

OVERCOMING CHALLENGES RELATED TO PERMEATION TESTING OF COATED PAPER PACKAGING MATERIALS

Coated paper is becoming an attractive option for sustainable packaging. However, accurately testing the barrier performance can be challenging without understanding the root cause of testing failures

Challenge

To serve as barrier materials, coated paper products must go through permeation studies such as Oxygen Transmission Rate (OTR) or Water Vapor Transmission Rate (WVTR) tests. However during permeation testing, inaccurate data can lead to improper decisions. Testing of these coated materials offers several unique challenges:

1. Frequent over ranging the analyzer
2. Sealing on the sample
3. Edge leakage

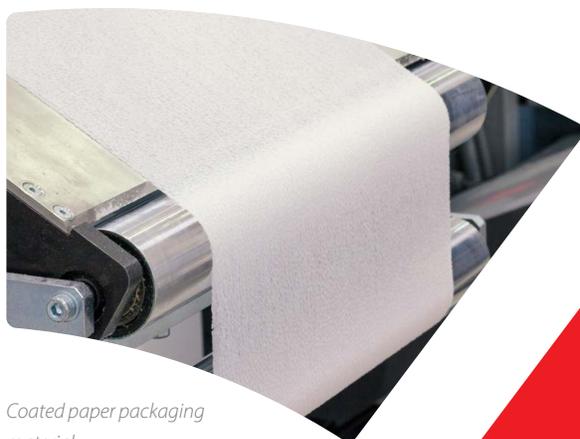
Application

Due to their porous nature, paper and paperboard are not considered to be good barrier materials for many packaging purposes. However, by applying a thin polymer coating they can become a suitable environmentally friendly barrier material.

While development of the specialized coatings and the coating process might be the primary focus of the team, experience has taught us that the permeation measurement technique is also an important key to launching a successful paper-based packaging material. Through the early stages of the R&D process failed tests are common, but it is crucial to understand the potential causes of the failures and take steps to reduce misleading results.

Here are a few causes for high transmission rate results:

1. Paperboard inherently has a bumpy surface that is difficult to seal on. Permeation testing requires smooth surface area to form a good seal between the test sample and the test cell thus a smooth layer is required.



Coated paper packaging material



SOLUTIONS FOR SUCCESSFUL PAPER-BASED MATERIAL TESTING

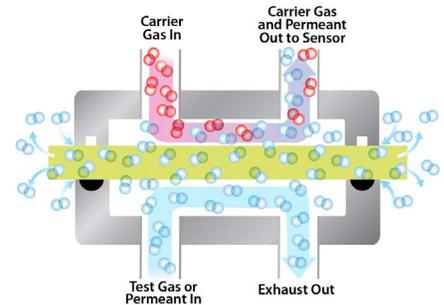
2. If the polymer coating is not thick enough these can be causes for test failures:
 - a. A thin coating will often not form a continuous film to cover the entire paper surface leaving bare spots or porosity.
 - b. A thin layer can leave the surface bumpy thus not allowing for a good seal between sample and test cell interface. Room air or moisture can leak through the interface.
3. The coating may be absorbed into the paperboard too much thus not forming a layer on top of the paper to form a continuous film.
4. The solvent in the coating can alter the structure of the substrate.
5. Coating itself might not provide an adequate barrier
6. Ingress of ambient air and moisture via the cross-section of the porous structure at the sample edge
7. High humidity may cause the paper substrate to swell and compromise the coating effectiveness.

Solution

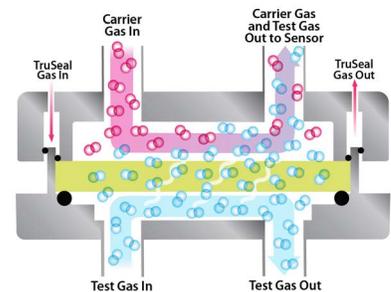
Paper-based substrates can be made into effective barriers following these tips:

- Select a barrier coating with adequate barrier properties. Please understand, a good oxygen barrier is not necessary a good moisture barrier.
- Use a microscope to examine the coating's thickness and finish to ensure it completely covers the bumpy surface of the paper substrate with a continuous layer.
- Test the compatibility between the polymer coating solvent and the substrate to make sure it does not alter the substrate.
- Start OTR testing with an OpTech-O₂ Model P that allows OTR analysis up to very high levels while refining your coating processes within the testing range of your OTR analyzer.
- Once your coating process is optimized, use conventional MOCON permeation analyzers for more accuracy and repeatable testing results.
- To eliminate edge leakage effect, MOCON offers specialized cartridges that seal sample edges for epoxy free testing or seal the edges of the samples to a foil mask with epoxy.

Possible path of edge-effect issue



MOCON Edge-effect Test Cartridge



Benefits

Implementing the above guidelines will help to optimize the development of coated paper materials into adequate packaging barriers. Allowing more accurate data to be generated, while reducing time, cost, and frustration.

Conclusion

For paper-based materials to provide adequate barrier protection they must be coated with an even and continuous polymer barrier.

- Apply enough barrier coating to cover the bumpy surface of the paper substrate.
- Study the compatibility between the coating vs substrate.
- Verify your applied coating achieves the target barrier level.
- Test OTR with MOCON OpTech-O₂ Model P for samples that are still showing porosity during R&D process.
- Once your coating process is proven, use MOCON Edge-effect cartridge to solve edge leakage issue while conducting QC analyses (Refer to a separate AN).