Sulfuryl fluoride as a quarantine treatment for timber

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Why is sulfuryl fluoride being considered?

1. Methyl bromide (MeBr) is being phased out.

2. Currently most timber commodities exported from, or imported into, Australia are treated with MeBr at rates between 48 and 128 g m^{-3}.

3. Seeking a fumigant that eradicates all pest arthropods, chromista, fungi, and nematodes.

4. Sulfuryl fluoride is a broad spectrum fumigant used for pest control and fumigation of buildings and structures.
Advantages of sulfuryl fluoride

1. Treatment costs broadly comparable to those for methyl bromide, cheaper than heat treatments.

2. Possibly better penetration of timber than MeBr but very limited data.

3. Lower sorption on wood than MeBr.


5. Not corrosive to plastics and equipment.

6. No pest resistance identified.
Challenges to getting new fumigant treatments accepted for quarantine purposes


2. Inappropriate test procedures.

3. Details of treatment submissions to IPPC Technical Panel on Phytosanitary Treatments confidential and not peer reviewed.

4. Level of control undecided: probit-9 not appropriate.

5. Quarantine treatments must work effectively first time.
Efficacy of sulfuryl fluoride for pest groups of potential concern


2. Bacteria – the sparse available data indicates not effective.


4. Fungi – may be effective at high doses but published data contradictory.

5. Insects – most data relate to pests of stored products (grains); eggs are resistant.

6. Mites – limited effectiveness but few studies.

7. Nematodes – effective at high doses.
Fungi

1. *Ceratocystis fagacearum* 30 day colonies on wood blocks at 21°C; some survival at a CT value of 11 316 g h m\(^{-3}\).

2. In wood naturally infected with *C. fagacearum* some survival at a CT value of 14 950 g h m\(^{-3}\) at 21°C.

3. In the same study other (undetermined) fungi survived 35 010 g h m\(^{-3}\) at 10–20°C for 72 h.

4. Six species of wood decay basidiomycetes as 42-day old colonies on wood blocks were killed by a CT of 2800 g h m\(^{-3}\) at 21°C.
Insects

1. Published studies have used numbers of insects well below those needed for probit-9 confirmation. Generally dose-response curves lacking.

2. For effective treatment of emerald ash borer (Agrilus planipennis) larvae and adults a CT of 3723 g h m$^{-3}$ was required at 15.6°C and 3172 g h m$^{-3}$ at 21.1°C.

3. For Xyleborus pfeili eggs at 15°C a dose of 2400 g h m$^{-3}$ caused 23% mortality; at 25°C 39% mortality.
CT (concentration x time product) for the fumigation of insects with sulfuryl fluoride

USDA treatment for social insects
CT (concentration x time product) for the fumigation of insects with sulfuryl fluoride

Maximum CT for grains and dried fruit

SO$_2$F$_2$ dose (g h m$^{-3}$)

Temperature (°C)
CT (concentration x time product) for the fumigation of insects with sulfuryl fluoride

Average CT needed to achieve probit-9 control of Asian longhorn beetle larvae

Data modified from Barak et al. 2006
CT (concentration x time product) for the fumigation of insects with sulfuryl fluoride

CT needed to achieve probit-9 control of Asian longhorn beetle larvae at 95% confidence level

Data modified from Barak et al. 2006
Mites

1. Not usually considered to be timber pests but very often associated with timber as contaminants.

2. For *Tyrophagus putrescentiae* (ham mite) a CT of 4800 g h m$^{-3}$ at 23°C killed 100% of adults and nymphs but only 95% of eggs.
Pinewood nematode, *Bursaphelenchus xylophilus* (24 h schedule from Buckley *et al.* 2010 in submission to Technical Panel on Phytosanitary Treatments)

<table>
<thead>
<tr>
<th>Treatment Temp. °C</th>
<th>Initial dose g m⁻³</th>
<th>Minimum target CT g h m⁻³</th>
</tr>
</thead>
<tbody>
<tr>
<td>15–19.9</td>
<td>183</td>
<td>3200</td>
</tr>
<tr>
<td>20–24.9</td>
<td>131</td>
<td>2300</td>
</tr>
<tr>
<td>25–29.9</td>
<td>88</td>
<td>1500</td>
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<tr>
<td>30–34.9</td>
<td>82</td>
<td>1400</td>
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<tr>
<td>35&gt;</td>
<td>60</td>
<td>1000</td>
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Pinewood nematode, *Bursaphelenchus xylophilus* (24 h schedule from Sousa *et al.* 2010 in submission to Technical Panel on Phytosanitary Treatments)

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## Hydrolytic stability

<table>
<thead>
<tr>
<th>pH</th>
<th>Temperature °C</th>
<th>Half life (time)</th>
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<tbody>
<tr>
<td>2</td>
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<td>25</td>
<td>3.1 days</td>
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<td>7</td>
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<td>6.7 hours</td>
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<td>4.6 hours</td>
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<tr>
<td>8.1</td>
<td>Not stated</td>
<td>18 minutes</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>4.0 minutes</td>
</tr>
<tr>
<td>9</td>
<td>25</td>
<td>2.8 minutes</td>
</tr>
</tbody>
</table>
Other issues

1. A greenhouse gas with a warming potential 4780 times greater than CO₂.

2. USA EPA has banned use of sulfuryl fluoride for fumigation of food, food storage and processing facilities.
Take home messages

1. Sulfuryl fluoride has potential to replace MeBr for specific applications e.g. treatment of social insects such as termites.

2. Effective treatment of fungi and pinewood nematodes generally requires much higher doses than current label permits.

3. Need more studies of effective doses for insect eggs.

4. For mixed populations of diverse pests the effective dose will need to be much greater than current label CT of 1500 g h m⁻³.

5. Temperature response data contradictory. Unlikely to be effective in temperate regions where ambient temperature <15°C.