caboose (Figure 3) where the electrical controls are also housed. However, the low pressure hydrogen store is located in an adjacent section. The whole caboose is sledge mounted and it is hoped that by frequently moving this around burial in the snow will be prevented.

Johnson Matthey Equipment

The steady growth in business based upon the palladium diffusion process led first to the formation of a small business group and more recently to the founding of a commercial company—Johnson Matthey Equipment Limited—whose main business is in on-site hydrogen generators. However, activities include the supply of small laboratory purification equipment with hydrogen outputs ranging from 28 litres per hour through to modules with outputs up to 56 cubic metres per hour. These may be linked together to form a much larger piece of purification equipment, but generally the modules are installed separately, just prior to the work station in order to reduce the risk of the pure gas becoming contaminated.

The development of on-site hydrogen generators has progressed from the first small units used to fill civil meteorological balloons to military units capable of producing 4.2 cubic metres per hour in almost any climatic condition. The market for civil on-site generators has grown steadily and many G10 units ($10m^3$/h) and a smaller number of the newer G25 units ($25m^3$/h) operate in industries as diverse as electronic device manufacture, alternator cooling in power stations, tungsten heat treatment, and in many others where merchant hydrogen has proved too expensive or where the supply is uncertain. Additionally a G50 module ($50m^3$/h) is to be introduced in the near future.

The commercial success of these generators depends largely upon their low operating costs, which enables hydrogen to be produced at a cost significantly below that of gas delivered in cylinders; this accounts for the short payback times for these generators. Compact size and near automatic operation are additional benefits while the purity of the hydrogen produced, at 99.9999 per cent, is a further bonus. Typical installations are shown in Figures 4 and 5.

Extending the Product Range

Following on the successful use of silver-palladium alloy for hydrogen production and purification, the manufacture of a range of equipment using a palladium on alumina catalyst has been started. This equipment removes oxygen from hydrogen gas streams that contain oxygen, or hydrogen from oxygen gas streams. The "Oxygone" range of equipment, as these units are called, represents a further broadening in the range of products offered by this new company, which is dedicated to the promotion of equipment utilising the remarkable physical and chemical properties of the platinum group metals.

References

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Hydrogen Storage for Vehicles

Hydrogen may be used as the fuel in suitable internal combustion engines and the possibility of using it to power motor vehicles is being considered. However, a major problem is that of storing the hydrogen in a compact, convenient form. A solution may be to use hydrogen to hydrogenate benzene to cyclohexane, which can be distributed in much the same way as petroleum products. The motorist would fill the tank of his vehicle with hydrogenated hydride, from which hydrogen would be released by an onboard catalytic dehydrogenation reactor.

Success could depend upon the dehydrogenation step, an endothermic reaction which is reversible. A report of a simulation study for a palladium on alumina catalyst indicates that a dehydrogenation reactor for cyclohexane is feasible, at least in theory (A. Touzani, D. Klvana and G. Bélanger, *Int. J. Hydrogen Energy*, 1984, **9**, (11), 929–936). Heat normally dissipated by the cooling system could be transferred to the reactor by a system of heat pipes, and would compensate for the endothermicity of the dehydrogenation reaction.