

# **Container Performance Model for Beverages**

| M-RULE                     | 1                                    | M-RULE Container Performance Model<br>You are logged in as Container Consuling, Inc. \temp17 temp17 temp17   |  |
|----------------------------|--------------------------------------|--|--|
| Introduction               | Model Results Model Results Tips     |  |  |
| Jser Guide<br>Ferms of Use | Results: 1 L                         | iter CSD barrier closure   |  |
| rivacy Policy              | Standard Results Ex                  | acutive Results  |  |
| 3eneral Help               | Permeation Charts:                   | Permeation Charts: CO2 Loss O2 Incress H2O Loss Nitrogen Loss Bottle Expansion/Contraction   |  |
| Passwords<br>Email Us      | Sidewall<br>Diffusion / Solubility C | harts: CO2 Diffusion CO2 Solubility O2 Diffusion O2 Solubility H2O Solubility Slass Transition Temp  |  |
| Jnits Selection            | M-RULE                               | M-RULE Container Performance M<br>You are logged in as Container Consulting, Inc. Itemp17 Liter  |  |
| olymer Blend Creation      | Introduction                         | Model Results Model Results Tips   |  |
| olymer Modification        | User Guide                           | 1 Liter CSD harriar closura  |  |
| Composite Materials        | Terms of Use                         | Kesuns: I Liter oco bener closure  |  |
| Parkane Creation           | Privacy Policy                       | Standard Results Executive Results   |  |
| losure Creation            | General Help                         | Permeation Charts: CO2 Loss O2 Ingress H2O Loss Nitrogen Loss Bottle Expansion/Contraction   |  |
| Beverage Creation          | Passwords                            | Sidewall   |  |
| Environment Creation       | Email Os                             | Diffusion / Solubility Charts: CO2 Diffusion CO2 Solubility O2 Diffusion O2 Solubility H2O Solubility Glass Transition Temp  |  |
| illing Condition Creatio   | Units Selection                      | Evinit Data  |  |
| conditions Selection       | Polymer Blend Creation               | Oxygen Solubility vs. Laver vs Time: Time in weeks   |  |
| lodel Results              | Polymer Modification                 | 0.016  |  |
|                            | Composite Materials                  | 0.014  |  |
|                            | Reskone Creation                     | 0.012  |  |
|                            | Closure Creation                     | 0.009  |  |
|                            | Beverage Creation                    | 0.008  |  |
|                            | Environment Creation                 | 0.000  |  |
|                            | Filling Condition Creation           | 0.003  |  |
|                            | Conditions Selection                 |  |  |
|                            | Model Results                        | 1.96.<br>5.881<br>7.81<br>7.81<br>7.81<br>7.81<br>15.73<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.735<br>15.7355<br>15.735<br>15.735<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7355<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.7555<br>15.75555<br>15.75555<br>15.75555<br>15.75555<br>15.75555<br>15.75555<br>15.755555<br>15.755555<br>15.7555555<br>15.75555555<br>15.75555555555 |  |
|                            |                                      | - Sublayer 1 - Sublayer 3 - Sublayer 5 - Sublayer 7 - Sublayer 9 - Sublayer 10   |  |
| L                          |                                      | - Sublayer 2 - Sublayer 4 - Sublayer 6 - Sublayer 8 - Sublayer 10 - Sublayer 12  |  |

### A Powerful Permeation Model

- For new package development
- For strategic analysis of alternative technologies
- For assessment of competitive materials/packages
- For package authorizations
- For light-weighting programs with existing packages
- For barrier technology development
- For materials development

#### Secure, Flexible, Fast, & Accurate! Validated against real-world data!

## Driven by Market & Industry Needs \_\_\_\_

M-RULE<sup>®</sup> is a flexible and robust tool which helps you meet the changing market and industry needs for your packaged products.

With M-RULE<sup>®</sup>, you can quickly optimize package weight, sidewall thickness, resin and closure, as well as evaluate different barrier technologies (including oxygen scavengers) to achieve shelf-life targets.

You can simulate the full range of real environmental conditions experienced by your packaged products, including conditions in different markets and climates during filling, storage, and distribution. You can quickly assess opportunities for cost savings and shelf-life extension based on changes to the package, changes to the filling conditions, and changes to your storage and distribution conditions, without the need to first create and evaluate physical prototypes.

# Powered by Science & Technology \_

M-RULE<sup>®</sup> is a unique permeation model.

It is not an empirical model driven by a database of permeation values. Rather, it is a fundamental model based on firstprinciples prediction of the diffusion and solubility of gases.

It inherently accounts for all the factors that affect permeation, including concentration-dependent diffusion, temperature, crystallinity, orientation, stress and stress relaxation.

It simultaneously calculates the migration of  $O_2$ ,  $N_2$ ,  $CO_2$  and  $H_2O$ , and continually revises the diffusivities and solubilities of each of these permeants as a function of the above factors.

It incorporates Vitamin C degradation and oxygen scavengers. It also predicts

volume expansion and creep as a function of pressure and polymer modulus.

It includes all the major barrier technology options, including plasma coatings, multilayers, blends and nanocomposites.

It is accessed via a user-friendly Webbased interface with 128-bit encryption security.

### Built Upon Decades of Experience

M-RULE<sup>®</sup> integrates the expertise of the professional team of Container Science, Inc., Plastic Technologies, Inc., SBA-CCI, Inc., MXI Modeling, Inc. and CoreSouth Software, Inc. Consequently, M-RULE<sup>®</sup> draws upon decades of experience in:

- Applied Polymer Science
- Permeation Physics
- Chemical Kinetics
- Modeling/Computer Simulations
- Laboratory & Testing Procedures
- Chemical & Industrial Process Analysis

Industry Economic Analysis

Value-Chain Modeling

- Project Management
- Software Development
- Package Development & Improvement
  Fechnical Training



### Contact Us...

Let us demonstrate how the M-RULE<sup>®</sup> Container Performance Model for Beverages can help you meet your packaging objectives.

#### Subscription/Sales Information:

#### Contact: John Maddox SBA-CCI, Inc. j.maddox@sba-cci.com Phone +1-904-382-8735

Fax +1-904-212-1362 www.sba-cci.com

#### Training:

Contact: CAE and Simulation Services Plastic Technologies, Inc. VPSupport@plastictechnologies.com Phone +1-419-867-5424 Fax +1-419-867-7700