COMBINED ENERGY SOURCE FOR SIMULTANEOUS PRODUCTION OF COOLING, HEATING, POWER AND DESALINATED WATER

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Summary. In the Arabian Gulf region, we can observe significant strain of the electricity system providing power also for cooling purposes. It is especially visible in the Kingdom of Saudi Arabia due to avalanche increase in the electricity demand for cooling purposes. Design and erection of a Multigeneration source in close proximity to the media recipients will decrease the infrastructure load and due to significant share of renewable energy, also decrease environmental footprint. The paper presents an innovative system for cooling, heating, power and desalinated water production based on a novel triple-component chiller configuration supplied from Combined Heat and Power source and Solar Panels Field. The system has been erected in King Abdulaziz City for Science and Technology (KACST). The presented system consists of Li-Br absorption chiller, adsorption chiller, compressor chiller, two Diesel internal combustion engines and solar panel field. The system has been designed and erected in a fully fuel-flexible manner enabling separate operation of each and every equipment in any possible configuration enabling verification of various operation strategies implementing fossil fuels as well as renewable heating.

1. INTRODUCTION

In the world, we can observe not only an increasing demand for electricity and heat, but also for cooling and fresh water. Especially in areas with high sun exposure, such as tropical and equatorial zones. The Arabian Gulf region is one of such an areas. It is not uncommon that the temperature in the Kingdom of Saudi Arabia exceeds 45°C during the summer months. It also results in high demand for cold in order to provide residents and enterprises with thermal comfort. The Middle East countries, especially in the Arabian Gulf region, are also characterized in that fresh water is not readily available. For this purpose, large investments are made for central seawater desalination installations.

Trigeneration (CCHP – Combined Cooling Heating and Power) is defined as a system of combined generation of electricity, heat and cold [1] hence due to possibility of simultaneous additional generation of desalinated water, the term of Multigeneration has been used. The installation of equipment that converts energy, at the moment unusable (heat), into a useful (cold or desalinated water), allows to significantly extend the operation time of cogeneration systems with nominal power [2]. This leads to improving their operational energy efficiency as well as when renewable heat is produced from solar panels, enables its efficient utilization. As indicated by Fumo et al. [3] and Patchers [4], Wu and Wang [5], Cho et al. [6], it is necessary to individually consider the legitimacy of using the technology, select the units from the solutions available on the market, and design the installation of the source and the strategy of its work [7]. Kong et al. [8], Cardona and Piacentino [9], Lozano et al. [10] and Mohammadi [11] concentrate in their analysis on the most widespread model of trigeneration installations: a co-generator and a heat utilization system for the production of cold in a form of an absorption chiller. According to Seyfouri [12] they can be extended by peak coverage sources to improve economic indicators of investments leading to deeper hybridization of such a source. Figure 1 presents basic trigeneration source elements.

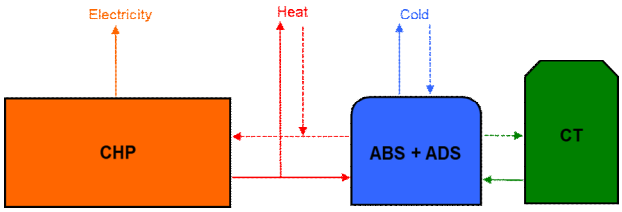

Fig. 1. The basic elements of the multigeneration source. CHP - cogeneration system, ABS - absorption system, ADS – adsorption system, CT - cooling tower

The role of trigeneration systems clearly grows in the context of the increasing demand for electricity for air conditioning purposes in the summer, reaching up to 85% of all energy consumed in office buildings [13]. In favor of the multigeneration solutions, there are also visible changes in the municipal sector soughing after not only electricity, heating / cooling production but also desalinated water generation what is visible for example in the Arabic Peninsula.