Rask og enkel simulering av emballasjens barriere og innholdets holdbarhet

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About Norner | Polymer producers | Oil and Gas | Consumables | Chemical industry | Building & infrastructure

Independent Industrial Polymer Institute

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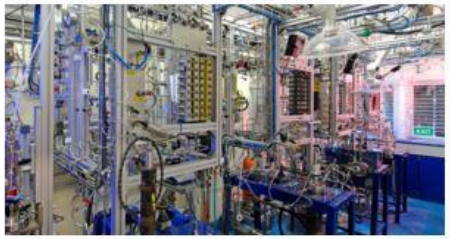
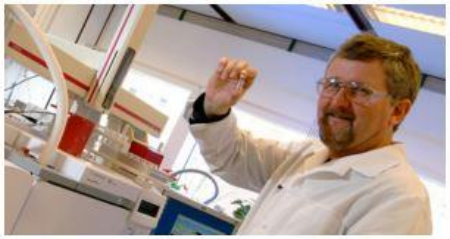
"We provide strategic advisory, innovation projects and testing services



Polymer producers



Laboratory testing services

Oil and gas

Consumables

Chemical industry

Building and infrastructure

Norner is…

- **Industrial** plastics and packaging institute
- **International** innovation company
- Clients through the plastic **value chain**

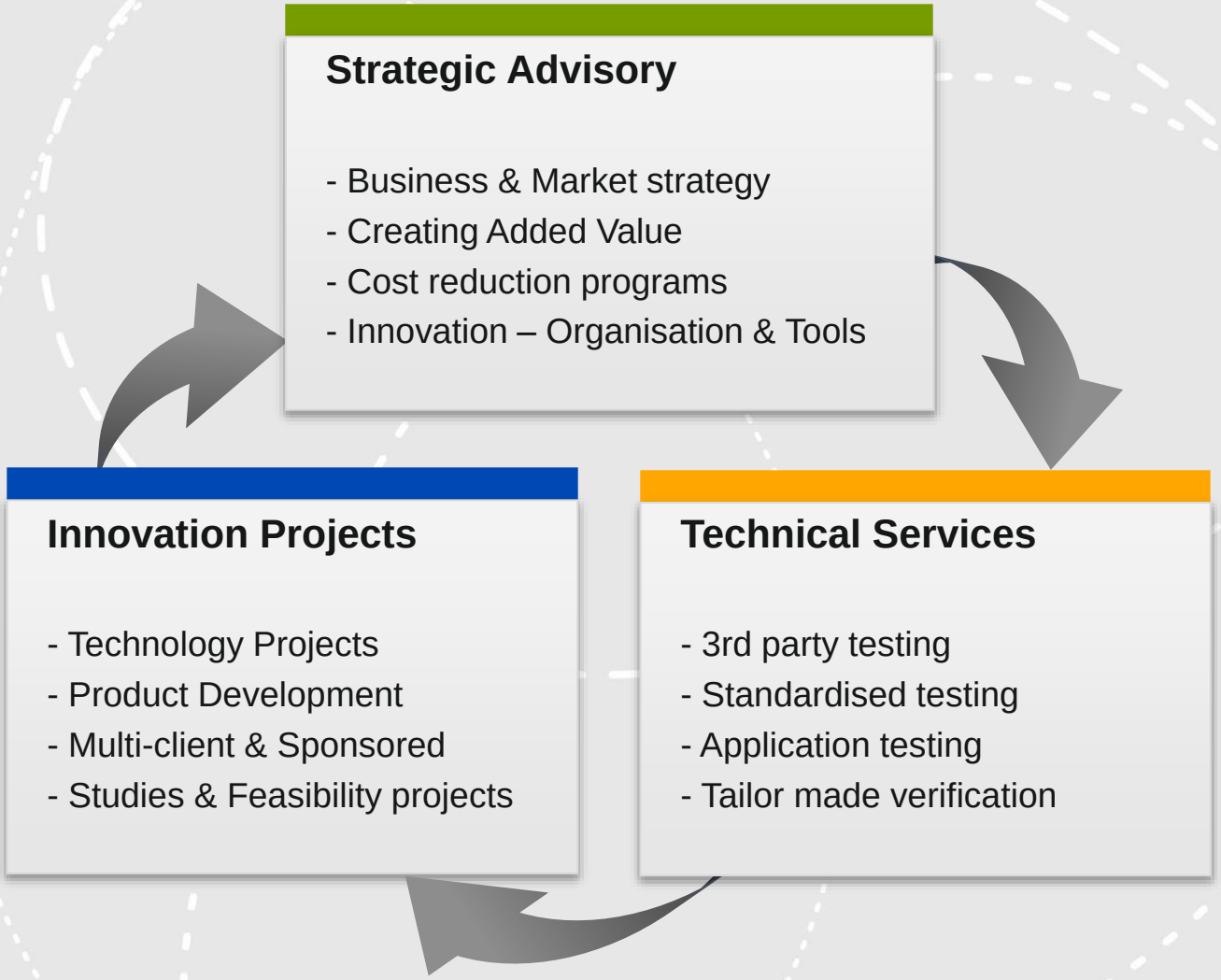
50 Scientists, polymer technologists, end user specialists, lab and conversion engineers.
International innovation projects

4000m² Scientific Laboratories

- Our vision

Innovation through Insight

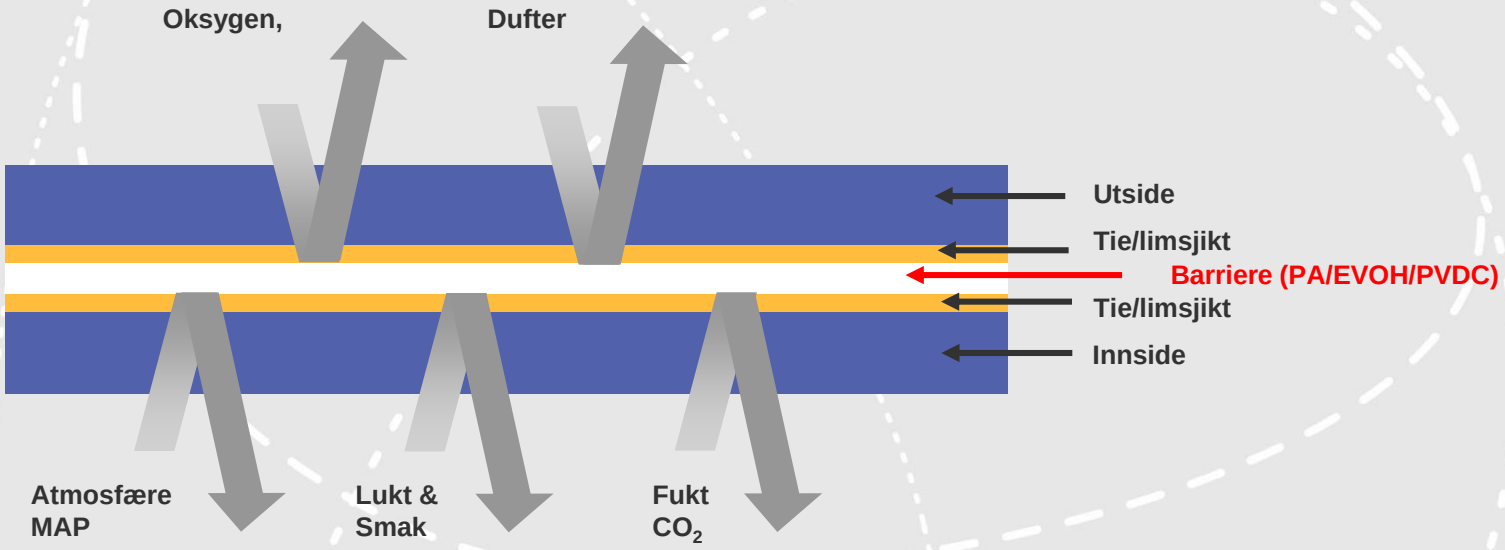
Norner Service Offerings



Emballasjeutvikling og testing

Prototyper, resepter, kvalitetssikring, testing, analyser, og kompetanse

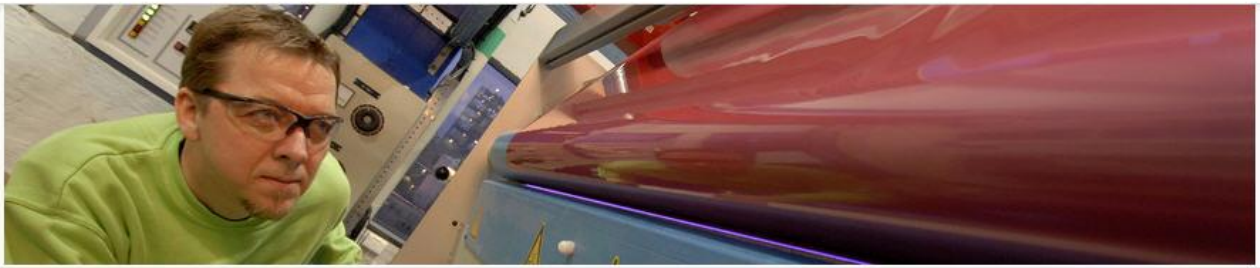
Barrierestruktur - prinsipp



Key barrier properties

- Prevent ingress of oxygen
  - Delay growth of microorganisms and fungi
  - Prevent oxidation reactions
- Prevent ingress of moisture
  - Keep dry foods dry
- Keep desired balance of oxygen and carbon dioxide
  - Extend shelf life of respirating vegetables and fruits
- Prevent loss or ingress of flavours and solvents
  - Prevent loss or change of aroma and taste
  - Prevent loss of perfumes in household chemicals
  - Prevent drying of solvent based products (e.g. paint)

Barriere emballasje i alle varianter !



Oxygen and Water Vapor Transmission Rate Calculator

Additive testing
Norsok M-501
Failure analysis
Third party test lab
Plastic pipe testing
Automotive testing
Packaging industry
- Plastic Films
- Product performance testing
- Migration testing
- Case study - Superior MDO film
- Sibyl Material Database
- Odour Testing
- Oxygen and Water Vapor Transmission Rate Calculator

Norner is an independent, industrial Polymer Institute for the plastics and material industries.

- We offer free use of our OTR and WVTR calculators.
- This simulation models estimates the oxygen and water transmission rate of plastics packaging material like PP, PET and EVOH.
- Barrier properties of co-injection multilayer and in-mould-label solutions can be studied and evaluated.
- The combination of geometrical options, permeability properties and environmental conditions provides an useful tool when working with the design, development and application of plastic packaging.
- The OTR and WVTR values are calculated separately.

OTR Calculator

Film	Cup (Frustum)
Cuboid	Bottle

WVTR Calculator

Film	Cup (Frustum)
Cuboid	Bottle

Calculation steps

1. Define geometry parameters (e.g length, radius, height).
2. Choose materials (define layer material and thickness).
3. Define environmental conditions (temperature, humidity).
4. Push calculate.
5. View and evaluate calculation results.

Contact us

Send us your request

About the calculators

- Assumptions and limitations
- Disclaimer

Packaging solutions

- Packaging Material Database - Sibyl
- Food regulations
- Rheology
- Migration testing
- **Free OTR and WVTR Barrier Calculator**

Plastic processing

Laboratory services

Pharmaceutical packaging analysis

Strategic advisory

Biobased polymers

Free OTR and WVTR calculator

Norner offers free use of OTR and WVTR Barrier Calculator. You can access via the below icons.

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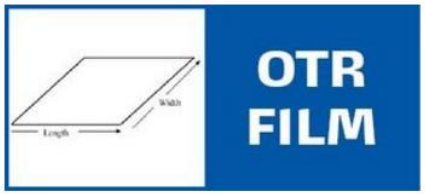
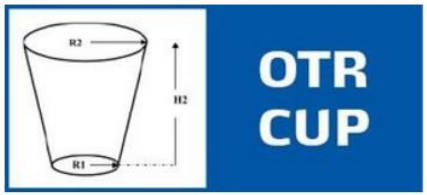
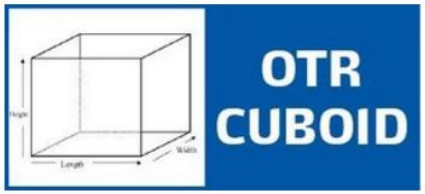
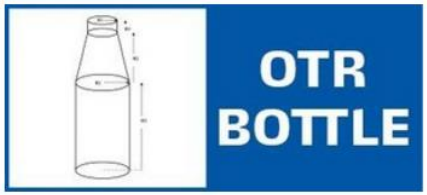
OTR Calculator

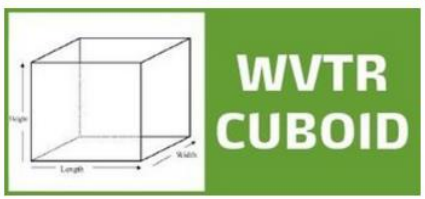






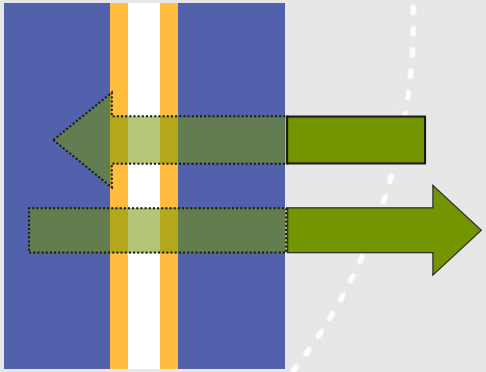


WVTR Calculator



Calculation basics and assumptions

- The OTR/WVTR calculator is a tool for simulations in the design phase
- Instrumented testing of permeability and actual testing of shelf life is still essential - but might be limited/reduced.
- Permeability is a process of absorption, dissolving and desorption
- Transport of a gas is a diffusive process and follows Ficks law
- Solubility of a gas in through the polymer follows Henrys law
- The driving force is the difference in partial pressure on both sides
- Temperature dependency calculation is based on Boltzman weighting
- Effect of humidity is taken into account via an empirical expression



Packaging solutions

- Packaging Material Database - Sibyl
- Food regulations
- Rheology
- Migration testing
- **Free OTR and WVTR Barrier Calculator**
- processing
- atory services
- haceutical packaging is
- gic advisory
- sed polymers

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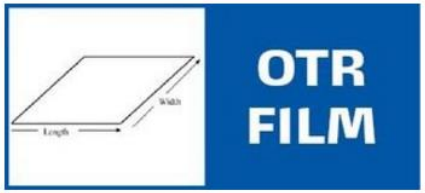
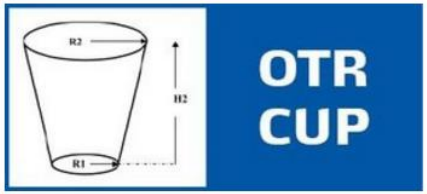
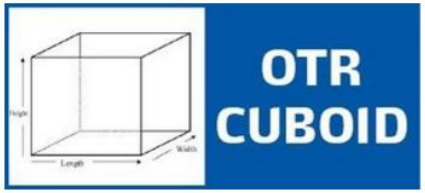
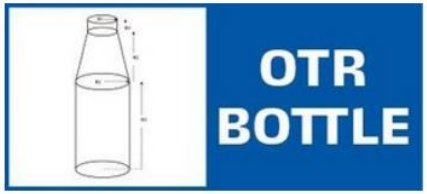
OTR Calculator

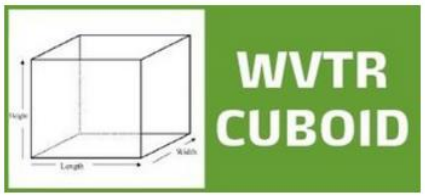








WVTR Calculator



A

MAIN BENEFITS

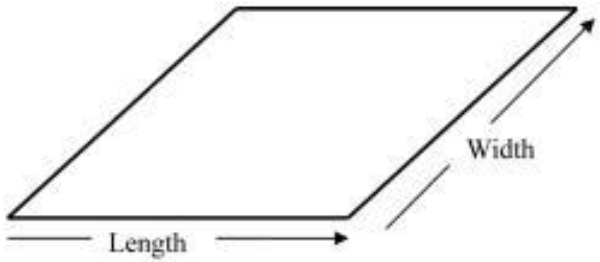
- Easy to use
- Flexible
- Many formats
- Many polymers
- Custom values

B

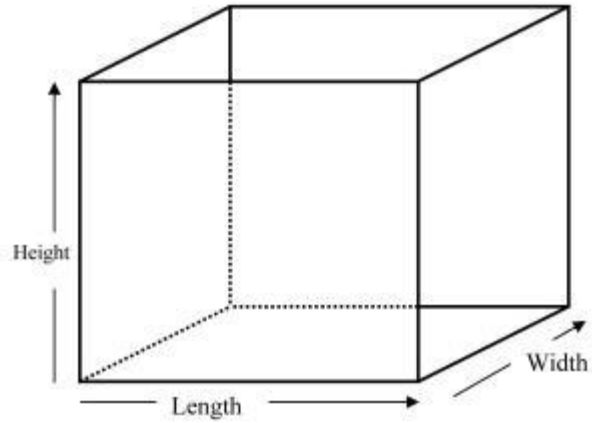
CALCULATE & SIMULATE

- Your pack spec.
- Specify parameters
- Calculate
- Vary conditions
- Generate data
- Create curves

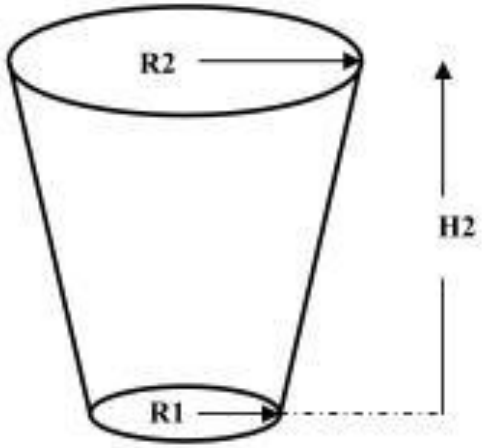
Packaging shapes for simulation



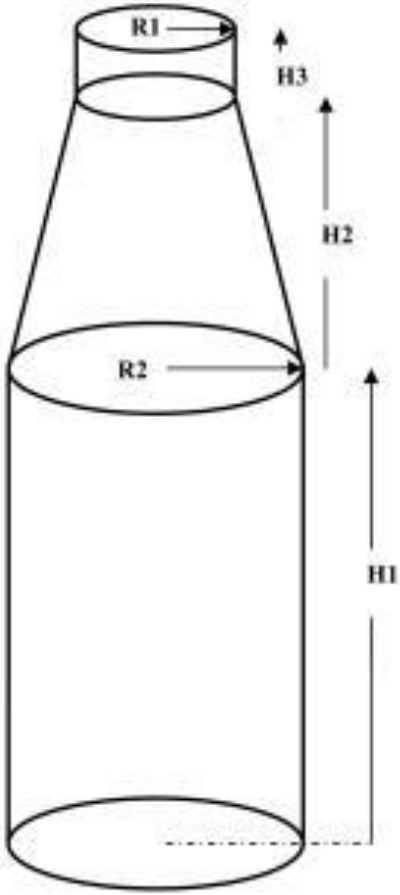
Multilayer



Multilayer
IML option



Multilayer
IML option

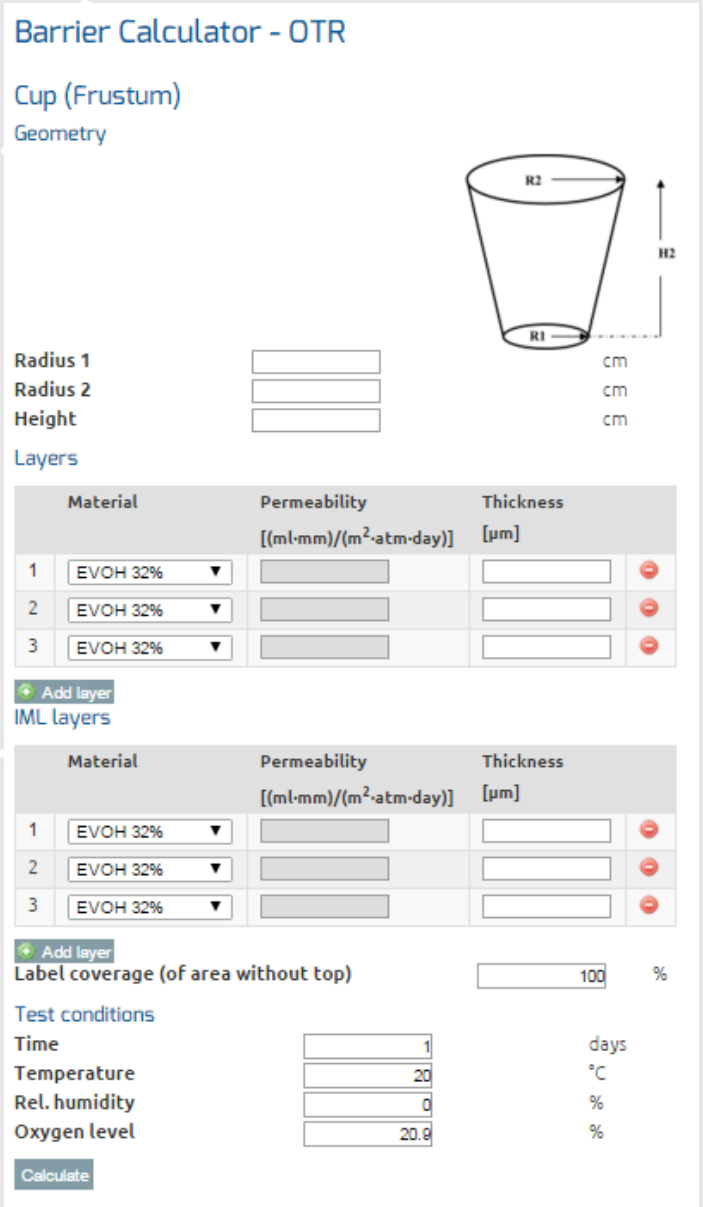


Multilayer

Options for OTR and WVTR simulations

- Selection of standard materials
- Insert custom OTR/WVTR values
- Flexible number of layers
- Adjustable thickness for any layer

- Vary time
- Vary temperature
- Vary humidity
  - Outside
  - Inside
- Optional IML for Injection moulded cups and cuboids.



Calculation Cases

OTR
Vacuum pack with sealed 7 layer film

Conclude
Calculator usefulness

WVTR
HDPE liner for cereals

OTR
Vacuum formed tray with lid

Simulating WVTR properties

Preventing cereals from softening

Polyethylene Cereal Liner

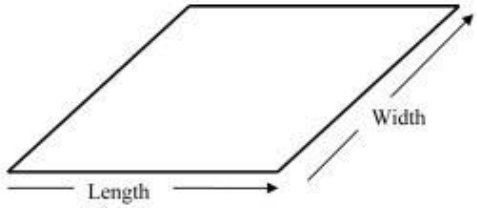
3 layer film: HD/HD/LD
Each layer of 10µm
Assume active film surface of pack is 30x50cm
Assume volume = 2 litre

Barrier Calculator - WVTR

Film

Geometry

Length	30	cm
Width	50	cm



Layers

	Material	Permeability [(ml·mm)/(m²·atm·day)]	Thickness [µm]	
1	HDPE(d964)		10	
2	HDPE(d964)		10	
3	LDPE (d914)		10	

Add layer

Test conditions

Time	1	days
Temperature	20	°C
Rel. humidity outside	70	%
Rel. humidity inside	0	%

Calculate

Repeat calculations for each condition

	Material	Permeability [(ml·mm)/(m²·atm·day)]	Thickness [µm]	
1	HDPE(d964)		10	
2	HDPE(d964)		10	
3	LDPE (d914)		10	

Add layer

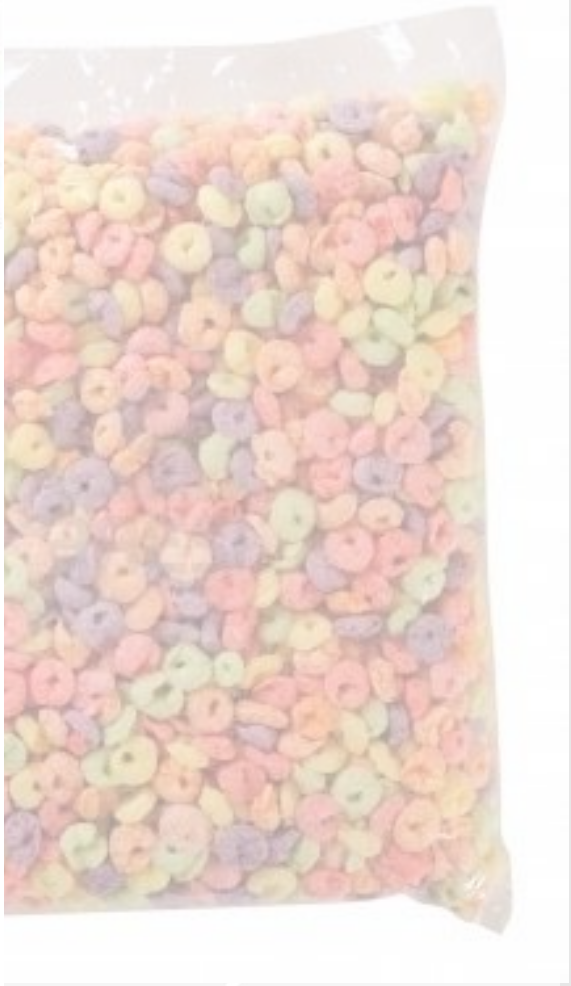
Test conditions

Time	730	days
Temperature	20	°C
Rel. humidity outside	20	%
Rel. humidity inside	0	%

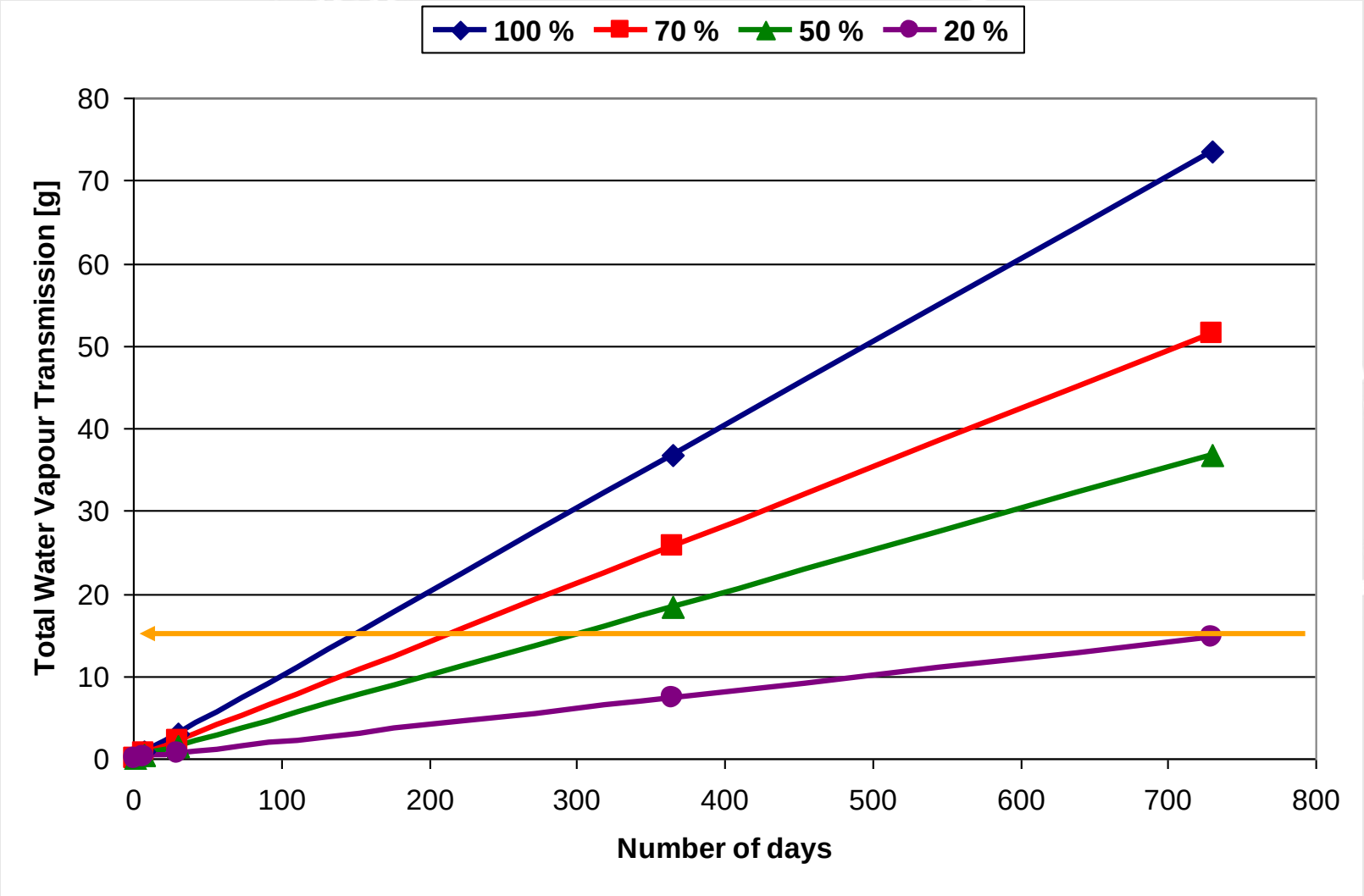
Calculate

Results

Total thickness	*L*	0.030	mm
Permeability, overall	*P*	1088.665	(ml·mm)/(m²·atm·day)
Area (excluded top)	*A*	0.150	m²
Volume, water vapor	*q*	18271.621	ml
Transmission rate	*TR*	25.030	ml/(package·day)
Transmission rate	*TR*	166.864	ml/(m²·day)
Transmission rate	*TR*	0.134	g/(m²·day)



WVTR vs. time and relative humidity



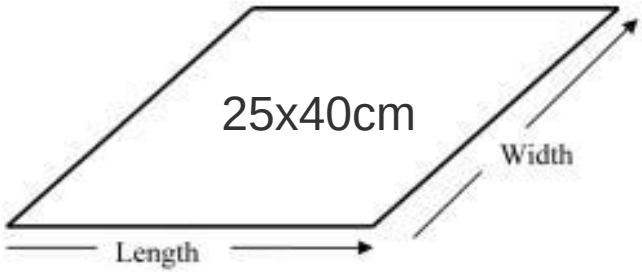
Simulating OTR

Vacuum packaged meat

Vacuum package of fresh red meat

- Blown coextruded 7 layer film
  - 40µmPE / 4µmTie / 5µmPA6 / 3µmEVOH32 / 5µmPA6 / 4µmTie / 40µmPE
- Active surface area = 25x40cm^2

illustration photo



Calculations

	Material	Permeability [(ml·mm)/(m²·atm·day)]	Thickness [µm]	
1	LDPE		40	
2	LDPE		4	
3	PA6 Cast		5	
4	EVOH 32%		3	
5	PA6 Cast		5	
6	LDPE		4	
7	LDPE		40	

Add layer

Test conditions

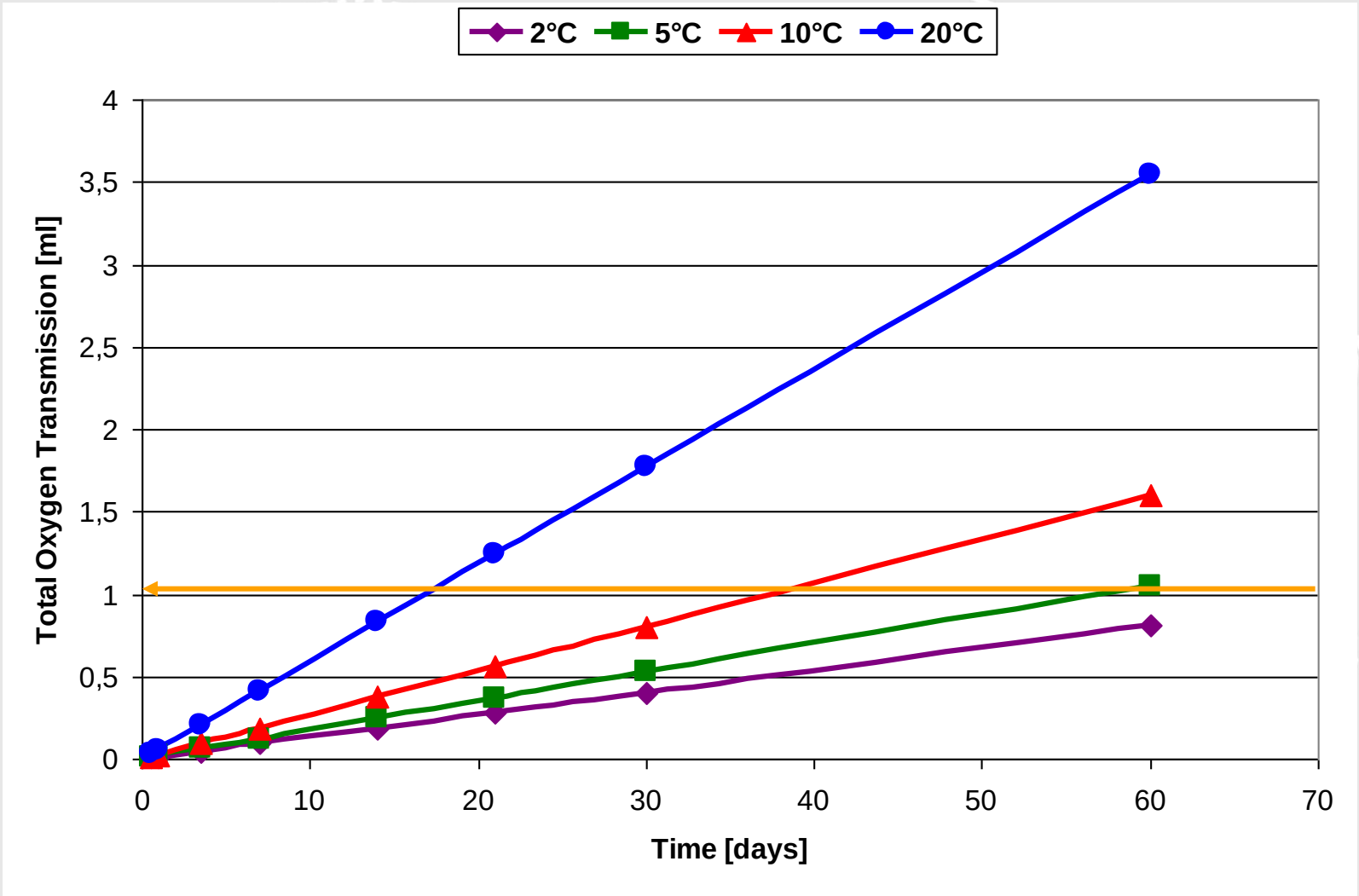
Time	3,5	days
Temperature	2	°C
Rel. humidity	65	%
Oxygen level	20.9	%

Calculate

Results

Total thickness	*L*	0.101	mm
Permeability, overall	*P*	0.065	(ml·mm)/(m²·atm·day)
Area (excluded top)	*A*	0.100	m²
Volume, oxygen	*q*	0.047	ml
Transmission rate	*TR*	0.013	ml/(package·day)
Transmission rate	*TR*	0.135	ml/(m²·day)

OTR vs. time and storage temperature



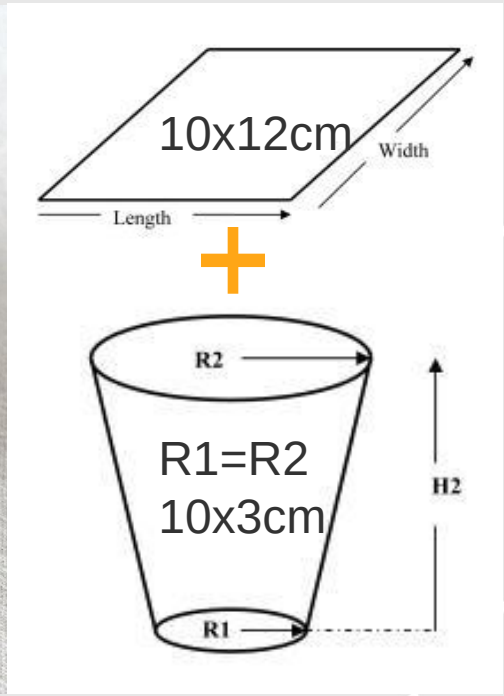
Simulating OTR

Vacuum formed tray with seal on lid

Package of sliced cooked meat

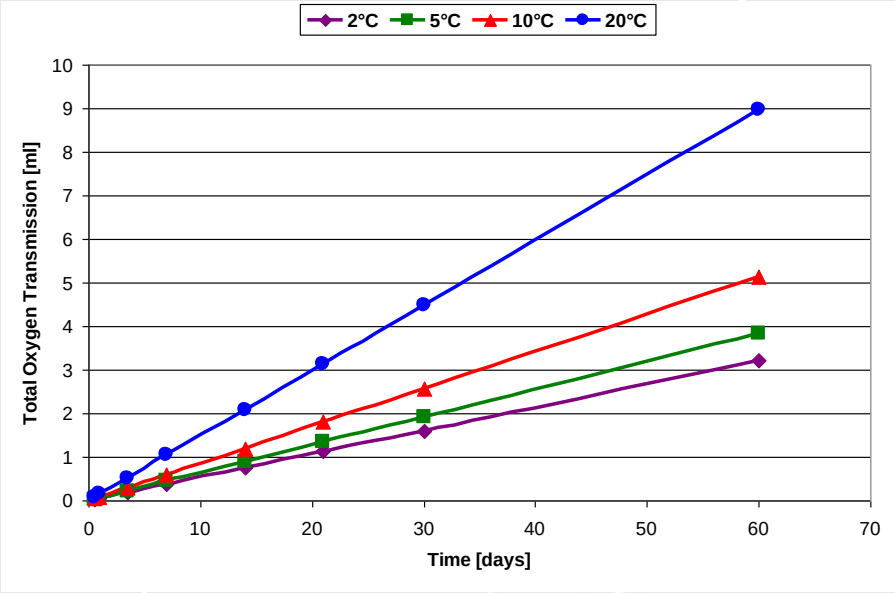
- Add two calculations
- Lid film: 12µm PET / 4µm PVDC / 50µm PE
- Bottom: 200µm APET / 25µm PE / 5µm PA / 25µm PE
- Volume of vacuum formed container = 3dl

illustration photo

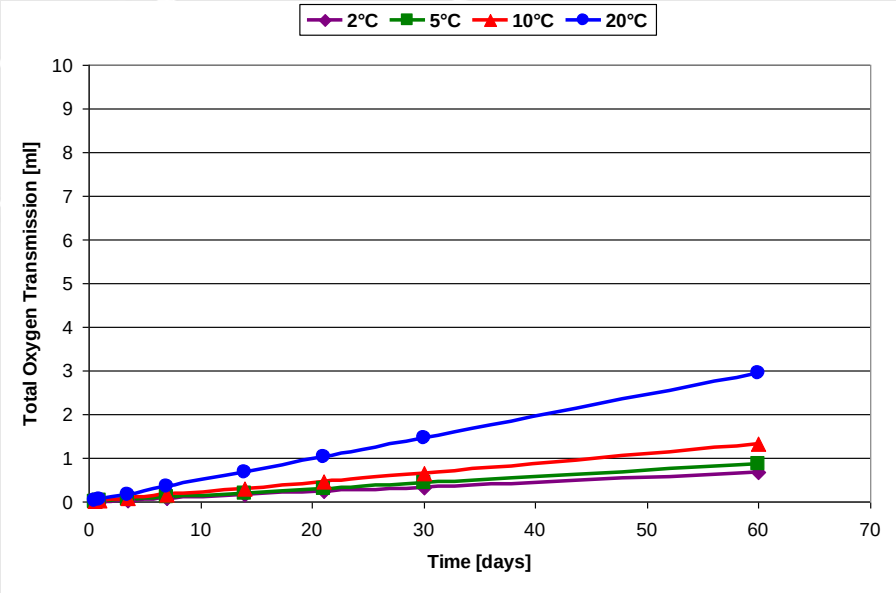


OTR vs. time/temp for each part

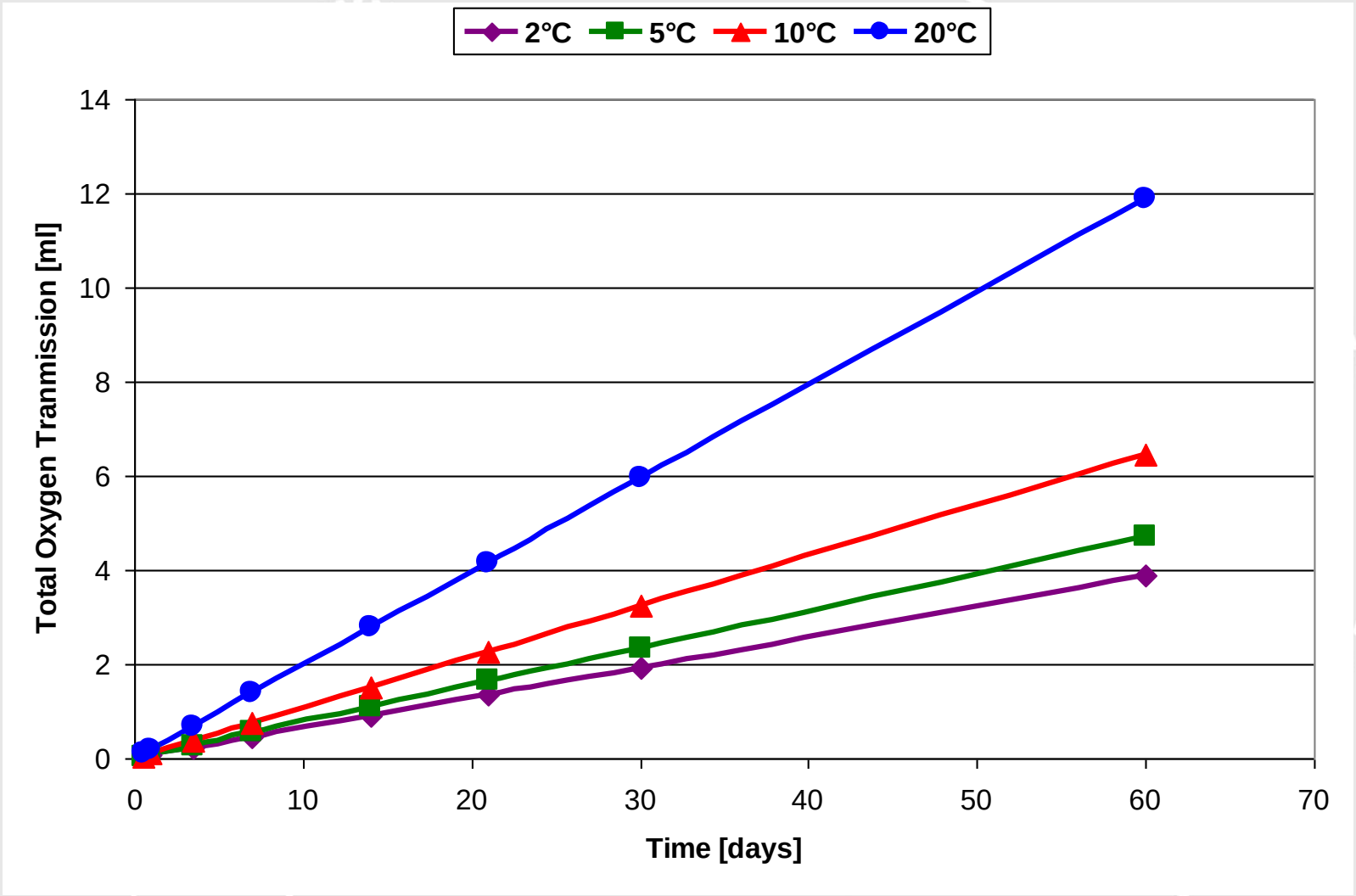
The vacuum formed tray



The lid



OTR vs. time and storage temperature

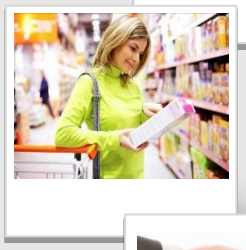


Shelf life

- Definition
  - The period between the manufacture and the retail purchase of food product, during which time the product is of satisfactory quality in terms of nutritional value, flavour, texture, appearance and safety
- Complex dependency of
  - the products “activity”
  - the environment in distribution esp. temperature
  - the package properties esp. permeability

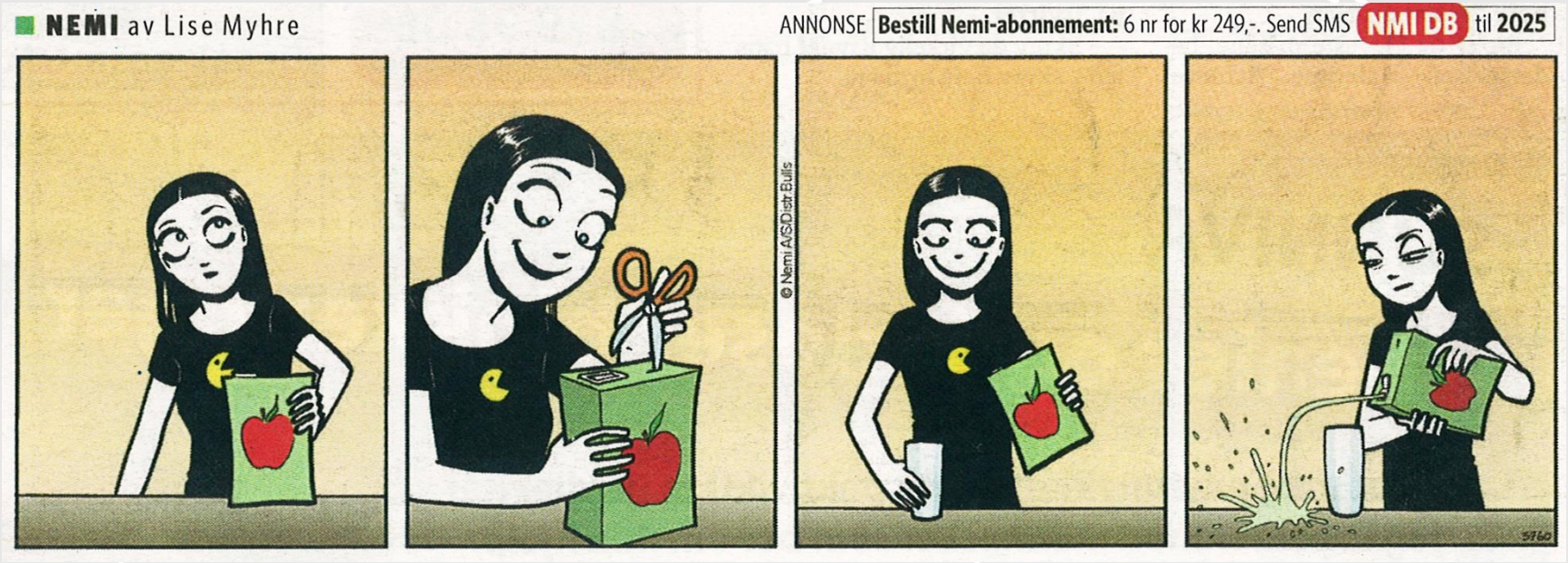
- Microbiological and/or enzymatic deterioration (aerobe and anaerobe)
- Oxidation e.g. Lipidic oxidation of fish or Rancidification of fatty foods
- Moistening, drying, taste/odour, colour
- Package inner atmosphere O_2, H_2O, CO_2, N_2

Benefits of OTR / WVTR calculator



Relevant	The package content O_2 and H_2O is a key factor for shelf life of many food products
Specific	Calculating the ingress of O_2 and H_2O for specific package configuration
Insight	Simulating variations in package storage and value chain environment
Cost saving	Fast detection of limiting factors of package design and less need for testing

Emballasje er high tech!



Takk for meg ☺

Assumptions

- The top of the containers is assumed to be 100 % tight.
- Wall thickness of the container and IML barrier film is constant.
- Steady state condition of permeation
- Diffusion in one direction only.
- The concentration-distance relationship through the polymer is linear (follows Henrys Law).
- The permeability coefficient is a constant of the material.
- The OTR model assumes 0 Vol% oxygen inside container initially.
- The container is empty.

Limitations

- Calculated values will have some deviation from real values.
- OTR will have best accuracy at temp. 23 ± 5 ºC and < 65 % RH.
- The permeability humidity corrections in the OTR model are performed for OPA6, PA6, PET and EVOH based on curve fitting permeability values at 20 ºC.
- The WVTR model will have best accuracy at 20 - 30 ºC.
- Permeability is a function of temperature, following an Arrhenius type of equation.
- The vapour pressure of water is a function of temperature and modelled using the Antoine equation (WVTR model).
- Influence of processing conditions (e.g orientation and crystallinity) and conversion technique is not considered in detail.