"Alternate Gas Fumigants"

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Fumigants have been used worldwide for many years. To be effective, fumigation should be carried out in gastight storage. The standard of gastightness is consistent with a decay of an excess external pressure from 500 Pa to 250 Pa in not less than 5 minutes in filled storage (SCA Technical Report 1980). Because of their volatility, fumigants dissipate from foodstuffs upon exposure to the open air with minimal chemical residues. However, after ventilation there is no ongoing protection from insect re-infestation.

The currently preferred fumigants are methyl bromide (liquefied gas) and phosphine (generated from solid phosphide which reacts with atmospheric moisture or liquefied gas). $ECO_2FUME^{®}$ (2 wt% PH_3/CO_2) a non-flammable gaseous phosphine fumigant was developed by BOC (Ryan and Latif, 1989) to eliminate phosphine's flammability hazard [LEL = 1.6%]. $ECO_2FUME^{®}$ has been patented (British Patent 2177004, US Patent 4.889,708) and is globally marketed by CYTEC Industries Inc. $ECO_2FUME^{®}$ will treat in excess of 12,000,000 tonne of grain in 2001 and most is used by SIROFLO®, the CSIRO Division of Entomology patented flow-through fumigation technique.

As an industrial gas company, it was predictable that BOC's initial fumigant involvement was using nitrogen and carbon dioxide. Nitrogen is extracted from ambient air and carbon dioxide is recovered from by-products from the petrochemical and fermentation industries process streams. BOC's fumigant portfolio includes Agrigas M (100% methyl bromide); Agrigas MC (2 wt% Chloropicrin; 98 wt% methyl bromide); Fumigas 900 (90 wt% ethylene oxide, 10 wt% carbon dioxide); Fumigas Non Flammable (9 wt% ethylene oxide; 91 wt% carbon dioxide).

Commodity Fumigation:
An approximate comparison of concentration and exposure time for the above fumigants is give in the table below:

Fumigant Gas / Product	Typical Concentration	Exposure Time
Nitrogen	99% min.[O_2 < 1%]	15 days
Carbon Dioxide	35% min.	15 days
ECO_2FUME [2% PH_3/CO_2]	0.04% a.c.	7 days
Agrigas M [100% CH_3Br]	0.60% a.c.	1 day
Agrigas MC [98% CH_3Br]	0.60% a.c.	1 day
Fumigas 900 [90% C_2H_4O]	0.5% a.c.	1 day
Fumigas NonFlammable[9% C_2H_4O]	0.5% a.c.	1 day
Sulfur Dioxide	0.75%	30 min

It should be noted that ethylene oxide (EtO) is not recommended for foodstuff because of concerns of potentially carcinogenic chemical residues formed such as

chlorohydrins and ethylene glycol. There could however, be application in non-food commodities eg timber.
Also with sulfur dioxide there is a concern of corrosion with some metals and should avoid contact with unprotected mild steel.

Soil Fumigation:
Fumigation with ethylene oxide can kill fungi in soil (Gennari et al 1987) using 10% EtO, 65% RH, 40^{o}C, 8 hours. The microbial analysis indicated that EtO treatment is an effective soil sterilent comparable to autoclaving and heat treatment. EtO modifies some soil parameters, but the changes are of a minor importance. There appears to be potential for EtO product as an alternative to methyl bromide in soil fumigation

Reference:

Ryan, R.F. and Latif, S.E. (1989) "Fumigant System" US Patent 4,889,708 Dec 26.

SCA Technical Report Series No.8. (1980) "Dosage Recommendations for the Fumigation of Grain with Phosphine" Standing Committee on Agriculture Entomology Committee, Canberra.

Gennari, M., Negre, M., Ambrosoli, R. (1987) Effect of ethylene oxide on soil microbial content and soil chemical characteristics. Plant Soil. 102 : 197-200.