EVAPORATIVE COOLING

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1.0INTRODUCTION

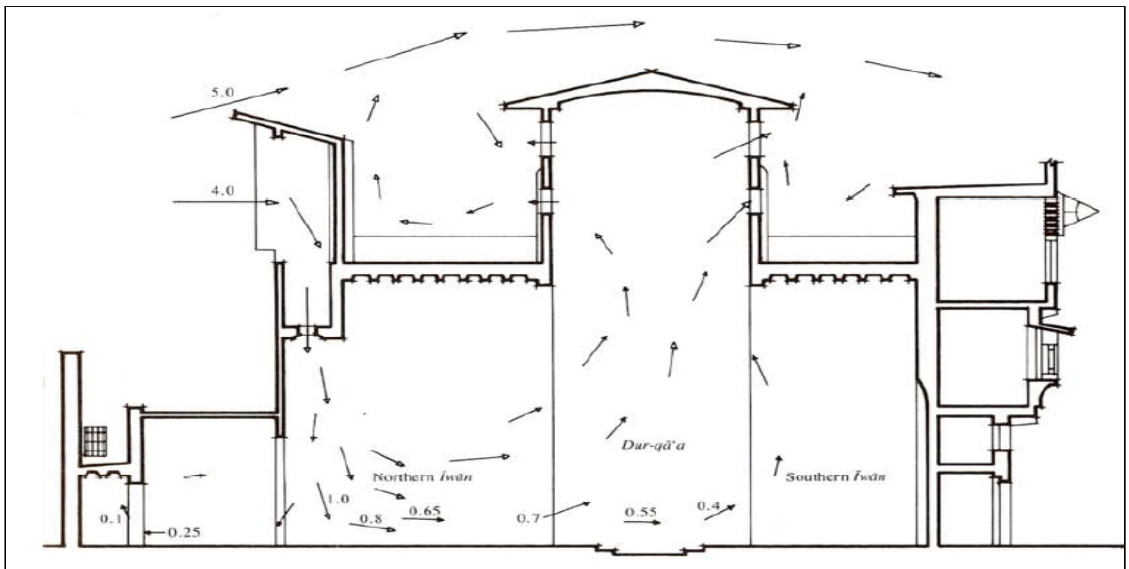
Water will evaporate if air with a lower dew point passes by. (M. Santamouris, 2007) mentioned that the process result in the conversion of sensible heat into latent heat at a constant wet bulb temperature, therefore the air not only gets cooler but also gets more humid. This phenomenon is called Evaporative Cooling it was used about a thousand years ago in vernacular architecture in the Middle East and North Africa during the era of the Islamic Empire. Some like (Hassan Fathy, 1986) even argue that it dates back to (1300 B.C.) in Egypt, he says that ancient Egyptians used wind catcher with water evaporation system as proven by drawings in tombs in Thebes (Luxor). Also Evaporative cooling was used in Hot Arid Climates by merely to put a wet cloth in front of the window to cool the breeze passing through. The technique was developed and harnessed further during the Islamic Era. (Rosa Schiano 2004) mentioned that porous pottery and clay jars were used for cooling in a system called Muscatese Evaporative cooling system.

During the last century Evaporative cooling was reused for cooling in Hot Arid Climates. As mentioned by (M. Santamouris 2007) Evaporative cooling was used and commercialized in Desert Coolers since 1920. Afterwards at 1980's Evaporative cooling was used in down draught cool tower by (Bahadori 1985) as an upgrade to the traditional wind catcher, and was upgraded and used since. Finally a recent research by the European Commission, The Nottingham University and (Rosa Schiano 2004) used modular porous ceramic cuboids filled with water and stacked upon each other in front of an opening, the stacked cuboids act as a conduct surface where the passing air gets cooler and more humid due to evaporation and convection with the leaking water, By which harnessing the Evaporative cooling.

2.0TRADITIONAL WIND CATCHERS (*MALQAF & BADGIR*)

The *Malqaf* is a: "shaft rising high above the building with an opening facing the prevailing wind. It traps the wind from high above the building where it's stronger and cooler, and channels it down into the interior of the building" (Hassan Fathy 1986). It was traditionally found in Egypt and then it started to be found around the Middle East, North Africa and far to the east until Pakistan and Afghanistan. In Iran, Iraq and countries of the Gulf it was named the *Badgir* a the same concept but instead of facing the prevailing wind it has two or even four openings to catch wind from all directions. The Wind catcher goes back to the ancient Egyptians at (1300 B.C.), it was used in a house in *Tal Al Amarna* as represented in wall painting of the tombs of Thebes (Luxor) as argued by (Hassan Fathy 1986). Then it was harnessed and developed by Muslim architects during the Islamic Empire era in the Middle East and North Africa. An Example of traditional wind catchers is the *Malqaf* at the house of *Muhib Ad-Din Ash-Shāf'î Al-Muwaqqî,* where a *Malqaf* is used to ventilate the building as shown in Figure 1.

Figure : Section of the Malqaf at the house of Muhib Ad-Din Ash-Shāf'î Al-Muwaqqî in Egypt, (Hassan Fathy 1986)



Section through the Qā 'a of Muḥib Ad-Dīn Ash-Shāf 'ī Al-Muwaqqī, showing how the *malqaf* and wind-escape produce internal air movement. Arrows indicate the direction of airflow; arrow length corresponds to airspeed. The measurements were made on 2 April 1973 by scholars from the Architectural Association School of Architecture in London. All wind and airspeeds are given in meters per second. (See p. 57.)

In some designs air captured by the Malqaf was cooled and humidified by passing over water in the basement, a Salsabil (water fountain) or porous clay and pottery jars filled with water as shown in Figure 2 and 3. By which harnessing evaporative cooling to cool air and solve the issue of the lack of humidity in Hot Arid Climates.

Figure : Sample of Malqaf using Salsabil (fountain), (Hassan Fathy 1986)

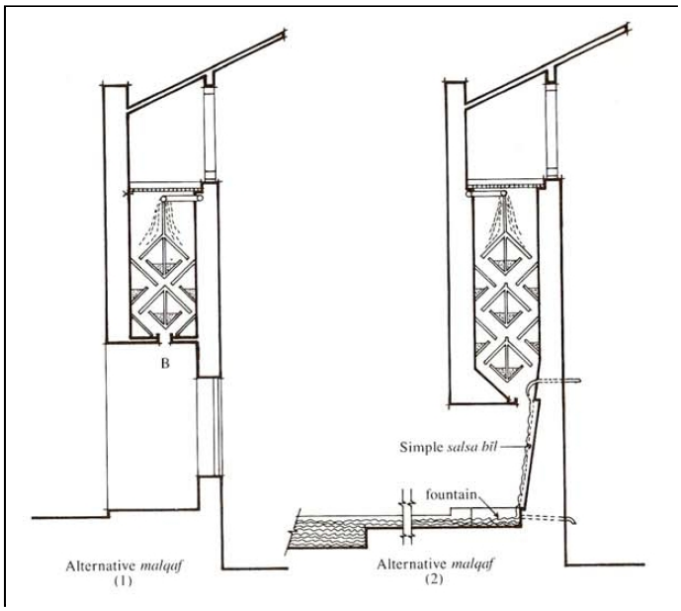
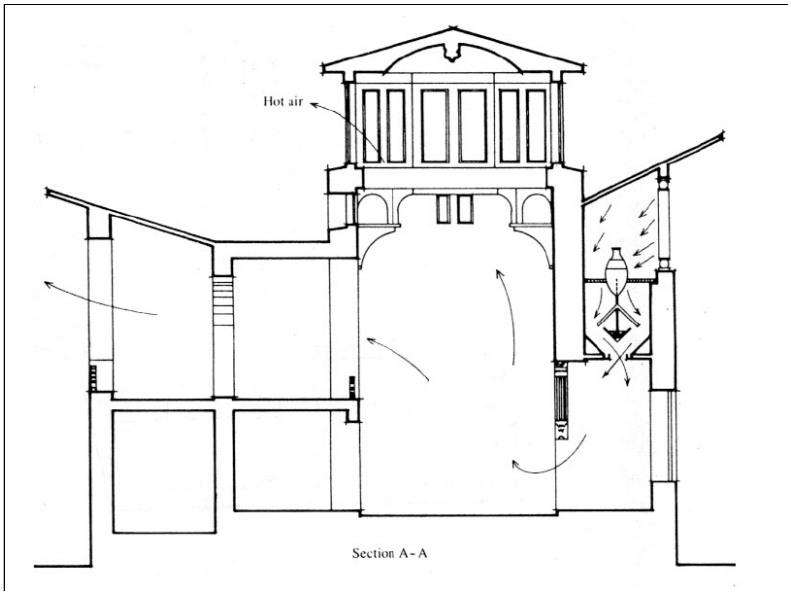
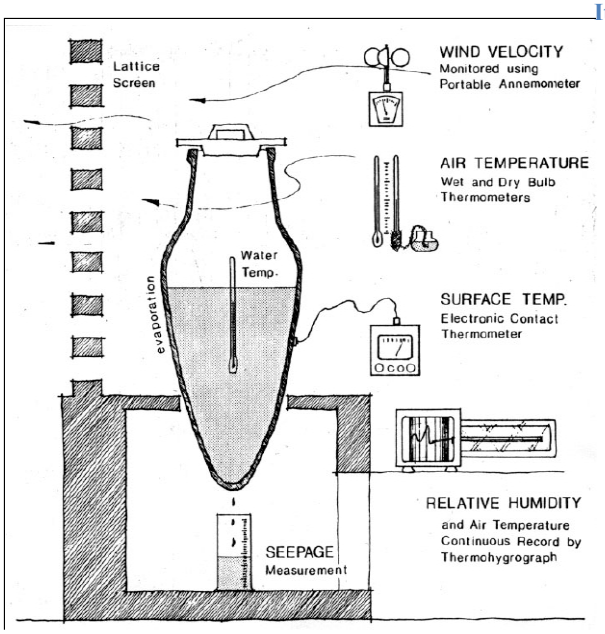


Figure : Section of Malqaf using Pottery Jars to cool Air at Maziara Egypt by Hassan Fathy (Rosa schiano 2007)

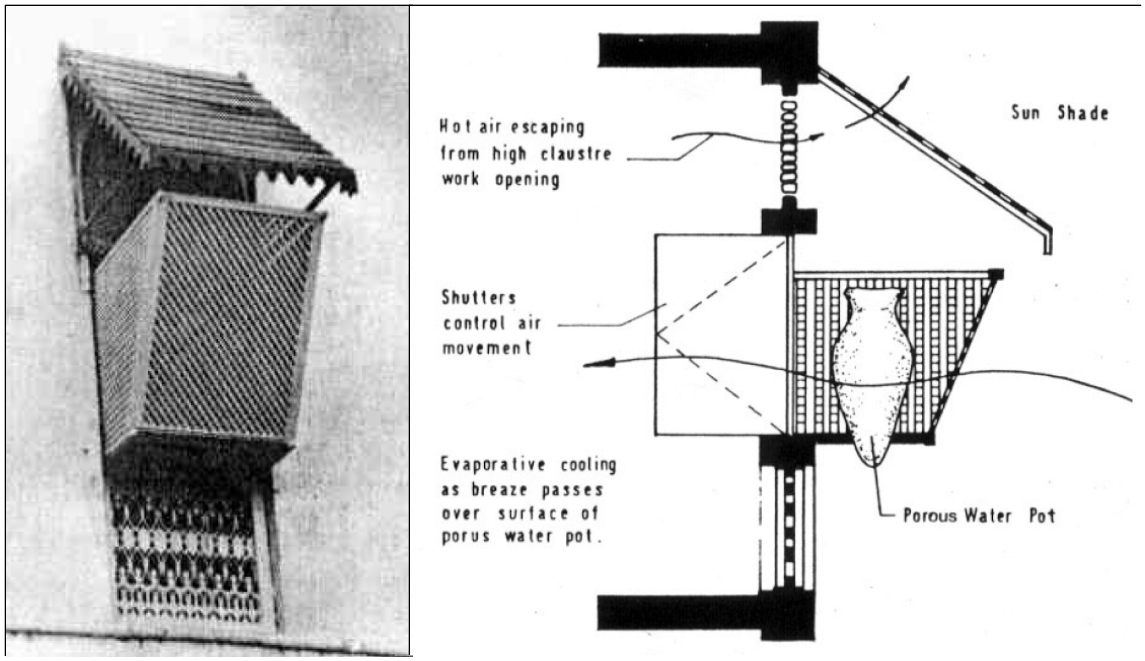


3.0MUSCATESE EVAPORATIVE COOLING WINDOW

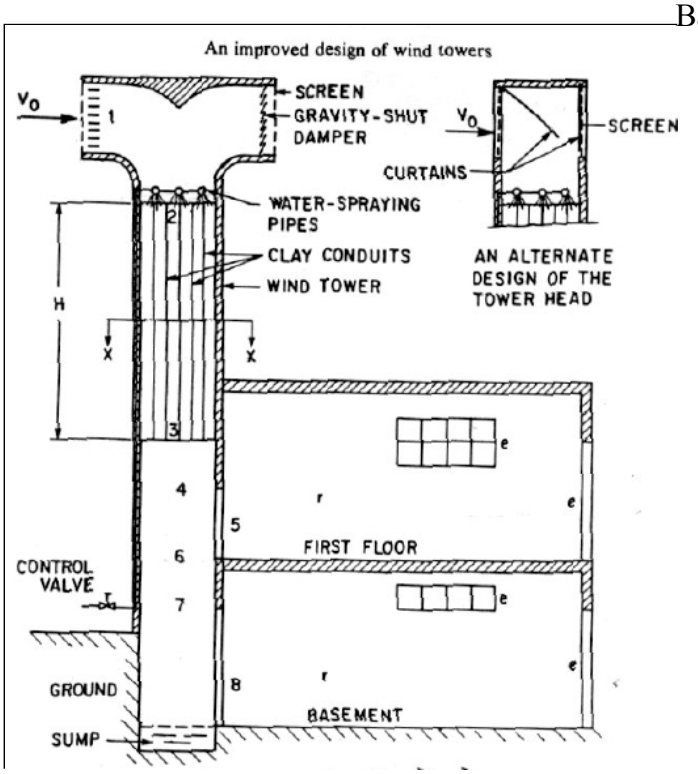


It is a *Mashrabiya* ["wooden grille or grate used to cover windows or balconies" (Andrew Peterson 1996)] containing a porous pottery or clay jar filled with water as shown in Figure 4 and 5. The system differs from the ordinary *Mashrabiya* that it is mainly used for ventilation and cooling. When air passes through the grill it passes by the porous jar, the air gets cooler and more humid due to Evaporative Cooling. By which the building is ventilated, cooled and humidified solving the three issues of Human comfort in Hot Arid Climate.

Figure : Muscatese Evaporative cooling window system (Rosa Schiano 2007)



DOWNDRAUGHT EVAPORATIVE COOL TOWERS (DECTs)



Bahadori (1985) developed the Downdraught Evaporative Cool Towers as an upgrade to the traditional *Malqaf & Badgir*. (M. Santamouris 2007) mentioned the modifications done by Bahadori. First the inlet of the tower was equipped with gravity shut dampers to reduce losses. Secondly water sprinklers to spray water at the top of the tower. Finally he put clay conduits under the sprinklers to increase the area of moist surface to improve cooling as shown in Figure 6. By which Evaporative cooling was optimized to gain maximum cooling and humidification.

(M. Santamouris 2007) mentioned further research done on (DECTs). First Cunningham and Thomson (1986) built an experimental tower in Arizona, in the U.S. for further research. Another DECT tower was built in the Blaustein International Centre for desert Studies at Sde Boquer, Israel, but it used and mechanical fans to induce air movement and cooling. At the world Exposition held at Seville, Spain (1992) DECTs were employed to achieve thermal comfort for the pedestrians, about 6 towers were built to promote the use of DECTs. Afterward

DECTs were used in many buildings in Hot Arid Climates and other Climates but wasn't widely spread due to high cost and size.