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PRESSURE TESTS TO DETERMINE NEED FOR SHEETING LOADED FREIGHT CONTAINERS BEFORE FUMIGATION

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ABSTRACT

In Australia, before freight containers loaded with hay may be fumigated with methyl bromide (MB) without being enclosed under sheets or "tarps", compliance with a pressure test standard is required. Containers that fail to meet the standard must be fumigated under sheets. Routine pressure testing of freight containers provides rapid evaluation of the appropriate fumigation regime in commercial practice. It eliminates the need to sheet all containers, increases the number of containers that can be fumigated per day and reduces the average labour requirement per container treated.

Subjective assessment of pressure tests indicates that approximately 99% of new plywood-floored containers and 70% of new plank-floored containers meet the standard, as do more than 80% of old (3–4 years) plywood-floored containers. However, less than 10% of the old plank-floored containers — those which have made 1–2 voyages — meet the standard.

INTRODUCTION

Containerised hay consignments are regularly exported from South Australia to Japan where they are inspected on arrival to determine that they are free from insect infestation. Prior to shipment, the commodity is fumigated with methyl bromide (MB) to ensure compliance with Japanese phytosanitary requirements (de Lima *et al.*, 1994). Preshipment fumigation of containerised hay is a regular part of Australian Fumigation Pty Ltd's (AFPL) business.

The consignments are treated in accordance with the Australian Quarantine Inspection Service (AQIS) standard for MB fumigation (Anon., 1994), which requires that the gastightness of all containers be measured (and recorded) prior to fumigation (unless the containers are fumigated under sheets).

This paper briefly reports on some of the results — and the commercial implications — of pressure testing approximately 6,000 containers over a 3-year period.

MATERIALS AND METHODS

The containers used in the work reported here were all 12.2 m (40 ft) long. None were pre-selected for gastightness prior to loading. The date of manufacture on the compliance plate indicated the age of each container.

Pressure testing was done with a CONTESTOR pressure decay timer (Sharp, 1982; Sharp and Cousins, 1982). Containers were slightly pressurised (to 250 Pa) with air supplied through a specially designed manifold from a bank of compressed air cylinders. When the air supply was turned off, the pressure halving time was measured by the CONTESTOR. All pressure tests were carried out after the containers had been loaded with double-dumped hay.

In the work described here, AFPL applied the gastightness standard established by Sharp (1982) for the in-transit disinfestation of freight containers with carbon dioxide. This requires a pressure halving time from 200–100 Pa $\geq$10 sec. Containers that could not be pressurised to 250 Pa (the starting pressure for the test) at a set flow rate were deemed by AQIS to have failed the standard (de Lima *et al.*, 1994); they were therefore enclosed under gastight sheets before being fumigated.

Fumigations were carried out using MB at a dose of 44–58 g m^{-3} with a requisite minimum concentration $\times$ time (Ct) product of 200 g h m^{-3} after a 24-h exposure period (de Lima *et al.*, 1994). To ensure that the required Ct product had been achieved, gas concentrations were usually monitored only once, at the end of the exposure period. Thus, because a constant MB concentration over the exposure period (based on the reading taken at the end of it) was assumed, the Ct products reported here represent under-estimates.

MB concentrations were determined using a RIKEN™ IF 18 instrument (Gastech Australia).

RESULTS AND DISCUSSION

Since the introduction of the AQIS standard for MB fumigation, AFPL has routinely pressure-tested hay-filled containers prior to fumigation. The age of the container being treated was not recorded in all cases; where it was, it ranged from 3–82 months with pressure halving times from 11 to 85 sec (Tables 1–3). Sharp *et al.* (1986) reported that container gastightness does not deteriorate with age in any predictable way. The more recent work reported here, undertaken over the past 3 years, appears to support this observation.

Estimated Ct products, calculated from concentrations measured in containers that passed the pressure test standard after 22-, 23-, 24- and 27-h exposures, are shown in Table 1. In all cases the required 200 g h m^{-3} Ct product was easily attained. Similarly, most containers that met the pressure test standard had already achieved the target Ct product by 12–15 h after treatment (Table 2).

It should be noted that there is some indication that containers which failed to meet the 10-sec pressure halving standard could achieve the 200 g h m^{-3} Ct target at a pressure

TABLE 1
Pressure tests of hay-filled plywood-floored freight containers dosed with 58 g m^{-3} MB

Owner	Age (months)	Pressure halving time 200–100 Pa (sec)	Concentration after 22–27-h exposure (g m^{-3})	C/C_0	Ct product (g h m^{-3})
NOSU	12	11	13[a]	0.224	>286
NOSU	23	18	15.5[a]	0.267	>341
TRLU	23	31	18.5[a]	0.319	>407
TRIU	41	14	15[a]	0.259	>330
NOSU	58	16	18.5[a]	0.319	>407
TRIU	–	17	11[b]	0.190	>253
OOLU	–	19	15[b]	0.259	>345
TRLU	–	32	12[b]	0.207	>276
TRIU	34	14	15[c]	0.259	>360
OOLU	39	18	11[c]	0.190	>264
OOLU	48	14	12[c]	0.207	>288
OOLU	51	16	13[c]	0.224	>312
OOLU	82	13	14[c]	0.241	>336
POCU	–	24	16[d]	0.276	>432
CAXU	–	15	10[d]	0.172	>270
POCU	–	65	10[d]	0.172	>270
POCU	–	42	10[d]	0.172	>270
POCU	–	15	10[d]	0.172	>270

[a]22 h; [b]23 h; [c]24 h; [d]27 h. C_0 = initial dose 58 g m^{-3} MB; C = concentration after 22–27-h exposure.

TABLE 2
Pressure tests of hay filled plywood-floored freight containers dosed with 58 g m^{-3} MB

Owner	Age (months)	Pressure halving time 200–100 Pa (sec)	Concentration after 12–15-h exposure (g m^{-3})	C/C_0	Ct product (g h m^{-3})
TEXU	7	85	16[a]	0.276	>192
TRLU	15	12	16[a]	0.276	>192
NYKU	23	11	16[a]	0.276	>192
TPHU	57	12	18[a]	0.310	>216
OOLU	–	12	14[b]	0.241	>182
OOLU	–	19	16[b]	0.276	>208
OOLU	–	12	15[b]	0.259	>195
OOLU	–	14	17[b]	0.293	>221
CRXU	–	18	13[b]	0.224	>169
OOLU	3	17	16[c]	0.276	>240
OOLU	3	22	12[c]	0.207	>180
OOLU	5	20	16[c]	0.276	>240
OOLU	10	16	15[c]	0.259	>225
OOLU	34	22	18[c]	0.310	>270

[a]12 h; [b]13 h; [c]15 h. C_0 = initial dose 58 g m^{-3} MB; C = concentration after 12–15-h exposure.

halving time of 6 sec. This is shown in Fig. 1, where final Ct products are plotted as a function of pressure halving times. The figure includes data from de Lima *et al.*, (1994) and from Table 3 adjusted to an initial MB dosage of 58 g m^{-3}. Some of those containers that passed the 10-sec pressure test, monitored at 12–15 h after dosing, had still not achieved the required Ct product but would be expected to have done so at 24 h. On the other hand, of 12 containers that failed the 10-sec pressure test (see Tables 1–3), five failed to achieve the required Ct product of 200 g h m^{-3}.

De Lima *et al.* (1994) suggest that a pressure halving time from 200 to 100 Pa ≥6 sec is sufficient to allow containers loaded with hay to be fumigated with MB without enclosing them under sheets. They recommend adoption of this period as the standard in this specific application. Because AFPL was obliged to work to a 10-sec pressure halving standard, the limited data in this work, obtained in this range of the pressure test, do not substantiate this suggestion. However, de Lima (pers. comm.) has indicated that the recommendation is supported by the results obtained from a series of objective pressure tests.

AFPL's subjective assessment of the pressure tests it has undertaken has indicated that approximately 99% of new plywood-floored containers and 95% of old (3–4 years) plywood-floored containers passed the pressure test. Failure of old containers to pass was usually associated with gross structural damage. Only about 70% of the new plank-

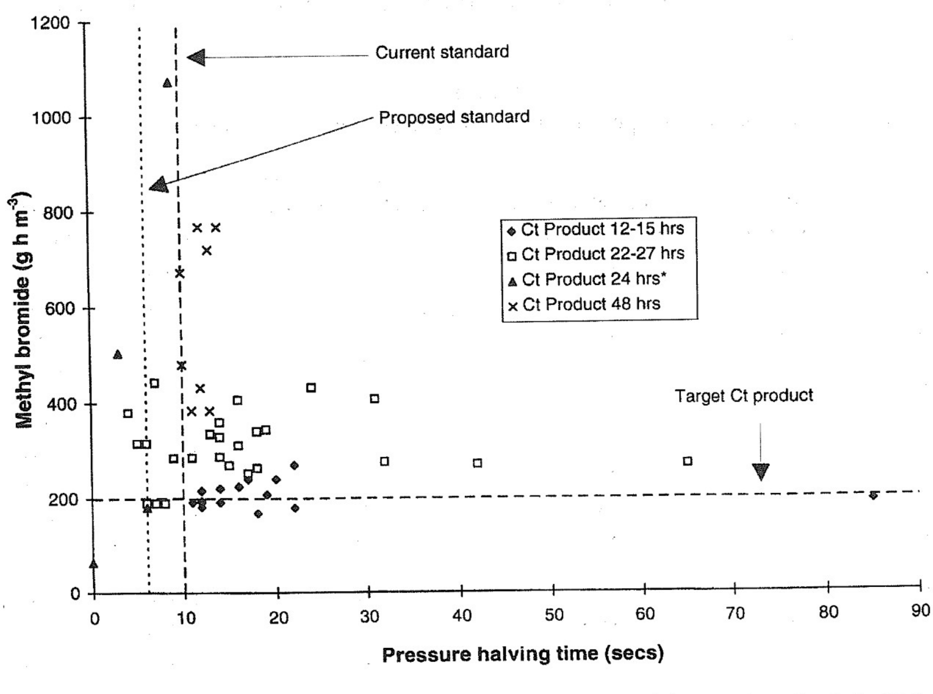

Fig. 1. MB Ct products as a function of pressure decay testing of freight containers loaded with hay.

TABLE 3
Pressure tests of hay-filled plywood-floored freight containers (age unknown) dosed with 44 g m^{-3} MB

Owner	Maximum pressure achieved (Pa)[1]	Pressure halving time (sec)	Concentration after 24-h exposure (g m^{-3})	C/C_0	Ct product (g h m^{-3})	Ct product (g h m^{-3}) corrected[2]
YMLU	120	4	12	0.272	>288	>380
TPHU	150	5	10	0.227	>240	>316
YMLU	150	6	10	0.227	>240	>316
YMLU	150	6	6	0.136	>144	>190
TRIU	200	7	14	0.318	>336	>443
YMLU	180	7	6	0.136	>144	>190
YMLU	180	7	6	0.136	>144	>190
INBU	200	9	9	0.205	>216	>285

[1]Reason for not taking pressure test to 250 Pa unknown. [2]Dosage corrected to 58 g m^{-3}.
C_0 = initial dose 44 g m^{-3} MB; C = concentration after 24-h exposure.

floored containers passed the pressure test; passing depended on the sub-floor treatment. After 1–2 voyages, only <10% of "old" plank-floored containers met the pressure test standard. It should be noted that the undersurface of some new plank-floored containers had been treated with tar (or a similar material) that enhanced the pressure test results on them in comparison to the results on those not treated in this manner. The pressure-enhancing effect is lost after 1–2 voyages because the planks "work" under the weight of the vehicles used to stow cargo in the containers (and subsequently the weight of the cargo itself). This "working" appears to open the seal between the planks. It has also been noticed that gaps open up between the planks when they shrink. The difference we observed between plywood and plank-floored containers in gastightness confirms the observations made by Sharp and Banks (1980) that plank-floored containers can leak extensively through the floor.

Overall, the results of the pressure tests reported here would seem to be favourable, in the long-term, to the adoption of a carbon dioxide technique for in-transit disinfestation of commodities in plywood-floored freight containers (Banks, 1988).

In commercial fumigation practice, use of the CONTESTOR has provided AFPL with savings in labour and time. Using a CONTESTOR, a 2-person fumigation team working at 3–4 different container yards is able to fumigate 25 containers in a 6-h shift, whereas without this instrument the time required for this work could be 8–10 h. In situations where containers are frequently not available until midday, or later, this becomes advantageous. Where large numbers of containers have to be treated, those meeting the pressure test are fumigated immediately while those that fail are sheeted and treated later by a second team.

CONCLUSION

Freight containers loaded with hay can be effectively pressure-tested under commercial conditions to determine their level of gastightness. Those that meet the standard (a pressure halving time from 200–100 Pa ≥10 sec) can be fumigated without being enclosed under sheets and are able to achieve a target Ct product of >200 g h m^{-3} after a 24-h exposure period.

Plywood-floored containers were assessed as more gastight than were plank-floored ones, and they retained their gastightness longer than did those with plank floors.

In commercial fumigation practice, pressure testing has provided savings in terms of both labour and time.

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