Vapormate™ Introduction.
Biosecurity Treatments 2014
Methyl Bromide and Alternatives Conference.

Chris Dolman – Global Business Manager
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The Fumigation Market

Linde have been supplying fumigants in Australia for over 40 years
  • Key products have included Methyl Bromide and Eco2fume

The fumigation market is changing
  • Increased focus on ozone depleting and global warming properties
  • Increased focus on residues & human health
  • Local populations are increasingly concerned about air quality
  • Traditional pesticides are being de-registered by the APVMA
Fumigant Registration

Worker & Bystander Exposure

- TLV
  - Methyl bromide 1 ppm
  - Phosphine 0.3 ppm
  - Sulfuryl fluoride 1 ppm
  - Ethyl formate 100 ppm
  - EDN 10 ppm
  - Low human toxicity
  - Non-carcinogen/mutagen

Environmental Safety

- Non-ozone depleting
- Non-hazardous air pollutant
- Naturally occurring substances
- Degrades into earth friendly metabolites
- Qualify for organic status

Public Safety, Environmental Groups

Grower & Commodity Groups

- Broad-spectrum activity efficacy
- Satisfy bio-security requirements
- Ease of use
- Short hold time/short vent time/REI
- PPE
- Crop safety
- Bio-security approvals
- Non-corrosive
- No residues

Regulatory Authorities

Governmental Trade

Industry Trade Associations
What is Vapormate?

Developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) & BOC Limited as a Methyl Bromide replacement

Vapormate is 16.7% (by wt) Ethyl Formate in balance Carbon Dioxide

- Ethyl Formate is naturally occurring – found in fruit, cheese, beer etc
- Ethyl Formate is Generally Regarded as Safe (GRAS) by FDA USA
- Ethyl Formate is a common food flavouring
- Food grade Carbon Dioxide is used as a propellant
- Organic status in process
Key Product Features

Vapormate has some key advantages

- Non-ozone depleting or known global warming properties
- Broad spectrum activity – stored product to horticultural insect pests
- Controls all life stages of insects (eggs -> adults)
- Favourable toxicological profile – TLV 100ppm v 5ppm
- Quick treatment time – 1 to 24 hours depending on commodity
- Quick ventilation – 30 minutes
- Commodities can be consumed as soon as ventilation is complete – no withholding
- Classified as Table 5 by the APVMA – Maximum Residue Limits are not necessary
- Natural break down products are ethanol and formic acid (already considered organic)
Global Registrations

Vapormate is registered throughout the world

• South Pacific: Australia, New Zealand
• SE Asia: Indonesia, Korea, Philippines, Malaysia
• Middle East: Israel
• There are a number of biosecurity approvals as well e.g. Korea
• Pending: USA, PNG, Sri Lanka

Commodities vary by country and target pest including

• Grains, oil seeds (nuts), dried fruit, cocoa and equipment
• Vegetables: Lettuce, onion, kumara
• Fruit: tropical fruit, table grapes, citrus, bananas, berries, capsicum, pineapple
• In development: tobacco, cars, general cargo treatments, and much more…….
Vapormate Equipment

There are two pieces of kit needed for the safe application into an enclosed chamber

Vaporiser
- Vapormate is heated to 55°C to create a fumigant vapour
- To heat the product, vaporising the active ingredient, to ensure penetration throughout the enclosure

Monitors
- Safety monitoring to manage human exposure
- Dose monitoring to ensure effective treatment

This equipment can be purchased from Linde and ensures safe and effective treatment
Portable Electric Vaporiser (PEV)

Design Codes
- AS 4041 (2006) : Pressure Piping
- AS 3100 (1994) : Approval & Testing Electrical Equipment

Test Pressures
- Oil Chamber : 600 kPa
- Vacuum Jacket : $3.4 \times 10^{-5}$ Torr
- Heat Exchange Coil : 25500 kPa

Construction
- 316 Stainless Steel throughout

Electrical
- Power Supply : 2 x 240V (single phase)
- Current : 2 x 10 A
- Power : 2 x 2400 W (4800 W total)

Operating Temperatures
- Oil Bath : Typical Set Point 110°C (Range 70°C - 130°C)
- Product Outlet : 80°C - 100°C
- Emergency Cut Out : 180°C

Dimensions
- Height : 950 mm
- Footprint : 490 mm x 360 mm
- Weight : 55 kg
Personal Protective Equipment (PPE)

When working with Vapormate there are some key risks that need to be managed – asphyxiation (CO2) and inhalation (ethyl formate)

Linde recommended PPE
• Eye / Face Wear splash-proof goggles
• Hands Wear full-length PVC gloves
• Body Wear safety boots
• Respiratory Wear a Type AX (Organic vapour) respirator

A monitor should be used to assess CO2 and ethyl formate levels are safe

Make yourself familiar with the MSDS before you apply Vapormate
Linde have a product stewardship program for sensitive products such as fumigants.

A key element is ensuring our customers are set up to manage the product safety and effectively.

All new customers must complete risk assessments as well as be trained to use Vapormate.
• Linde has experts situated around the world

• Support is available with trials

• Training is also available as part of our Product Stewardship Program

• Engineering support is available for application equipment
Case Study 1: Dole Korea

The Challenge

• Dole Korea imports 83,000 tonnes of fruit into Korea including 30% of the banana market
• Korea is moving ahead to phase out MeBr by 2015

The Solution

• Dole Korea moved to Vapormate and are continuing to look for label additions
• This has increased sales and ensured that quality product arrives on supermarket shelves

“At Dole Korea, we increased our sales volume by switching from methyl bromide to VAPORMATE,” says Kim Nam-Kook, Director

“VAPORMATE also improves quality during storage and distribution of imported fruit by delaying the Maillard reaction relative to methyl bromide.”
Case Study 2: Fresh Food Exports New Zealand

The Challenge
• Fresh Food Exports Ltd expanded its initial persimmon and blueberry orchard to include strawberries
• Methyl Bromide was decreasing shelf life and making exports problematic

The Solution
• Working with QTC Fresh Food Exports introduced Vapormate for a range of fresh fruit
• This has enabled further exports with new fruit being explored currently

“We have seen that fruit treated with VAPORMATE was in excellent condition on arrival in other countries and that the post-treatment shelf life was not compromised,” concludes Kesha.

“VAPORMATE offers faster venting times. So we are able to treat and clear more fruit for export more quickly, thus maximising each shipment,”
A selection of Efficacy Data
### Sample Label - differs by country

<table>
<thead>
<tr>
<th>SITUATION</th>
<th>INSECTS</th>
<th>APPLICATION RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal grains and oilseeds in sealed storage (with moisture content ≤12%) and Grain storage premises and equipment</td>
<td>Complete control of all stages of: Lesser grain borer <em>(Rhizopertha dominica)</em>, Flour beetle <em>(Tribolium castaneum)</em>, Psocids (various species), Storage moths <em>(Esthelia spp., Plodia spp.)</em>, Saw-toothed grain beetle <em>(Oryzaephilus spp.)</em>, Flat grain beetle <em>(Cryptolestes spp.)</em> Complete control of eggs, larvae and adults of: Rice weevil <em>(Sitophilus oryzae)</em></td>
<td>660 g/m³ held for 3 hours exposure time or 420 g/m³ held for 24 hours exposure time</td>
</tr>
<tr>
<td>Horticulture produce (Post harvest only) fruit, vegetable, flowers in sealed storage</td>
<td></td>
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<tr>
<td>Vegetables</td>
<td></td>
<td></td>
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<tr>
<td>Leafy vegetables (lettuce)</td>
<td>Aphid <em>(Nasonovia ribisnigri)</em></td>
<td>120 g/m³ (1 hour exposure)</td>
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<tr>
<td>Bulbs (Onion)</td>
<td>Onion thrips <em>(Thrips tabaci)</em></td>
<td>160 g/m³ (1 hour exposure)</td>
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<td>Fruit vegetables (Sweet pepper)</td>
<td>Western flower thrips <em>(Frankliniella occidentalis)</em></td>
<td>70 g/m³ (2 hours exposure)</td>
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<td>Tubers (Kumera and Rhubarb)</td>
<td>Detritus moth <em>(Opogona omoscpa)</em></td>
<td>30 g/m³ (2 hours exposure)</td>
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<tr>
<td>Fruits, Bananas</td>
<td>Mites <em>(Oligotetranyx spp.)</em>, Mealybugs <em>(Dysmicoccus spp.)</em> Scale <em>(Aspidiotus spp.)</em></td>
<td>420 g/m³ (6 hours exposure)</td>
</tr>
<tr>
<td>Pineapples</td>
<td>Mites <em>(Dolichotetranyx floridanus)</em>, Mealybugs <em>(Dysmicoccus neobrevipes)</em> Scale <em>(Diaspidis bromiliae)</em></td>
<td>420 g/m³ (2 hours exposure)</td>
</tr>
<tr>
<td>Grapes</td>
<td>Light Brown Apple Moth <em>(Epiphyas postvittana)</em>, Redback spiders <em>(Latrodectus hasselti)</em></td>
<td>240 g/m³ (2 hours exposure)</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Long-tailed mealybug <em>(Pseudococcus longispinus)</em>, Two-spotted spider mite <em>(Tetranychus urticae)</em>, Western flower thrips <em>(Frankliniella occidentalis)</em>, Plague thrips <em>(Thrips imagines)</em></td>
<td>120 g/m³ (2 hours exposure)</td>
</tr>
<tr>
<td>Kiwifruit</td>
<td>Western flower thrips <em>(Frankliniella occidentalis)</em>, Two spotted mite <em>(Tetranychus urticae)</em></td>
<td>250 g/m³ (1 hour exposure)</td>
</tr>
<tr>
<td></td>
<td>Oleander scale <em>(Aspidiotus nerii)</em>, long tailed mealybugs <em>(Pseudococcus longispinus)</em></td>
<td>140 g/m³ (6 hours exposure)</td>
</tr>
</tbody>
</table>
Grain & Stored Products: 100% insect mortality

Weevils, beetles and moths (all life stages)
Cocoa & Tobacco: 100% insect mortality

- Tobacco Moth and Cigarette Beetle
- Indian Meal Moth
- Foreign Grain Beetle
Table Grapes: 100% insect mortality

- Long tailed Mealy Bugs
- Red back spider
- Light brown apple moth
- Western Flower Thrips
Citrus: Finalising work on the FRW

- Citrus Mealy Bugs
- California Red Scale
- Fullers Rose Weevil
- Light brown apple moth
Strawberries: 100% insect mortality

Western Flower Thrips
Blueberries & Persimmons: 100% insect mortality

Insect Mortality:

- Western Flower Thrips
- Long tailed Mealy Bugs
- Red back spider
- Two spotted and Tydeid Mites
- Light brown apple moth

Thrips and mites have been eradicated through treatment.
Bananas: 100% insect mortality

Two applications
• Container or fumigation tent fumigation
• Fumigation of each box in the production line

Efficacy
• Mealy bugs
• Mites
• Scale
### Pineapples Malaysia

#### Vapormate Trials & Development in MY

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<th>Target Pest</th>
<th>Target Products</th>
<th>Trials</th>
<th>Stages of Live</th>
<th>Efficacy</th>
<th>Phytotoxity Test</th>
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<tr>
<td>Jack Beardsley mealybug</td>
<td>Pineapples</td>
<td>Conducted @ various dosage / exposure</td>
<td>Eggs, crawlers &amp; adults</td>
<td>100% mortality</td>
<td>Fruits quality are not affected</td>
</tr>
<tr>
<td><em>(Pseudococcus jackbeardsleyi)</em></td>
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<tr>
<td>cigarette beetle</td>
<td>Pepper</td>
<td>To embark trials in 2(^{nd}) half of 2014</td>
<td>Egg, larva &amp; adults</td>
<td></td>
<td></td>
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<tr>
<td><em>(Lasioderma serricorne)</em></td>
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</tbody>
</table>

**Target Pest**
- **Jack Beardsley mealybug** *(Pseudococcus jackbeardsleyi)*
- **cigarette beetle** *(Lasioderma serricorne)*

**Target Products**
- Pineapples
- Pepper

**Trials**
- Conducted @ various dosage / exposure
- To embark trials in 2\(^{nd}\) half of 2014

**Stages of Live**
- Eggs, crawlers & adults
- Egg, larva & adults

**Efficacy**
- 100% mortality

**Phytotoxity Test**
- Fruits quality are not affected

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**Pictures from Pineapples Trials in MY**

**Pictures of Peppers/ Pest**
General Cargo e.g. spider and hitchhiker treatment

• Millions of shipping containers are moved around the world

• These may be everything from general food to car parts

• Linde have conducted studies on hitchhikers pests
  • E.g. cockroaches, spiders, crickets, moths etc

• Residue testing has also been carried out on packaging

• General treatment will be approved in New Zealand soon
Bed Bugs: A potential alternative
Questions?

Visit our Linde Crop Science Website (http://cropscience.linde-gas.com)

This site includes
• Product labels & registrations
• Product fact sheets
• Case studies
• Product stewardship information
• Contact details to request more information

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Need more information?
Question 1

VAPORMATE is a

a) Pre-harvest fumigant

b) Post-harvest fumigant

c) Insecticide

d) Fungicide
The active ingredient of VAPORMATE is

a) Ethyl Formate

b) Formic acid

c) Ethanol

d) Carbon Dioxide
The TWA-TLV over 8 hours period for Ethyl Formate is

a) 10 ppm

b) 5 ppm

c) 50 ppm

d) 100 ppm