



# Evaporative Cooling

## Chosen for energy efficiency

When Summer Temperatures are typically 46.c. The need for indoor cooling is obvious. A new tobacco processing plant in Tete. Mozambique has therefore installed evaporative coolers of energy efficient spot/comfort cooling.

By Elizabeth Abeno

Grinaker -LTA Zimbabwe and four other construction companies were invited by Mozambique Leaf Tobacco Export to submit tenders for the design and construction of a tobacco processing facility in Tete, northwestern Mozambique, in February 2003.

The design had to consider harsh local climatic conditions. The brief also innovation would, in addition to price, play an important part in the tender review and award. Grinaker-LTA Zimbabwe selected a team of consultants comprising Arup Africa and Architects Workshop (a Harare-based architectural practice) and a fixed price lump sum bid was submitted in April 2003.

After several months, during which a number of additional buildings were incorporated in the projects, the client obtained final approvals from various Mozambican government departments and Mozambique Leaf Tobacco Import Export and Grinaker-LTA Mozambique signed an agreement on October 24, 2003 for the design and construction of the project. This included the design

and construction of a processing factory (65 000 m<sup>2</sup>); double storey office block (31 000m<sup>2</sup>); entrance complex with clinic, changing rooms and training facilities (3 400m<sup>2</sup>); residential houses, school, roads, sewers, water reticulation with boreholes 3km from site; and a 500-million £ reinforced concrete reservoir.

The site is enclosed by 4 km of electrified security fence. The International Federation of Consulting Engineers turnkey projects conditions of contract have been used. The project was due for completion in sections. The first was set for completion by November 17, 2004 and overall completion by May 16, 2005. The client processed the first tobacco through the factory in mid-2005 – less than two years after the contract was awarded. The development presented many challenges, ranging from the remote location and difficult climatic environment to additional risks associated with the fixed price 'design-and-build' concept run by Grinaker-LTA.

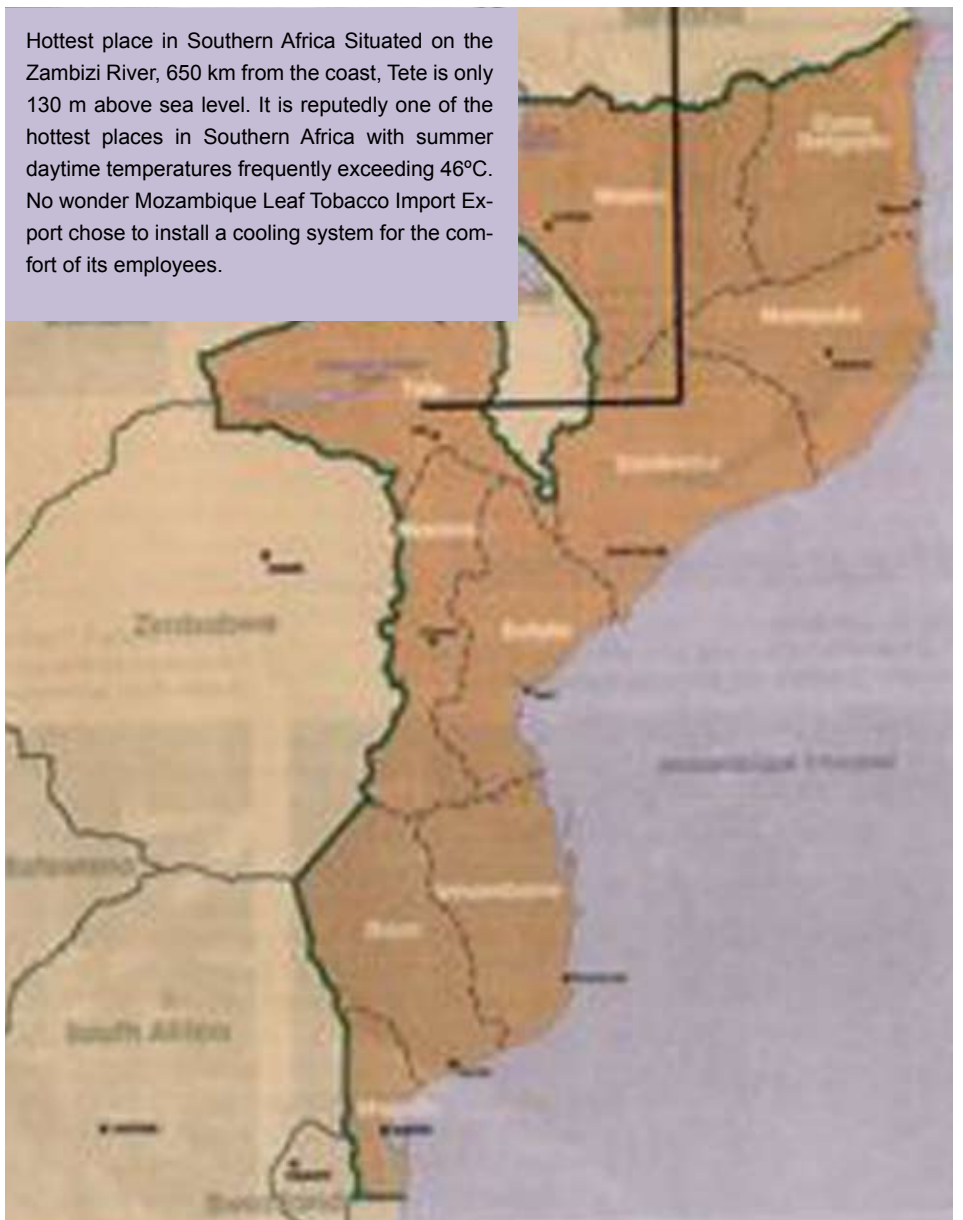


## Spot/comfort cooling required

According to Fabio Fedetto of Mozambique Leaf Tobacco (MLT), the main function of the evaporative cooling in Tete is the spot/comfort cooling of areas in the factory with high concentrations of employees (due to high ambient temperatures throughout the year). In fact, this is what the positioning of the units was based on. There is another small advantage in that the coolers do increase the relative humidity (rh) within the factory but, due to the physical size of the Tete factory, versus the number of evaporative coolers installed, this increase in rh has a little or no effect on the processing of tobacco.

Conventional air conditioning in a single open space would be by means of central ducting leading to several louvers. In order to reach the area where people work, the ducting was pass over large unpopulated areas. Since a large part of the building is used for storage of tobacco, there is no need to cool those areas – this is a situation in which several units, operating in a decentralized arrangement, works well. The firm of consulting engineers on the construction project, Arup, considered evaporative cooling in some detail although the final design and installation was handled by Modern Products of Cape Town.

Hottest place in Southern Africa Situated on the Zambizi River, 650 km from the coast, Tete is only 130 m above sea level. It is reputedly one of the hottest places in Southern Africa with summer daytime temperatures frequently exceeding 46°C. No wonder Mozambique Leaf Tobacco Import Export chose to install a cooling system for the comfort of its employees.





## Evaporative cooling offers advantages

Evaporative cooling is not seriously hi-tech. Evaporative coolers have a low first cost, use a lot less electricity than conventional air conditioners and do not use refrigerants, such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) that can harm the ozone layer. There are two types of evaporative coolers: direct and indirect (called two stage).

At this facility, the direct evaporative cooling system installed has 127 cooler units, which are bottom-discharge, roof-mounted with dropper ducts and plenums. The units employed in the Tete installation – EA150 Breezair coolers with six-way distribution plenums - have the capacity to supply 10 000m<sup>2</sup> air/hour/unit, stated Chris Cottle of Modern Products. With coverage

around 80m<sup>2</sup>, this refreshes and cools an area of about 10 000m<sup>2</sup>. The drop in temperature is, of course, directly related to the humidity of incoming air – the lower the humidity, the more effective the cooling. Cooling is effected by the drop in temperature of the filtered and moistened incoming air, and is typically between 6°C and 8°C.

### Significant benefits

While the installation of evaporative cooling in the Tete tobacco plant is not required for actual processing, it is essential for the comfort of employees. It had to deviate from the model used in the company's other plants elsewhere in the world to suit specific local conditions. When the plant is operating at full capacity, the benefits of the slight positive pressure that the expanded cooling system will provide should be more significant.

## Tobacco farming

Tobacco production in Mozambique's province of Tete has more than doubled in the last three years as more and more farmers are attracted to tobacco growing, according to the country's directorate of economics in the Ministry of Agriculture. Further expansion is now focusing on helping farmers to increase fields as well as quality. In fact, tobacco production in Mozambique has grown from 1500 t in the 1996/7 agricultural season, increasing every year to reach a national production of raw tobacco of over 50 000 t in 2003/4. Over the same period, the estimated number of tobacco-growing households has increased from 6000 to more than 120 000. Burly tobacco is grown in Eastern Africa – it can be air-dried. A bundle (klompie) is dried in open pavilions. When the farmers have sold the tobacco to the processing house, it is sorted and steam-conditioned, and the pliable leaves are chopped into grades. It is then baled into 200kg bags and shipped to cigarette manufacturers. Mozambique Leaf Tobacco Company has become known as the 'unchallenged tobacco processing market leader' after Alliance One pulled out of the country in May 2006. The company's state-of-the-art factory is also reputed to be Mozambique's first tobacco processing plant and the second largest in Africa.



# Direct evaporative cooling systems

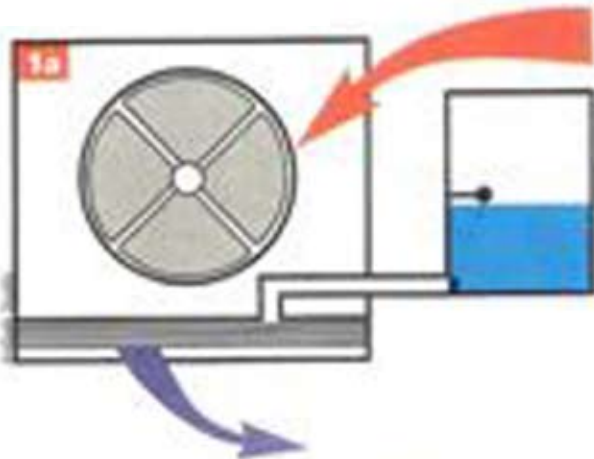
## 1. Warm air drawn from outside



A fan draws air through a permeable, water-soaked pad in a roof-mounted box. As the air passes through the pad, it is filtered, cooled, and humidified.

### 1a. More energy-efficient

Evaporative coolers use about a quarter of the electricity of conventional air conditioners. They require a supply of water to keep the filter moist. This means running a water supply to each and every unit on the roof where a 1m x 1m x 1m box contains filter media in each of the four walls and houses a water pump, water reservoir and fan. The units consume 35l To 40l of water per hour when running continuously, and the reservoir holds 60l , trickle-refilling as evaporation consumes the water. The water level in the reservoir is controlled by a ball valve. On cooler days or when humidity is high, the water pumps can be switched off so that only filtering takes place.



## 2. Cool air distributed to interior

### Air dissipation

The dissipation of incoming air is at a height of 4m above the floor in areas where people are concentrated.



### Concentrated heat load

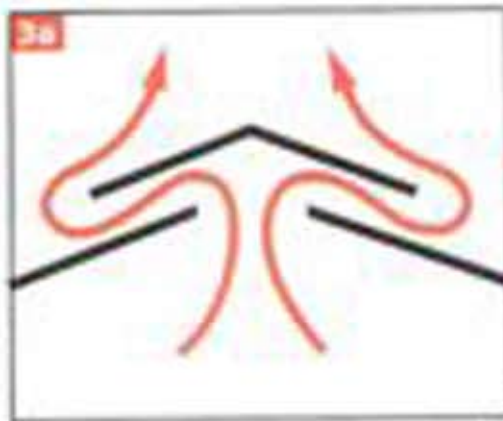
Processing machines generate lots of heat and create an uncomfortable Working environment.



### 3. Extraction of hot air



The combination of canopies and turbines enables the removal of hot air from the structure.



#### 3a. Four apexes

Extraction of warm air was incorporated into the structural design. The structure is approximately 80m wide and the roof has four apices running longitudinally. Above each of the apices is a canopy with an air gap between it and the roof itself. This design is intended to allow for natural ventilation of hot air, which rises inside the building. In addition to this canopy, wind-driven turbines have been fitted to the roof above the hottest operating machines in order to further extract hot air. The advantage of these turbines is that they don't require maintenance.

#### Phased installation



The installation of evaporative coolers in the plant was phased according to initial operating requirements: Phase 1 is complete but additional cooler installations would be simple to perform should the need arise.

