR (g/100in<sup>2</sup>/day)*</b>	<b>OTR (cc/100in<sup>2</sup>/day)**</b>
Flexible Stand-up Pouch	48ga AlOx PET / 2.5mil PE	0.06	0.20
Flexible Stand-up Pouch	48ga mPET / 2.5mil PE	0.05	0.05
Flexible Stand-up Pouch	48ga PET/ 4mil PE	0.20	3.0
Flexible Stand-up Pouch	54ga PVDC PET/ 2.5mil PE	0.25	0.50
Paper Can	401 x 705 Safetop (metallized liner)	0.05	0.05
Plastic Container	13mil clarified PP	0.03	5.0

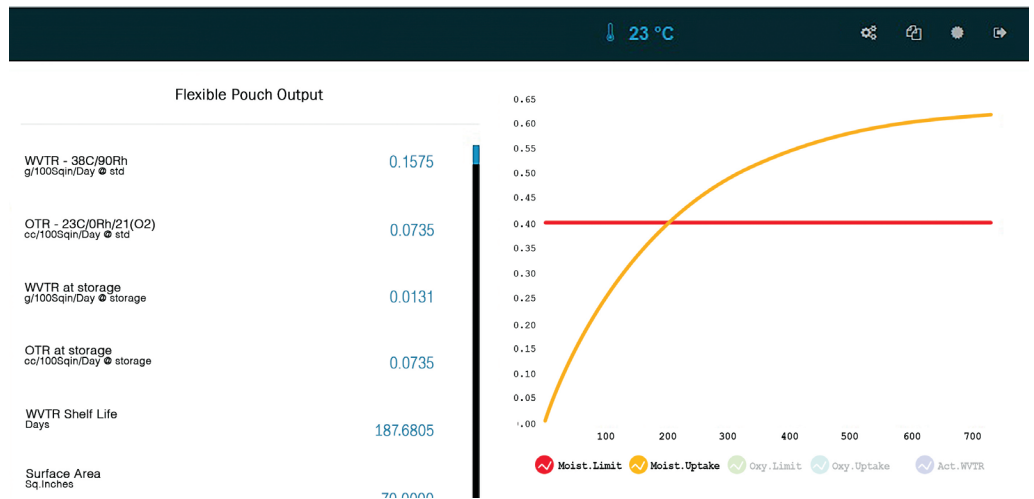
\* Flatstock WVTR samples tested at 38°C / 90%RH

\*\* Flatstock OTR samples tested at 23°C / 0% RH

The last step in the process is to use the tool to estimate shelf life. This is then as simple as plugging in the appropriate values into our Tempo tool as seen in Figure 3. The user enters critical information such as package size, barrier properties, starting and failure moisture contents and storage conditions, and the output is an easy-to-read graph and estimated shelf life.



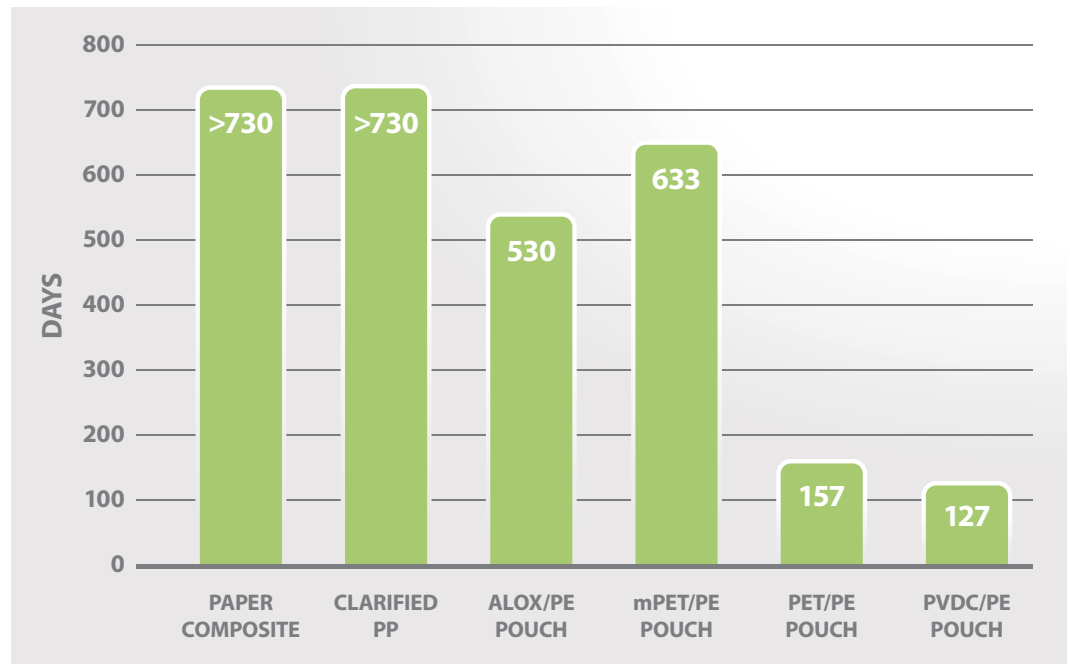
**Figure 3.** Screenshot of the Tempo data input fields for flexible pouches.



**Figure 4.** Screenshot of the Tempo tool. Shown is the estimated shelf life of freeze-dried pet treat stored at ambient conditions and packaged in a stand-up flexible pouch with a PvdC-coated PET barrier.

We were able to quickly and efficiently estimate the shelf life for over 120 combinations of pet treat products, package formats, package sizes, storage conditions and barrier properties. This type of analysis would typically require numerous resources and a significant amount of time to complete.

Tempo allowed us to evaluate many different package or product change effects on the shelf life of a treat. Shown below in Figure 5, we quantified the effect of switching package format or barrier material on moist cat treats when stored at arid conditions.



**Figure 5.** Estimated shelf life comparison for various barrier and package types of moist cat treats at arid conditions (38°C/20%RH).





We are also able to identify the effect that changing package size or product fill weight would have on the estimated shelf life of a product. Seen below in Figure 6, changing the surface area of the package from a 220 in<sup>2</sup> stand-up pouch to a 120 in<sup>2</sup> pillow pouch results in extended shelf life for freeze-dried cat treats stored at ambient conditions.

We stopped the shelf life estimation at 2 years (730). Any shelf life longer than this period is marked as greater than 730 days.



**Figure 6.** Estimated shelf life comparison for different package sizes of freeze-dried pet treats at ambient conditions (23°/50%RH).

## TIME IS OF THE ESSENCE

If increasing your speed of innovation and speed to market sounds appealing, let's talk. We believe our Tempo accelerated shelf life modeling tool will lead to significant savings in time and money by optimizing your package design so that it is a perfect fit for your product, and ultimately reduces your overall product development life cycle.

We welcome the opportunity to demonstrate how Tempo can put time on your side.

