New Guinea in prehistoric times when Torres Strait was shallow and dry — such conditions existed as recently as 8000 years ago.

Like most fruit-eating birds, cassowaries are attracted by the bright orange and red colours, not the smell, of fruits. Bats, which also act as important dispersers of rainforest seed, more often eat dull-coloured fruit. They are attracted to the musty or turpentine smell of these fruit. No large mammals eat the native fruit from this region of northern Queensland. Man is the only possible contender, and his taste usually stops at bananas and mangoes.

Mary Lou Considine

Seed dispersal by cassowaries (*Casuarius casuarius*) in north Queensland's rainforests. G.C. Stocker and A.K. Irvine. *Biotropica*, 1983, **15**,170–6.

A 'sauna' for cheap, efficient heat storage

At the CSIRO Division of Energy Technology, Dr Don Close has devised a heat store, much like a rock-filled sauna, that promises to be much cheaper and more efficient than existing types. As well as being useful in industry, his design could find favour for solar-powered electricity-generating schemes in which concentrating collectors produce the steam.

Industry often needs heat at temperatures above 100°C — and up to 300°C. To minimize the size of the boiler installation, it commonly uses some type of heat store to even out the intermittent heat demand and match this to the continuous rating of the boiler supply.

At the moment, the most attractive techniques for high-temperature heat storage involve either accumulating steam in high-pressure cylinders (at perhaps 100 atmospheres pressure) or storing heat at atmospheric pressure in a tank filled with rocks and a high-boiling-point oil. The former has the disadvantage of an expensive high-strength container. The latter suffers from poor efficiency due to the poor heat-transfer properties of oil, which means that large heat exchangers are needed.

The cost of the heat store is an important consideration in minimizing the total cost of a system, particularly in the case of a solar set-up. The heat store's efficiency — the proportion of heat input that can be extracted when it is needed — is a vital factor for a solar system. This is because the store invariably costs less than the solar collectors, so any quantity of heat that it loses needs to be made up by an enlarged area of collector.

Dr Close's heat store operates at atmospheric pressure, yet it conducts heat in and out easily, giving a high operating efficiency at low cost. A 3-m-deep store could be fully charged or discharged in only 5 hours, a much better performance than currently used heat stores can manage unless they have help from large expensive heat exchangers.

The diagram shows how it's done. A tank is filled with rocks and a small quantity of liquid (water in the present experimental scheme). Heat fed in at the bottom of the store, through a simple heat exchanger, vaporizes the liquid; the vapour then carries the heat to the bulk of the store with the assistance of — and this is important — the gas (air) also present in the tank. Heat is extracted from the top of the tank when needed through another similar heat exchanger.

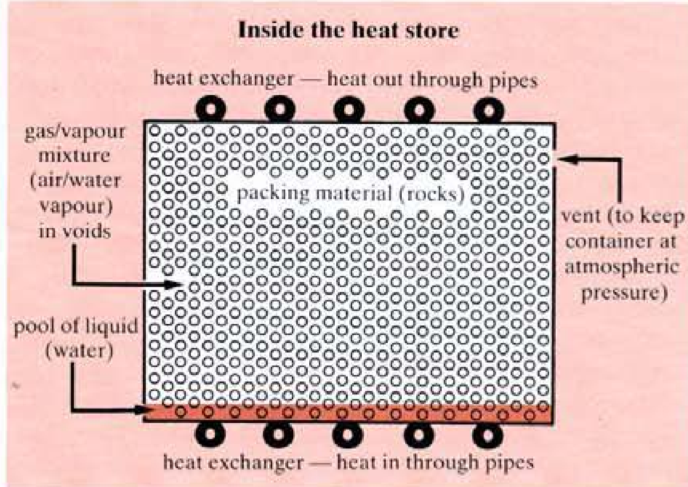
In effect, heat transfers through the system in the same way as it does in a sauna. The system also bears close similarity to much smaller devices known as 'heat pipes'.

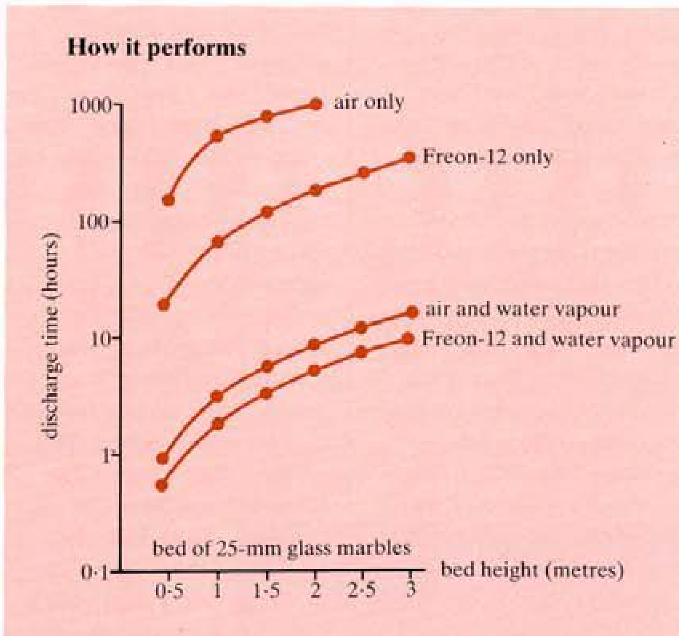
These metal rods employ the fast diffusion of a vapour sealed inside them to quickly conduct heat from one of their ends to the other. They are commonly used to draw heat away from confined electronic components, and have even been proposed, on a larger scale, as heat stores because of their excellent conductivity of heat. The drawback, of course, is that these devices are sealed, so they must be built to withstand high pressures (at high operating temperatures) and a near-vacuum (at low temperatures).

Dr Close's inspiration was to wonder how a leaky heat pipe would behave. A vent would allow operation at atmospheric pressure, and any lost working fluid could be replaced.

When he applied the theory of heat and mass transfer to this situation he was surprised to find that the air mixed with the vapour could actually assist in the conduction of heat. The difference in density between the gas and the vapour provides a buoyancy effect

Heat supplied to the bottom vaporizes water, and steam (and air) carry the heat quickly throughout the packing material. A vent keeps the container at atmospheric pressure.





The graph shows estimated times to discharge 80% of the store's energy (a measure of its heat conductivity) for various gases and vapours. Use of a condensing vapour (water vapour) increases heat conduction considerably.

The experimental heat store: a tank filled with glass marbles, some water, and air. It's heated by electricity at the bottom, and crisscrossed by temperature sensors.

that enhances convection and heat transfer in the system.

Experiments with a small-scale model, and a tank nearly 2 metres in diameter and 0·5 m high, have confirmed the theoretical predictions. The tank was filled with glass marbles (used in this instance because of their known size and properties: normally it would contain inexpensive rocks).

The relation between the molecular weights of the gas and the vapour is an important factor — they should differ considerably, to enhance the convection due to buoyancy effects — and Dr Close calculates that using dense Freon-12 gas instead of air could improve conductivity two- to three-fold. However, you would then need a controlled gas release and make-up arrangement to recover the expensive Freon-12.

You would need a similar elaboration if you used a liquid other than water. The choice of liquid depends on the desired operating temperature of the store. It helps to run the system at a temperature as close as possible to the boiling point of the liquid, for this maximizes the amount of vapour carried in the mixture.

Further experiments are in progress at the Division to look at the detailed behaviour of the system. These need to determine, for example, the behaviour of different gas and vapour mixtures, and how packing material and shape affect performance. The influence of the tank's geometry is another question to be worked out.

Nevertheless, Dr Close can see few obstacles to the setting up of a practical system. The day of cheap, efficient heat storage appears not far off.

Andrew Bell

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