DEPOSITS IN CYCLOPROPANE FLOWMETER TUBES

Sir,—The suppliers of cyclopropane receive occasional reports of the appearance of grease or oil in cyclopropane flowmeter tubes. The problem arises when a user turns on the cylinder valve and flowmeter control on a Boyle apparatus and notices the bobbin sticking in the tube. A sticking bobbin may be the result of static electrical charges (Clutton-Brock, 1972), but the observation of grease or oil on the inner surface of the tube often suggests an alternative explanation. This occurrence may lead to grossly inaccurate monitoring of the flow rate and is potentially dangerous, although as far as is known, there has not been any adverse effect on patients.

On occasions when this oily deposit has been observed, the cylinder and its contents have been examined closely, particularly for the presence of non-volatile constituents. So far there has been no report of greasy material in the cylinder. When there has been sufficient cyclopropane in the cylinder for full analysis, it has invariably complied with the normal standards of purity, including those given in the British Pharmacopoeia (1974). All cyclopropane cylinders are de-valved routinely and examined internally on being returned to Imperial Chemical Industries Ltd, before being refilled, and no oil or grease is used in the process of reassembly. It should be noted also that cyclopropane does not show any tendency to polymerize on storage. It is concluded therefore, that impurities in the cyclopropane, grease in the cylinder or polymerization of the cyclopropane may be discounted as possible causes of grease or oil appearing in flowmeter tubes.

Analysis of these oily deposits has indicated the presence of hydrocarbons and alkyl phthalates. Examination of the tubing taken from an affected Boyle machine then reveals that the presence of the oily deposits results from the materials used in the construction of the tubing, associated with the sequence of events which occurs when the cyclopropane cylinder is turned off. Some older machines, which may still be in use, and some older laboratory installations have tubing containing rubber or flexible plastic. The latter comprises usually polyvinyl chloride plasticized with dinonyl phthalate. This plasticizer is readily soluble in cyclopropane which, as a hydrocarbon, has also a strong affinity for rubber.

Both kinds of tubing are largely unaffected by gaseous cyclopropane at or near atmospheric pressure when exposed intermittently for a few hours, as in normal anaesthetic practice. However, if liquid cyclopropane enters the gas tubing and remains as liquid for a sufficient time, constituents of the tubing may be dissolved in the liquid cyclopropane, leading subsequently to the formation of oily deposits when the cyclopropane evaporates. For this reason, the sequence of events in turning off the supply of cyclopropane is important, particularly when a separate control tap is fitted to the base of the flowmeter unit and reinforced rubber or plastic tubing is provided for connecting to the cylinder. If the user turns off the flowmeter control first and then closes the cylinder valve, or forgets to do so, the tubing will contain cyclopropane at full cylinder pressure (that is 4.5 kgf/cm\(^2\) gauge at 15 °C (59 °F) or 65 lbf/in\(^2\) gauge). On standing, if there is a reduction in ambient temperature, liquid cyclopropane may be deposited. Contaminating materials then may be extracted from the tubing. On subsequent use of the apparatus, the liquid may be driven from the tubing into the flowmeter tubing carrying the tubing extract with it. The cyclopropane would then evaporate, leaving an oily deposit.

Modern anaesthetic apparatus has metal connecting tubes between the flowmeter unit and the cylinder, so that no extraction of tubing ingredients can occur. Moreover, the process of electroplating the metal tubes involves elaborate degreasing and washing procedures which clean them completely at the time of manufacture. However, there is still the possibility of traces of contaminants being carried through to the flowmeter tube by liquid cyclopropane if this is present in the connecting tubes at any time. Grease should never be used in pipe unions.

The above considerations suggest that the remedy for this particular problem is to ensure that, after use, the cyclopropane cylinder valve is turned off first and any pressure released at the flowmeter control so that the cyclopropane remains at ambient pressure. This should ensure the absence of greasy deposits, but there is, of course, the possibility that previous misuse of the apparatus may result in deposits appearing some months afterwards.

It should be noted also that a slow leak from the cylinder valve after closure, resulting from either a leaky valve or inadequate force used in closing the valve, could cause an increase in pressure in the tubing. If the cylinder is not required for some time, it is therefore better to remove the cylinder from the anaesthetic apparatus.

In summary, the following recommendations are made to avoid the formation of oily deposits in flowmeter tubes:

1. Metal tubing should be used whenever possible between the cyclopropane cylinder and the flowmeter block.

2. The cyclopropane flow should be stopped by turning off the cylinder valve first. The flowmeter control should then be closed. If the cyclopropane cylinder is not in frequent use it should be disconnected from the apparatus.

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REFERENCE