Development of methane–releasing permeation devices for intraruminal use

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For the past decade, methane production rate of grazing ruminants has been estimated by a tracer based technique in which the tracer (sulphur hexafluoride; SF$_6$) is released by a permeation device in the rumen and the ratio of methane and SF$_6$ in expired gas is determined (Johnston et al. 1994). While the method has been extensively used, the physical attributes of SF$_6$ gas (density and solubility) differ from those of methane so SF$_6$ is not an ideal tracer for enteric methane studies. These differences, together with SF$_6$ being a potent greenhouse gas, indicate that use of an isotopic form of methane in place of SF$_6$ would be advantageous for field studies. $^{14}$C and $^{3}$H labelled methane has been used for studies in housed animals (Murray et al. 1976) and stable isotopes ($^{13}$C, $^{2}$H) could potentially be used in the field.

Methane has a low boiling point and a high vapour pressure, relative to SF$_6$, so the constant release of SF$_6$ from permeation devices cannot be presumed to occur for methane. Two brass permeation tubes (internal volume 2.7 ml) with Teflon™ permeation membranes (125 µm, 7 mm diameter) at each end were constructed. With the lower membrane installed, each tube was cooled in liquid nitrogen and approximately 1500 ml of methane gas injected over a period of 4 minutes. The lower membrane installed, each tube was cooled in liquid nitrogen and approximately 1500 ml of methane gas injected over a period of 4 minutes. Methane that liquefied in the tubes was then trapped by fitting and tightening the upper membrane. Both membranes were repeatedly tightened on removal from liquid nitrogen. Tubes were incubated at 39°C and change in weight of the tubes was measured for 24 days (Figure 1).

The daily release rate of methane was not constant as had been found for SF$_6$ permeation tubes (Lassey et al. 2001), but declined at 2.3% to 2.6% of the initial rate of methane release each day. The rate of decline was strongly linear ($r^2 = 0.9 - 0.94$) which suggests that the release rate while the permeation tube was in the rumen could be adequately predicted from a preliminary (gravimetric) calibration period, with the standard error of the regression coefficient being less than 3% of the mean slope.

