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Review of the book 'Cisterns: sustainable development, architecture and energy'

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BOOK REVIEW

Cisterns: sustainable development, architecture and energy, by A. R. Dehghani-Sanij, edited by A. Sayigh, Denmark, River Publishers, May 2016, xxix+236 pp., € 65.00, ISBN: 9788793379527; e-ISBN: 9788793379510 (Denmark Head Office, Alsbjergvej 10, 9260 Gistrup, Denmark, www.riverpublishers.com)

Water plays a fundamentally important role for living on the Earth. All ancient civilisations were created and developed approximately alongside water resources. Nowadays, the lack of drinking water resources is one of the major global crisis due to the increase of the world's population, the global demand for it is increasing every day. Indeed, access to adequate water resources is a principal factor to attain sustainable development goals in all communities. According to people need for water, it has caused to establish engineering masterpieces by human for the collection and storage of water. Cistern is one of these masterpieces. Cisterns or underground cold-water reservoirs, which are called 'Aub-anbar' in Persian, have employed for centuries to store cold-water in the coldest days of the winter and use it throughout the warm months (Figure 1). These reservoirs have supplied cold drinking water for people who were living in warm climate regions once there were no water distribution and mechanical refrigeration systems.

The author believes that the architects and/or engineers of cisterns were totally knowledgeable about the principles of hydrology, hydraulic, thermodynamics, heat transfer, fluid mechanics, statics and strength of materials, as well as all these principles in their designs and works have been used. Also, based on the historical documents, the author believes that Iran is most probably the country where cisterns or Aub-anbars were first made and developed throughout the centuries. Hence, he has used the Persian word, Aub-anbars, instead of cisterns in the whole book. In fact, the meaning of 'Aub' and 'Anbar' in Persian are water and tank/reservoir, respectively.

This book contains 11 chapters with full analysis, illustrations and photographs. In chapter 1, the author discusses about the indigenous knowledge and its importance in achieving sustainable development, as well as the key role that the water plays in this issue. He reports that the indigenous water-engineering structures in Iran, such as Aub-anbars have built based on the indigenous knowledge, and these structures had various forms and designs regarding geographical and climatic conditions. Later in this chapter, the water storage and supply systems in various parts of the world, including rainwater harvesting systems, dams and water reservoirs (Aub-anbars) were described.

In chapter 2, holiness and the position of water in the Iranian culture, civilisation, and religion were explained. In this chapter, the author expresses that water has had a special position for Iranians throughout history because the plateau of Iran has always been faced with the water shortage; hence, they have attempted to confront the lack of water through various techniques. To solve the problem of water scarcity, Iranians invented and developed many water-engineering structures based on indigenous technologies. These structures include Qanats (subterranean canals), dams, ice-houses (or traditional ice-makers), Sangabs (or stone troughs) and Aub-anbars. In this chapter, each of them briefly was described.

In chapter 3, Aub-anbars were studied and discussed from an architectural point of view in details. These traditional structures categorised based on various criteria in this chapter, such as: function, application, the water collecting rate, the arrangement of the steps and other spaces, the accessibility method to water, the shape of the reservoir and the dome-coverage, the method of the construction, the method and the type of water collecting, their peculiar position in cities and neighbourhoods, size, the method of airing and cooling, and the type of decorations and the materials used in them. The author explains and analyzes all the above listed issues in detail with illustrations and photographs.

In chapters 4, the author discusses the health and quality of water in Aub-anbars. At the beginning of this chapter, the specifications of drinking water and its different pollutants were explained. Traditional Aub-anbars had health problems in the past. Later in this chapter, the author reports the various types of water pollution existing in the traditional Aub-anbars and different methods to remove them. Also, this chapter illustrates that several researchers investigated the water quality in Aub-anbars, which are located in different places in Iran, through physical, chemical and microbial tests. The obtained results show that by monitoring and controlling the quality of water in Aub-anbars, they can be a suitable alternative to provide drinking water without the use of electrical energy.

In chapter 5, various topics such as history of energy, energy sources including renewable and non-renewable energies, energy and environment, energy and development, energy and economy, and methods of energy storage were addressed. At the end of this chapter, thermal energy storage including sensible heat and latent heat has been discussed, because this kind of energy storage is used in Aub-anbars.

In chapters 6–9, the thermal performance of Aub-anbars was investigated using experimental, analytical, numerical and artificial neural network methods, respectively. These studies illustrated that there was a stable thermal stratification inside the water reservoir throughout the water discharge cycle. In addition, during the discharge cycle, the Aub-anbar provided the cold potable water with the temperature in the range between 11.5 and 13.1°C for people who were living around it, whereas the average ambient air temperature varied between 23 and 38°C. The author reports that the ambient air temperature in one of the hottest days has reached 42°C. It can be concluded that Aub-anbars can have acceptable thermal performance during the warm months, especially in hot and arid regions.

Chapter 10 presents an analysis of the energy and exergy in the Aub-anbar under study based on the measured empirical data. The obtained results indicate that approximately 80% of the cooling capacity stored in the winter was recovered during the summer. Aub-anbars as natural cooling systems

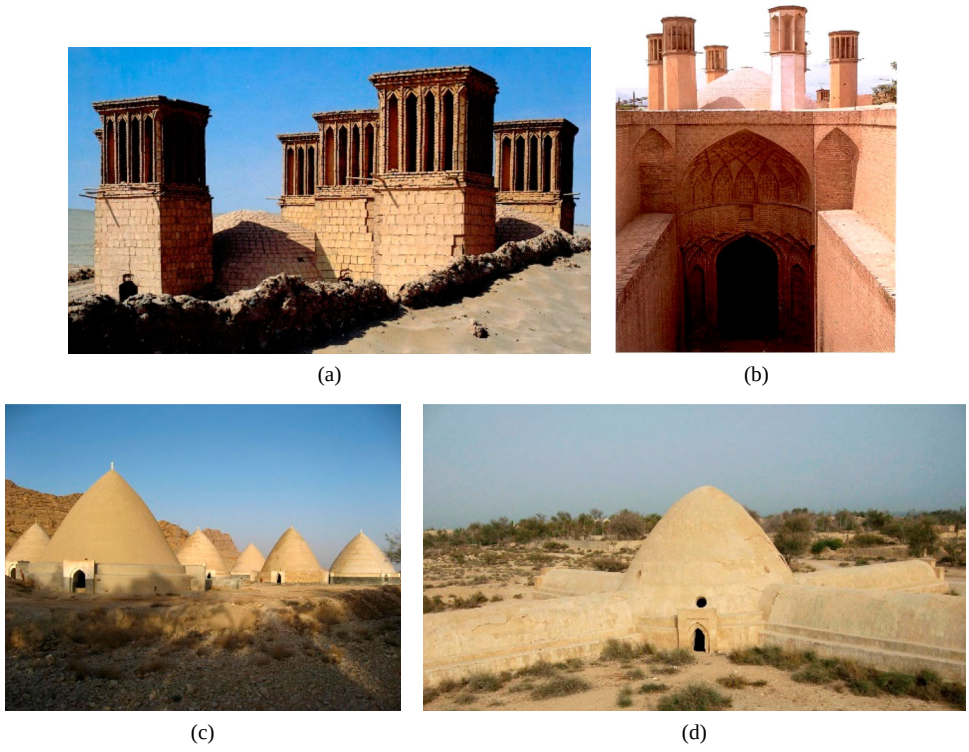

Figure 1. View of the cisterns in (a) near Yazd city, Yazd province (b) Yazd city, Yazd province, (c) Larestan city, Fars province, (d) Bandar-e Kong, Hormozgan province in Iran.

can lessen the electrical energy consumption as well as greenhouse gas emissions. Eventually, the colour photographs of Aub-anbars in various parts of Iran have been illustrated in chapter 11.

This book provides comprehensive and useful information associated with Aub-anbars from various aspects. The author has attempted to show how Aub-anbars can be employed to solve some problems of our lives in the present, including the water scarcity, energy and environmental crisis. By removing the health problems of Aub-anbars, these passive cooling systems can supply cold drinking water for people who are living around them during the hot summer season. Aub-anbars can be used in crisis situations such as earthquake, flood, freezing or destruction of water supply systems and drought. Additionally, the traditional Aub-anbars can have different uses today, such as: (1) cultural centres including libraries, amphitheater and fairgrounds, (2) Museums (handicrafts, etc.), (3) traditional centres like coffee house and teahouse, (4) storage place for the water of fire departments in old neighbourhoods, (5) natural cooling of the buildings through canals, and (6) tourist visiting places.

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