Chapter 8
Construction and Operating Parameters of Adsorptive Chillers

ABSTRACT

The chapter is devoted to the design and performance of adsorptive chillers. Basic types of design and operating principle of adsorptive chillers were analyzed. Advantages and disadvantages performance of one-, two-, three-, and four-bed solar power adsorptive chillers are compared. Performance of adsorptive refrigerators based on composite adsorbents was studied. The correlation between the adsorbent composition and the coefficient of energy performance of the adsorptive chiller was revealed. An optimal composition of adsorbent ‘silica gel – sodium sulphate’ is stated to be of 20% silica gel and 80% sodium sulphate. The maximal values of the coefficient of performance of cycle of studied solar adsorptive chiller about of 1.14 are stated for composites containing about 20 wt. % silica gel and 80 wt% sodium sulphate. As a consequence of decreasing of adsorbent mass, the coefficient of performance is shown to increase when sodium sulphate content in the composite increased. Regeneration process parameters of the composite were shown to strongly affect on the coefficient of performance of the adsorptive chiller. The growth of the coefficient of performance is stated to result from decreasing the difference between adsorbent temperature and regeneration

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temperature from 85 to 55°C. The basic factors affecting the net coefficient of energy performance of the adsorptive solar refrigerator were stated daily solar radiant flux alongside with composition of the adsorbent and difference between adsorbent temperature and temperature regeneration. Net coefficients of performance of solar adsorptive refrigerator based on composite ‘silica gel – sodium sulphate’ were stated to change from 0.25 to 0.34 during operating period. Utilization of the adsorption heat is suggested to warm the heat carrier which applied to heat adsorbent during regeneration. The ways to improve the design and performance of adsorptive solar chillers are suggested. The first one involves the introduction of solar collectors made of cellular polycarbonate plastics in the design of adsorptive solar chiller. Instantaneous efficiency coefficient were calculated as special thermal performance-solar radiant flux surface density ratio, optical efficiency factor is determined as special thermal performance-solar radiant flux surface density ratio at the equal temperatures of heat transfer medium and environment, reduced heat loss factor being calculated as the product of solar collector efficiency factor and net heat loss coefficient. The environmental test of developed collectors PSK-AV2-3, PSK-AV1-2, PSK-AV2-1, PSK-VS1-2, PSK-VS2-2, PSK-VS2-3, PSK-ST10-PW were conducted. The correlation of their results with laboratory tests when the thermohydraulic stand applied is shown. Relative accuracy of laboratory and environment tests was shown to be not exceeding 5 – 7%. The optical efficiency factor and the coefficient of thermal losses of polymeric solar collectors were determined. On the basis of the dependencies of the efficiency of the solar collectors vs. the reduced temperature, optimal designs of the polymeric solar collectors for the adsorption chilling solar systems are determined to be depended on the temperature of the regeneration temperature of the sorbents. As the temperatures of the regeneration of composite adsorbent ranged from 50°C to 60°C, appliance of the collectors PSK-AV2-1, PSK-CT10-PW occur to be expedient, and PSK-AB2-3, PSK-VS2-3, PSK-AB1-2, PSK-VS2-2, and PSK-VS1-2 are revealed to be more efficient when regeneration temperatures increased over 80 ºC. Thermotechnical characteristics of designed polymeric solar collectors are shown to surpass conventional metal and vacuum collectors. The perspectives of polymeric solar collectors in the design of adsorptive chilling solar plants were shown. Another way to improve the performance of adsorptive solar chillers concerns with equipping it with a photosensitive element and an electric drive, which will allow changing the angle of slope of the adsorber to the horizon depending on the intensity of the solar radiation. The chapter can be useful for design the efficient adsorptive chilling plants.
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