TEMPERATURE RISE OF THE ATMOSPHERE BY AN INDUSTRIAL DRY-COOLING SYSTEM

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Thermal engines are mankind's primary means of energy transformation (e.g. the conversion of fossil fuels to electrical energy) and require cold reservoirs to dispose of waste heat, the major depositories being large bodies of water and the atmosphere. With regard to the atmosphere as an industrial heat sink, nearly all systems in current use are wet cooled and consequently most of the waste energy is carried to the atmosphere as latent heat of evaporation of water. In many parts of the world, industrial water resources are becoming scarce and consequently the transfer of waste heat to the atmosphere via dry-cooling systems is being contemplated and a few small systems are already in use. Dry-cooling systems transfer all their energy to the atmosphere as sensible heat, and the resulting temperature rise may have a significant disturbing influence on the environment.

A limited amount of experimental work has been done to gain an insight into the effects of large thermal releases in the atmosphere, for example, in France artificial heat sources of up to 8000 MW have been operated for short periods and have produced effects such as elevated temperatures and artificial clouds. However, an opportunity to study continuous large thermal releases has become available with the construction of a forced draught dry-cooled thermal electrical power station (Matimba) in the almost virgin industrial environment of the northern Transvaal near Ellisras. Once the power station is fully operational, it will generate just over 7300 MW of sensible waste heat, at nearly 300 times greater than the mean solar flux of the earth's surface. Under calm wind conditions, the creation of a surrounding bubble of warm air, a so-called 'heat island', is relatively straightforward and the end effect is a general increase in ambient atmospheric temperature. In the presence of wind, the effect is more complicated. However, a simple order of magnitude calculation uder a moderate wind indicates that the atmospheric temperature could rise by as much as 8°C in the vicinity of the power station. This may have a significant effect on the environment, especially as in this case the day and night mean summer temperature is about 26°C. Moreover, overall efficiency of the power station decreases with increase in ambient atmospheric temperature. Therefore, apart from possible detrimental environmental effects, the temperature increase produced by the power station may feed back to the cooling system and consequently lower the power station effeciency.

Both the abovementioned simple model, and a more complex theoretical study using a second order closure model (Rao and Hosker, 1978), have predicted temperature rises of the order of 8°C. It has been stated by Mey *et al.* (1980) that "The most satisfactory method to assess the atmospheric effects of heat release is direct measurement .... but no experiment has been carried out to study the effects of dry-cooling towers". In order to measure an atmospheric temperature rise, eight field stations have been installed around the Matimba power station: five about 10 km distant, two within about 1 km from the power station, and one at 120 m above surface on the power station roof. Each surface station measures wind at 10 m and temperature at 1.2 m and 9 m height. Given the temperatures at these two heights, it is possible to extrapolate the data to obtain a measure of the vertical temperature fields to a useful degree of accuracy under winter nocturnaditions (Surridge, 1984). The data presently being accumulated will provide a comparative base for when the power station is first activated in 1986 and becomes fully operative towards the end of the decade, at which time the temperature rise phenomenon can be studied in detail. Present results have indicated that the mean atmospheric temperatures near the surface are similar throughout the region under consideration. For example, the standard deciation of the mean temperatures measured at five sites in the region is approximately 0.7°C during the winter and slightly less during the summer. This indicates a relatively homogeneous environment which will benefit the final data analyses by making more visible any increase in ambient temperature caused by the power station.

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