How Air Cargo covers help maintain quality of Perishables and temperature-sensitive shipments

Presentation for Cold chain association May 2012

Luxembourg
Agenda

• DuPont and DuPont Luxembourg

• Tyvek® porous barrier material

• The Cool chain problem

• A potential solution

• Experiences and results with Tyvek® Air cargo covers
  - Protection in catering
  - Protection of low weight pallets with pallet cover
  - Cold temperature protection

• Looking ahead
  - New product with better performance in the pipeline
  - New applications inside or outside ULD
DuPont 2011 Segment Sales

- **Agriculture**: $9.2B
- **Electronics & Communications**: $3.2B
- **Performance Chemicals**: $7.8B
- **Nutrition & Health**: $2.5B
- **Performance Coatings**: $4.3B
- **Performance Materials**: $6.8B
- **Safety & Protection**: $3.9B
- **Industrial Biosciences**: $0.7B

*$Total company sales exclude transfers.*
Science and technology capabilities around the world, working on local challenges.

- >9,500 scientists and engineers
- $1.7 billion R&D spend (2010)
- 100 R&D facilities worldwide
We are applying our science to find solutions to some really BIG challenges...

FOOD

ENERGY

PROTECTION

FEEDING THE WORLD

REDUCING OUR DEPENDENCE ON FOSSIL FUELS

KEEPING PEOPLE AND THE ENVIRONMENT SAFE

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Welcome to the Global Collaboratory™!

THERE ARE ALMOST 7 BILLION REASONS WHY WE SHOULD WORK TOGETHER.

As the world’s population approaches seven billion, the challenges facing humanity have never been greater. Fortunately, the solutions to many of the most fundamental challenges can be found in science, but providing for the food, energy and safety needs of a growing population will require more than science alone. It will require many people working together. People who can collaborate across borders, companies, governments, organizations and cultures to derive solutions—both large and small—to improve the lives of people around the world.

DuPont has a rich history of scientific discovery that has enabled countless innovations and made life better for people everywhere. And today, we’re working with more people, in more places, to make life better than ever can. Welcome to the Global Collaboratory.

Visit dupont.com/collaboratory to learn more.

TOGETHER, WE CAN FEED THE WORLD.

The world’s population will increase by 1.5 billion people per day for the next 60 years, which means the world will need to increase food production by 70% in that same period—more than the entire amount of rice that can be grown globally today. To feed this increasing number, we will need to develop new ways to produce food.

50% of all our research leads to new products and technologies that will help us produce food more efficiently.

TOGETHER, WE CAN DECREASE DEPENDENCE ON FOSSIL FUELS.

By 2050, the world will consume 40% more energy than today. And while the demand for energy grows, the supply of fossil fuels will not. Deep expertise in microbiology, fermentation, polymer science and electrochemistry will help make possible the conversion from fossil fuels to more sustainable alternatives.

2X The yield from the new bacteria is double the yield of average yields.

TOGETHER, WE CAN PROTECT WHAT MATTERS MOST.

As our population grows, we do the same in a larger and more sustainable world. Today, more than 1,000,000 people per year have more than 10% of working incomes. DuPont is working with companies, governments, academics and others in many areas of materials, products and solutions to protect life and our environment.

4MILLION

High performance DuPont™ Tedlar® makes it possible to store valuable solar power to meet this 4 million human energy needs.

3,000

Human lives are more than just a statistic. More than 3,000 health care professionals have been treated in hospitals daily, since the start of this year.

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DuPont Protective Technologies leverages a combination of technologies and capabilities into protection solutions for many markets.

**Capabilities**
- Barrier Protection
- Heat and Flame Protection
- Ballistic and Cut Protection
- Chemical Protection
- Particulate Protection
- Critical Process Protection
- Lightweight strength
- Electrical Insulation
- Fine particle filtration

**Leading Brands**
- Diverse Products
- Technical Expertise
- Application Development
- Sustained Investment
- Global Presence with Regional Response

**Key Market Segments:**
- Military, Emergency Resp.
- Protective Apparel
- Medical and Pharma.
- Energy
- Automotive
- Filtration
- Transportation
- Graphics
- Industrial
DuPont Luxembourg

DuPont Luxembourg Plant 1962-2012

Founded in 1962 as a manufacturing site for polyester films

Employees: 1150
Property Surface: 104 ha
History of DuPont™ Tyvek®
Examples of applications of DuPont™ Tyvek®

Tyvek® high density polyethylene

Protective apparel  Construction  Medical  Graphics

Envelopes
Advantages of a Porous Sterile Barrier Systems

Porous barrier materials
1. Allow the sterilisation gazes to enter and exit the package
2. Allow the package to adapt to changing pressures and temperatures as well as volume changes
3. Prevent the ingress of microorganisms i.e. maintain sterility
Why cost of material shall not be a prevailing driver?

Because
Low cost has a risk
Low risk is a value

Tyvek® Packaging = low risk

low price related to limitations
more product performance arguments
Focus on supply chains impacted by Avg. Temperature

Solar Radiation
Solar radiation on food held in direct sunlight increases the temperature above the ambient temperature. The amount of increase in temperature depends on the intensity of the radiation, shape and duration of exposure.

Intensity of solar radiation depends upon latitude, altitude, season, time of day, and degree of cloud cover.

• high temperature is detrimental to food quality and increases wastage
• in tropical climates with much higher solar radiation considerable quantities food deteriorate in quality at a rapid rate

Airport Latitudes: Tropics
Singapore 1
Kuala Lumpur 3
Sao Paolo 23
Abu Dhabi 24
Miami 25
Johannesburg 26

Airport Latitudes: Temperate
London 43
Luxembourg 49
Berlin 52

Spring Temperatures April 2010
Strengthening Global supply chains for food and Horticulture

Fresh chains globalize: F&V, Flowers, Meat, Fish

- Drivers: liking of freshness, year round supply, differentiation, low costs, logistics (air/ocean)

Courtesy FBR Wageningen
Air freight perishable commodities

Top 10 air freight commodities

Weight in tons (x 1,000)

Roses  Fresh Salmon  Asparagus  Fresh Mango  Fresh Tuna  Fresh Beans  Carnations  Fresh Capsicum  Fresh Cherry  Fresh Strawberry

Global Fresh / Frozen split
Frozen (4%)  Fresh (96%)

Top 10 = 41% of perishable air trade

Courtesy Seabury group
Today most products are in cardboard boxes uncovered or shrink wrapped
Direct Sun Adds Temperature to Ambient Reading

Trials under direct sunlight indicate product temperature rises over 10-15 C more than ambient, which is mitigated using Tyvek® Air Cargo covers.
Thermal Cover Systems

DuPont™ Tyvek® Air Cargo Cover - Operational

• **Extremely** lightweight
  - Euro pallet cover - less than 1kg
  - PMC ULD cover – less than 2.5kg
• Wraps down into very small package
• Easy-Fit 0.5 - 2 minutes max.
• 1 Piece of Tyvek® air cargo cover, no fixing or sealing required
• Bottom piece available to control contamination / pest threat
The problem

Temperature ‘excursions’ in the supply chain occur most often where processes are ‘uncontrolled’.

Source: IATA
The problem: summary of common Good Distribution Practice GDP (audit) findings

GDP Deficiencies

- Temperature Conditions: 30%
- Documents: 25%
- Premises & Equip: 8%
- Order & Supply: 8%
- Product: 5%

Source: UKMHRA
Key global manufacturing and distribution regions
Healthcare ‘Pharm-emerging Nations’

Brazil
Russia
India
China
South Korea
Turkey
Mexico
Thailand
Argentina
Malaysia
Egypt
S Africa

COLD CHAIN MANAGEMENT CONSULTANCY
Potential solution: Tyvek® Air Cargo Cover

Tyvek® unique pore structure reflects > 90% of solar spectrum

Avoids greenhouse effect of transparent film

Scattering
Solution: DuPont™ Tyvek® Air Cargo Cover – Benefits

- Helps reduce quality or loss of perishable items by
  - Providing thermal protection from solar radiation to reduce the damaging effects of the heat during transit
  - Lowering exposure to sudden ambient temperature changes
  - Allowing excessive moisture to escape
  - Limiting exposure to environmental elements
  - Providing protection from heavy rains and are tear resistant reducing potential damage from moisture
  - Providing UV protection from direct sunlight
  - Protection against airborne contamination such as dust, pollens and bird droppings
  - Eliminating visibility of contents reducing potential theft
Customer Chamber Trials

- Chamber Test – Aug 2010: Single skin cover over 1m high Euro pallet of 500ml water bottles (50% volume), no base

Trials performed by Amsafe Bridport
Chamber Test: Product @ 20°C / Ambient to +50°C

<table>
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<tr>
<th>Time (hours)</th>
<th>Temperature gain in preceding hour (°C)</th>
<th>Total temperature gain (°C)</th>
<th>Average temperature gain per hour (°C)</th>
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NOTE: Duration time to temperature limits depends on start temperature

1hr protection during temperature peaks in +50C ambient

Trials performed by Amsafe Bridport
Chamber Test: Product @ 20°C / Ambient to -20°C

<table>
<thead>
<tr>
<th>Time (hours)</th>
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<th>Total temperature gain (°C)</th>
<th>Average temperature gain per hour (°C)</th>
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</table>

NOTE: Duration time to temperature limits depends on start temperature

2-4hr protection during temperature spikes down to -20°C ambient

Trial Chamber Temp

 Least Temp Change (centre of pallet)

 Most Temp Change (top corner of pallet)

No Thermal Cover

Trials performed by Amsafe Bridport
Protection of Perishables & Temperature sensible products
Operational aspects examples in catering and flowers

Catering see also: DuPont Corporate add
Welcome to the Global Collaboratory™
DuPont™ Tyvek® Reduces Food Waste During Transport

http://goo.gl/VG3qo or www.youtube.com/dupont
ULD Unit load devices

ULD covered with Tyvek® Air Cargo cover

ULD with Tyvek® Air cargo cover on Lower deck
Performance Data
Unit Load Device cover Inside Temperature Test

**Average Top Surface Temperature**

- Uncovered ULD
- Covered ULD

**West Side Wall Surface Temperature**

- Uncovered ULD
- Covered ULD

**Average Internal Air Temperature**

- Uncovered ULD
- Covered ULD

Test of Tyvek® Air Cargo cover on ULD outside reported by Georgia Tech during a cold chain Forum 2012
Cold temperature performance

• To quantify the level of protection by an Air cargo cover when sensitive perishable Products transitions from a warm (25 C) to a cold environment (-20 C)
• The elapsed time was measured before a product reaches freezing point
Air Cargo Covers offer protection against cold 25 deg C to -20 Deg C
Test Results - Tyvek® cover vs. No cover at (– 20) Deg C

Product starts at 25 deg C
Covered vs uncovered palett
With 50% water filled eggs

Test Conditions:

- Two pallets with simulated loads consisting of water filled plastic eggs were conditioned for 24 h @ 25degC

- Both pallets were then immediately moved to a controlled environmental chamber at -20 degrees C.
Air Cargo Covers offer protection against cold
Test Results - Tyvek® cover vs. No cover at (– 20) Deg C

Product starts at 25 deg C
Looking ahead: New improved product line to be launched
Looking ahead: New improved product line to be launched

Expected benefits of improved Air cargo cover WS under development

- Better thermal protection performance due to low emissive surface (*)
  - Product provides additional protection for hot and cold conditions

- Lower fire-hazard (meet Self-extinguishing requirements according to FAR/JAR/EASA CS-25)
  - Flame-retardant using non-halogenated solution

- Breathable cover allows some humidity to escape potentially limiting condensation and damage of labels

- Exceeds performance of Tyvek® Air cargo cover WW White (*)

- Exceeds or meets performance of aluminum coated bubble wrap (*)

*(as measured under defined conditions)
Importance of reflectivity for protection from sun radiation

Stretch wrap has only 3.9% reflectivity !!!!

Tyvek® Metal inside has 92% reflection

Tyvek® styles with highest reflectivity chosen for Air cargo cover

Avoid adding stretch wrap on top of Tyvek®
  - as it lowers reflection
  - Stretch wrap inside Tyvek® limits respiration

This scattering of unique pore structure explains the good performance of the current vs stretch or transparent bubble wrap and gives orientation for product improvement
Field test with prototype with new Tyvek® style

Customers conclusion:
- The two covers clearly protect the load from the elevated temperatures.
- The new FR Tyvek® prototype outperforms the WW Tyvek cover in this radiant sunlight trial.

Trials performed by AmSafe in Sri Lanka with prototype
New Tyvek® WS gave 7 hours protection (T <25°C) compared to 4 hours for double white Tyvek® cover
Test of Tyvek® Air Cargo cover as liner in ULD (AKE) trials in South Africa with flowers to decrease temperatures

**Problem Statement:** current temperature spikes which customer has experienced in their transport from South-Africa to Japan have resulted in quality loss in product and decreased in shelf life

**Results:** Customer commenced trials in October 2011 with flowers between SA via Doha to Japan. Results thus far have proven that:

- Tyvek® reduced the average temperature by between 2 – 3 degrees Celsius per trip
- Tyvek® has shown to prevent heat build-up quite substantially in the AKE container at strategic points
- A qualitative assessment in Japan determined that the Tyvek® substrate was breathable enough and didn’t result in any spoilage of the product.
Sometime in 2011, the earth’s population will reach 7 billion.
By 2050, it will be 9 billion.
DuPont™ Tyvek® Air Cargo Covers Summary on one page
Offers additional protection for temperature-sensitive air freight

Protects temperature-sensitive products from extreme temperatures and sunlight

Benefits
- High protection from direct sunlight
- Insulates, reduces temperature changes
- Water resistant to reduce water/moisture damage
- Breathable to reduce condensation and dryness
- Protection against contamination (liquids, dust, pollens etc) / pest threat (insects, bird droppings etc)
- Visible / physical cover reduces potential theft / tampering

Offering: White & White-silver covers simple to use many sizes
Pricing*: different for smallest pallet to largest PMC sizes
*(only for orientation depending on order volumes and sizes*)

Sectors – Generics, Biopharma, Fruit/Vegetables, Flowers
Availability: Marketed in EMEA i.e. via AmSafe
US, China, India, MEA (direct and to be determined)
R&D: Development Pipeline to expand performance

Application:
• single-use covers reducing Logistics complexity
• addresses risks of global supply chains

Shrink Wrap Pallet Versus
Pallet covered with DuPont™ Tyvek® Air Cargo Cover

www.aircargocovers.dupont.com
Many available products, different sizes or ULD dimensions

Download from www.aircargocovers.dupont.com
Product safety information is available upon request
This information corresponds to our current knowledge on the subject. It is offered solely to provide possible suggestions for your own experimentations.
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Sufficient pre cooling and correct temperature management from start of the cool chain essential for optimal performance. DuPont is not liable for product damage during the use of the cover.

DuPont Tyvek® Air Cargo Covers are manufactured by DuPont utilizing technology by

Contacts us: in your region for information about sourcing and availability
See webpage below

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