

# DETERMINING THE OPTIMAL NUMBER OF MICRO-PERFORATIONS IN A PRODUCE PACKAGE

Learn how to properly determine the optimal number of perforations needed for your produce package to effectively maintain freshness and prolong shelf life.



## Introduction

The trend toward natural and healthy foods continues to grow with consumers demanding ready-to-eat produce as a convenient and healthy option. The challenge is produce has a limited shelf life, putting greater pressure on producers to get perishables to market at their freshest. To keep up with increasing demand, while minimizing waste and maximizing revenue, producers must optimize shelf life. Packaging plays an important role in this.<sup>1</sup>

This article provides a method to strategically determine the appropriate number of perforated holes in a flexible produce pouch that will effectively maintain freshness and extend shelf life. The objective is to correlate packaging permeation transmission with diverse respiration rates of different fruits and vegetables.



# TESTING IN-HOUSE CAN BE COSTLY AND TIME CONSUMING

Polyolefin films with high oxygen transmission (OTR) such as polyethylene (PE) film provide a good water vapor barrier and are effective for this application; however, fruit and vegetables consume oxygen as they respire. Introducing physical perforations (complete-through pin hole) or laser perforations (partial-through pin hole) makes packaging more breathable, resulting in reduced respiration rate and decomposition.

Follow the procedure below to determine the correct number of perforations needed to optimize shelf life.

### Procedure

1. Test OTR with ambient air (20.9% O<sub>2</sub>) of pouches without perforations on the MOCON OX-TRAN® Model 2/22 or 2/12 instrument. (Refer to the instrument's Operator's Manual for details). The results are reported as cc/(package•day).

Note: If you only test the film sample with results in cc/(m<sup>2</sup>•day), you'll need to convert the **film** OTR results to **package** OTR results by using the actual pouch surface area (m<sup>2</sup> unit of measurement).

First, you will need to measure your total package dimensions. For example, a bag with a surface area (total area that allows for permeation) of the package measuring 13cm x 15cm on 2 sides equates to 390 cm<sup>2</sup> or 0.039 m<sup>2</sup>.

Now use the following calculation:

$$OTR \text{ of pkg (no perforations)} = OTR \text{ of film} \times \text{surface area of pkg}$$

**Note:** Due to machine processing and seal quality, the package usually transmits more than the calculated value converted from film test results. Due to these variables, best practice is to test the complete package and confirm theoretical estimations made during package development.

2. Using the MOCON OpTech®-O<sub>2</sub> Model P and the permeation test cell, test the OTR contributed by the perforations. You may test a single physical perforation or, if testing more than one perforation results must be averaged to "each hole". The OTR

result must be stated in cc/day unit of measurement.

Use the following calculation to obtain the OTR contribution of each perforation (cc/day):

$$OTR \text{ perforations} = OTR \text{ total} - OTR \text{ (no perforations)}$$

Pouch Sample	Quantity of Perforations	OTR of Tested Perforation (cc/day)	OTR Per Perforation (cc/day)
Perf. Pouch - Fruit A	3	120	40
Perf. Pouch - Fruit B	3	98	33
Perf. Pouch - Veggie A	2	58	29
Unperforated Pouch	0	1.2	0

3. Depending on the amount of oxygen required by different vegetables, the package can be manipulated to satisfy the various respiration requirements by increasing or decreasing the number of holes.<sup>2</sup> The total quantity of perforations can be calculated using the following equation:

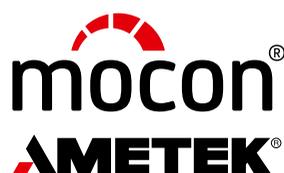
$$OTR \text{ total} = OTR \text{ bag (no perforations)} + OTR \text{ per perforation} \times \text{perforations}$$

It can be costly and time-consuming to test perforated pouch applications in-house given the instrumentation and expertise required. As an alternative, many produce packagers make the decision to send their film and pouch samples directly to a certified permeation lab such as MOCON, saving them time and money. Specialized testing services, and customer application training with detailed SOPs are available from MOCON, Inc.

### Footnotes

1. Devon Zagory, Devon Zagory & Associates, Davis, CA (1997). *Advances In Modified Atmosphere Packaging (MAP) of Fresh Produce*. Retrieved from UC ANR website August 10, 2017: <http://ucanr.edu/datastoreFiles/234-158.pdf>
2. Gordon L. Robertson (2012), *Food Packaging Principles and Practice, Third Edition*. See Chapter 18.

**For more information on permeation testing of produce packaging, contact your MOCON representative.**



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