THE USE OF SULPHURYL FLUORIDE IN EUROPE FOR STRUCTURE AND COMMODITY DISINFESTATION

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Methyl bromide - a widely-used broad spectrum fumigant used for crops on soil before planting and after harvest, and for commodity and structural fumigation

Phase-out under the Montreal Protocol:

Developed countries: No longer to be used after 1st Jan 2005 except for quarantine-related and critical applications for which there are no approved alternatives

Developing (Article 5(i)**) countries:** 20% use reduction from 2005. Phase-out as in developed countries by 2015.

Data (tonnes) on methyl bromide use worldwide and in Europe (Data extracted from UNEP 1999, 2003)

Year	Total world wide	Total for QPS uses	Total use in Europe
1991	72,689	-	18,020
1995	66,339	-	16,350
1997	62,750	-	17,000
1998	71,000	8,250	12,000
1999	61,500	12,200	12,700
2000	57,000	11,600	11,000
2001	50,000	10,000	8,500
2003	40,000*	10,000	6,000*

*Based on the transition from 40% to 25% of non exempt 1991 baseline levels in Europe, and from 50% to 30% for non Article 5(1) counties elsewhere

Summary of critical use applications to the Montreal Protocol by sector for 2005

Crop or use	Tonnes MB requested
Tomatoes	4012
Strawberry fruit	2948
Peppers and Egg plant	2447
Cucurbits	1422
Mills and Food Processors	910
Cut flowers	837
Miscellaneous	2860
Total	***15436***

Factors to be considered in replacing MB post harvest uses with another fumigant

- General efficacy against pests
- Ability to penetrate through bulk commodities
- Permeability of fumigant through barrier films paints, and structural materials
- Sorption into commodities and other materials
- Flammability
- Stability on different substrates at different temperatures and effects on sensitive equipment

Sulphuryl fluoride – A fumigant used for many years as Vikane® in structures against wood destroying pests

Now being registered in various countries as ProFume® for food premises and commodities:

- First registration, for empty mills and silos in Switzerland, was July 2003
- Federal registration in the US for grain milling and storage and dried fruit and nuts in Jan 2004 and now in 48/51 states
- Approval in Italy in April 2004 for disinfestation of flour, semolina and pasta mills
- Approval in the UK in July 2004 for treatment of emptied cereal grain mills and storage facilities

Time-lines for further registration and commercial adoption of SF in Europe

- Germany – Registration for mills and food processing facilities likely in late 2004
- France – Registration for mills etc. under review for 2005
- UK – Registration for food processing facilities likely in 2005
- Registrations for commodities in pipeline – 2006 onwards

First commercial fumigations in European countries:

Switzerland: July 2003; UK: July 2004; Italy: Sept 2004

Structures and commodities for which pest data have been obtained

Logs, timber, buildings

Museum artefacts, archives, fabrics

Cereal grains

Flour and cereal products

Dried fruit, nuts, beverages and spices

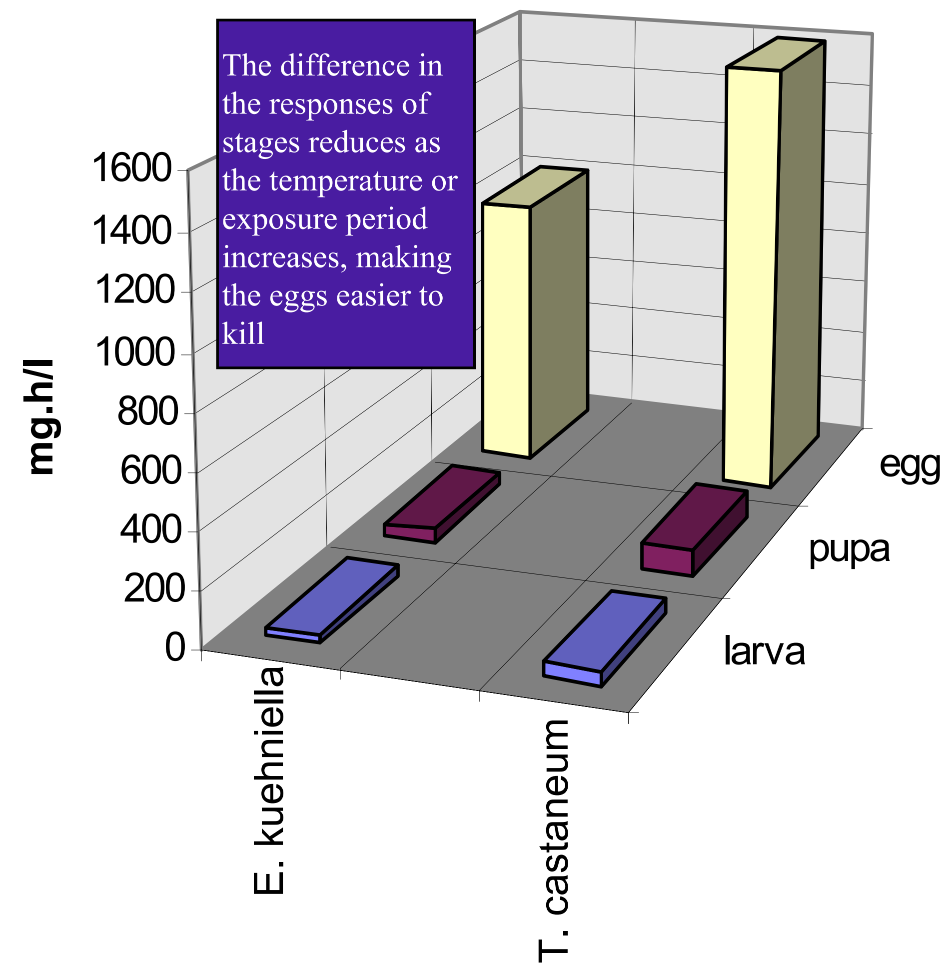
Fresh fruit, vegetables, chestnuts

Dried animal products, food residues

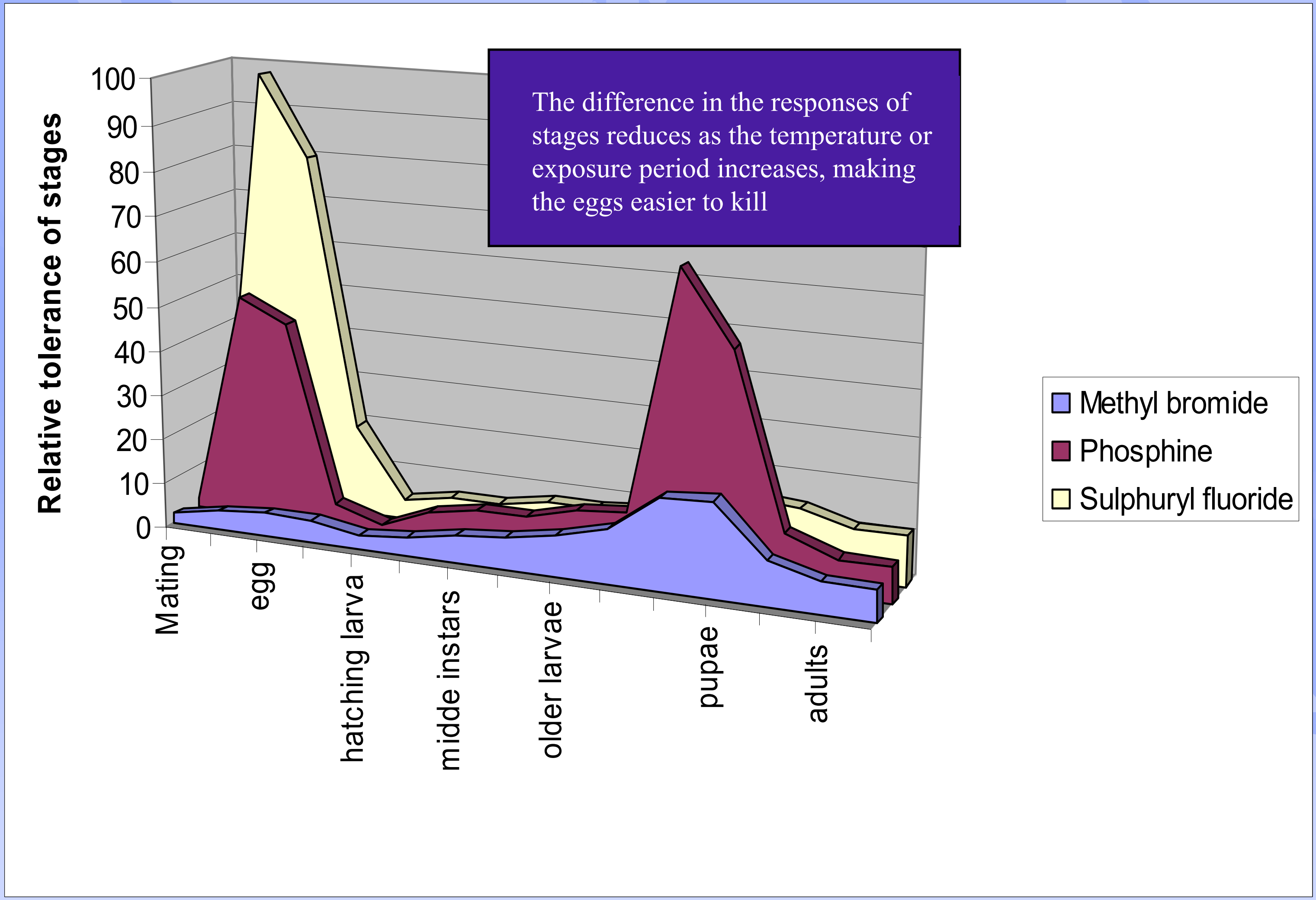
Exposure time and efficacy:

- All fumigants need a minimum time of exposure to allow them to work
  - Long acting fumigants: phosphine, carbon dioxide,
  - Quick acting fumigants: methyl bromide, hydrogen cyanide, sulphuryl fluoride.
- Temperature effects:
  - Decreased temperature slows development, tolerant stages need longer exposures for kill
  - Increased temperature increases rate of metabolism - can affect time threshold

Ct products (mg.h/l) of SF at 25ºC required to kill different stages of 2 leading mill pests



Exposure time and efficacy: variations in tolerance towards 3 fumigants as insect development proceeds



Toxicity of SF to some mill pests at 25^oC

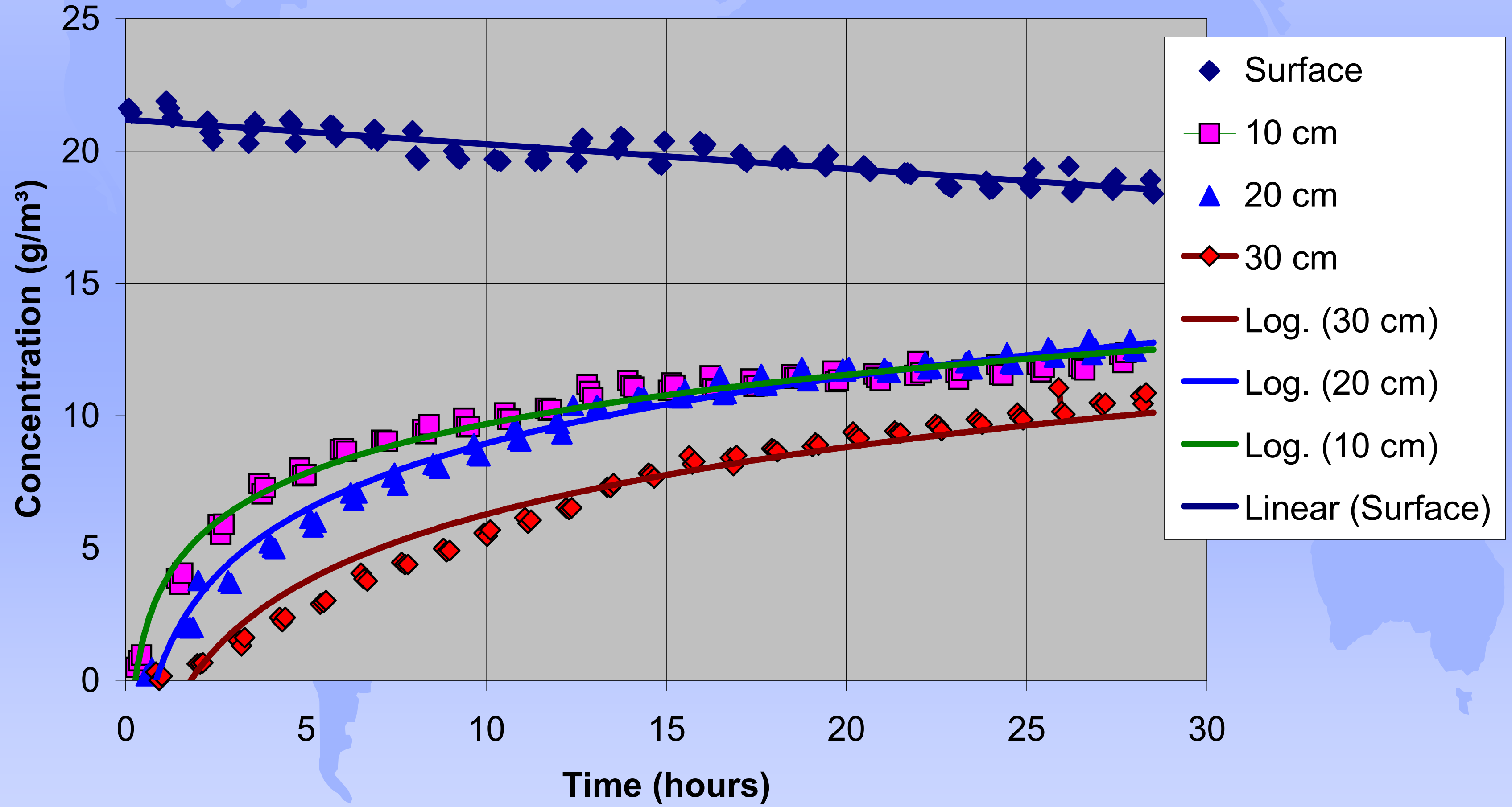
Species	Stage	Concn. range (mg /l)	Max Ct survived (mg.h/l)	Exposure survived (h)	Ct giving 100% kill (mg.h/l)
A. siro	Eggs	40-90	2635	30	-
	Post-emb	40-90	2184	25	2635
C. turcicus	Eggs	30-50	417	16	800
	Post-emb	5-6.0	144	25	183
G. cornutus	Eggs	10-60	1915	30	-
	Post-emb	10-11	87	8	120
L. bostrich-ophila.	Eggs	12-47	659	14	940
	Post-emb	12-22	-	-	c.200
P. tectus	Eggs	5-11	298	32	c.500
	Post-emb	5-11	227	24	298
S. granarius	Eggs	48-50	786	16	976
	Post-emb	5-6.0	11	2	16
T. molitor	Eggs	11-47	659	14	753
	Post-emb	9-11	227	24	298

Development under gas of 0-1 day eggs of *Cryptolestes turcicus* exposed to SF at 13.9 g/m^3 at 30 ^oC, 70 % rh :

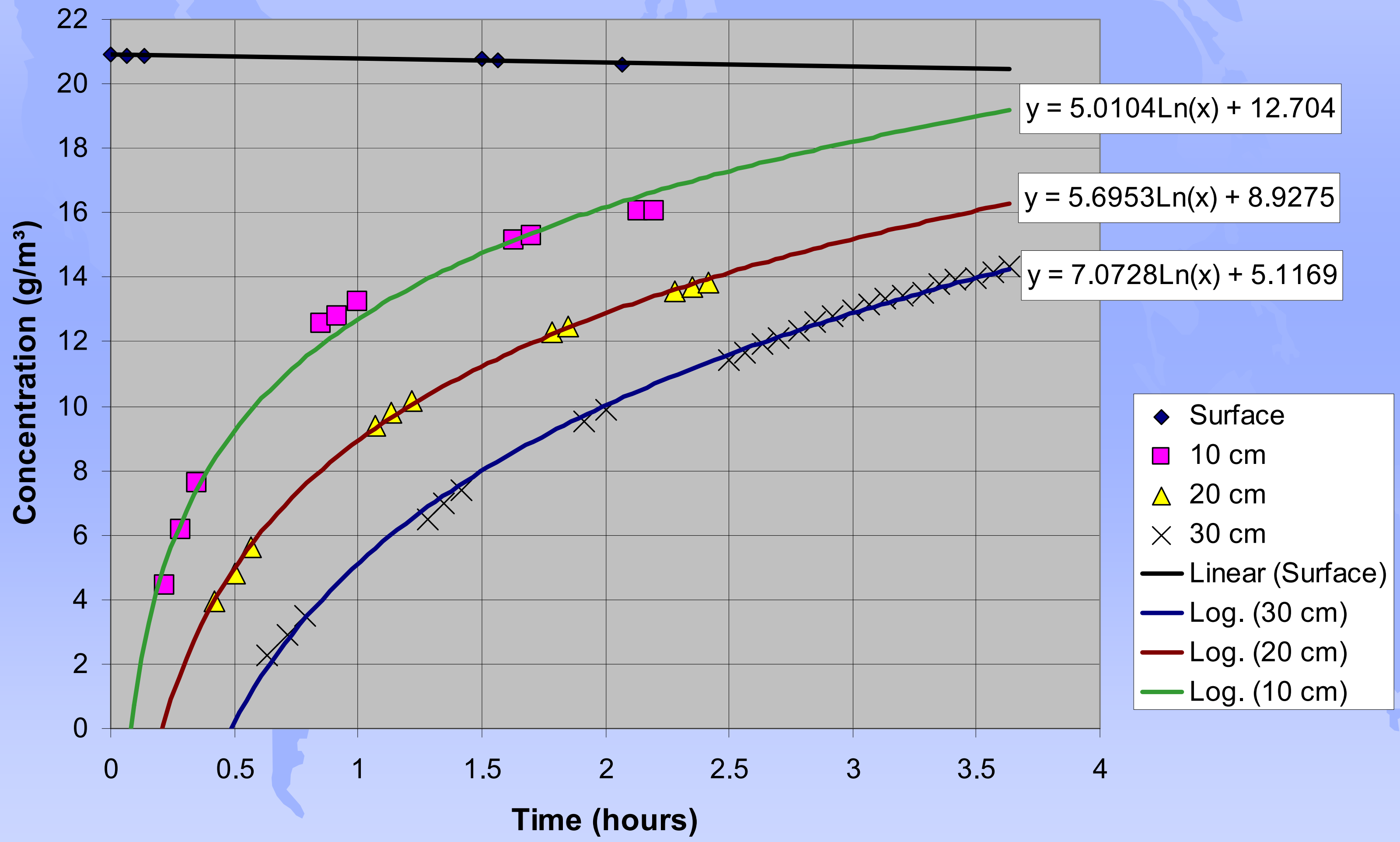
Exposure (hours)	Mean Time to Hatch (hours after treatment)	Mortality[1] (%)
Control	126.48	33.3
6	127.44	38.5
8	129.60	47.3
10	127.68	34.1

[1] Measured from emergence of adults, expressed as a percentage of the eggs (3 replicates of 50 per exposure) that hatched

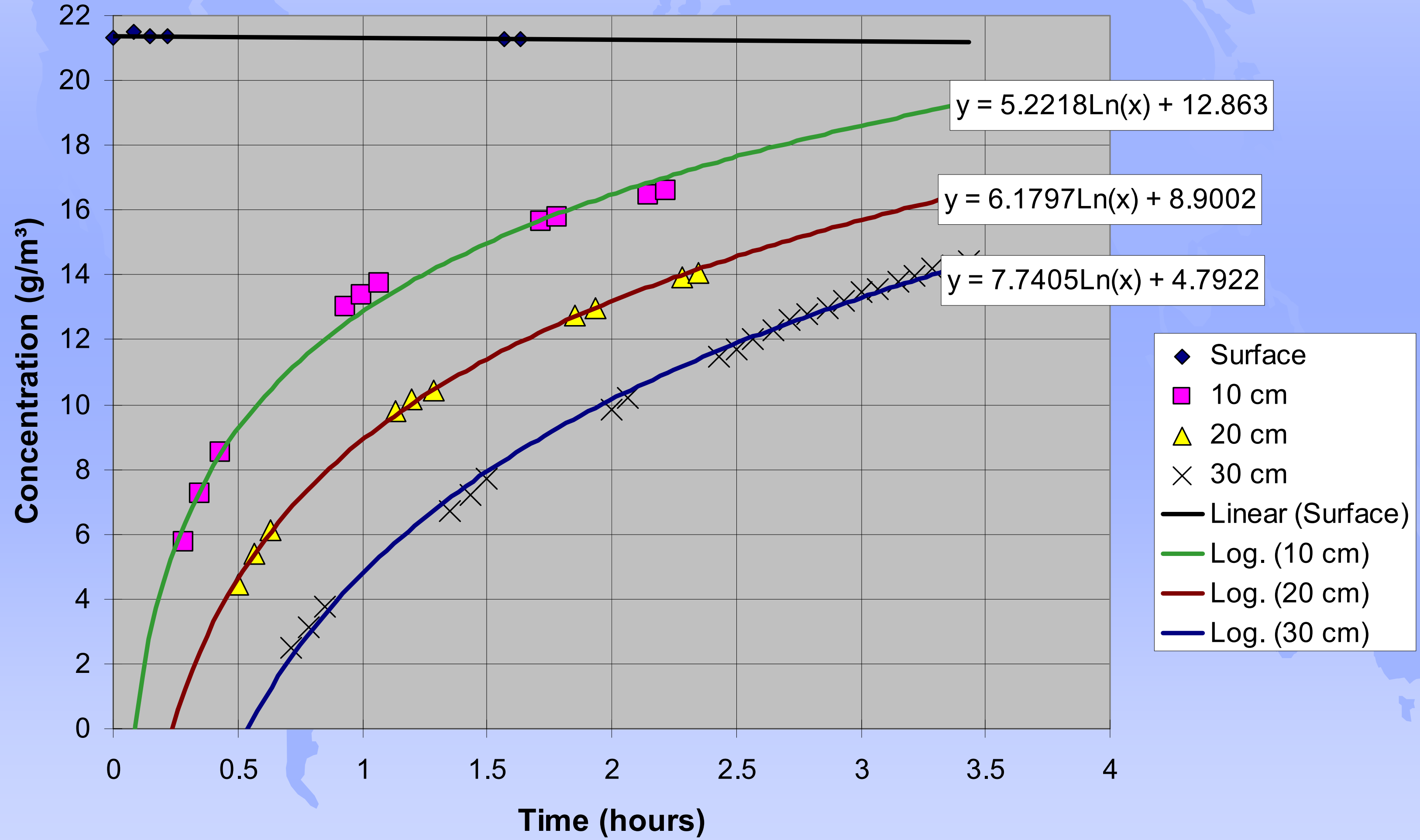
Penetration of methyl bromide (20 g/m^3) into flour at various depths at 21.2°C with air movement



Penetration of SF into flour at various depths in a chamber dosed with c.20g/cu.m at 28°C, with air movement



Penetration of SF into flour at various depths in a chamber dosed with c.20 g/cu.m at 18ºC, with air movement



PROPERTIES: The permeability of various sheeting and other materials to SF and MB

Material under test	Permeability to sulphuryl fluoride ($g\ h^{-1}\ m^{-2}$)	Permeability to methyl bromide ($g\ h^{-1}\ m^{-2}$)
LDPE	0.21	50
VIF	0	0.15
Gloss Paint	0.01	14.4
Emulsion Paint	No barrier	No barrier
Floor Tile	0	0
Plywood	No barrier	No barrier

PROPERTIES: Laboratory tests on the effect of sulphuryl fluoride on copper and computer equipment

Equipment	Accrued Ct product ($g.h/m^3$)	Temperature (^oC)	Relative humidity (%)	Effect
Copper tubes	3,300	20	70	None
	3,300	40	50	None
	3,300	40	100	Discoloration
Computers	22,000	50 +	50	None

PROPERTIES: Sorption of sulphuryl fluoride

- Sorption on to flour and grain less than a tenth that of methyl bromide

- Sorption on to structural materials negligible
- Heavy gas (vapour density 3.52) but low boiling point (-55.2^{o}C)
- Airing off after treatment is rapid
- No evidence of taint so far

Practical requirements for successful use of sulphuryl fluoride in mills

- Temperatures above 25^{o}C to speed insect development so that 24-h exposures are long enough to bridge the tolerant stage in eggs

- A good seal on the structure (gas half-loss times of at least 8h) to minimise the amount of gas required for the fumigation
- Maintenance of concentration levels above the minimum for full efficacy against eggs

Issues to be addressed to facilitate the transfer from MB to SF

- **Short exposures needed for SF to replace MeBr**
- **Insect eggs are tolerant in short exposures**
  - higher concentrations therefore required than for wood pests
- **Temperatures need to be increased in temperate climate fumigations**
  - supplementary temperature speeds development and helps to overcome egg tolerance
  - effect of high temperatures on reactivity with copper, steel and rust needed to provide adequate basis to ensure safe operational parameters for heating equipment