International Journal of Current Engineering and Technology
ISSN 2277 - 4106

Research Article

Modeling of the Heat Pump Station Adjustable Loop of an Intermediate

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Accepted 24 July 2013, Available online 01 August 2013, **Vol.3, No.3 (August 2013)**

Abstract

There are examined equations of dynamics and statics of an adjustable intermediate loop of heat pump carbon dioxide station in this paper. Heat pump station is a part of the combined heat supply system. Control of transferred thermal capacity from the source of low potential heat source is realized by means of changing the speed of circulation of a liquid in the loop and changing the area of a heat-transmitting surface, both in the evaporator, and in the intermediate heat exchanger depending on the operating parameter, for example, external air temperature and wind speed.

Key words: *heat pump station, automatic control, intermediate loop.*

Introduction

Heat pump systems with an intermediate coolant contour became widely used. Generally it is ground source heat pumps. Such heat pump systems work in on-off or pulse modes. During using heat pump systems in industry and in hybrid heating systems it is necessary for heat pump systems to work with continuous control actions (Juravleov A.A *et al*,2008; Sit B *et al*,2008). It is necessary for these systems to control heat power, which goes to a consumer, for example in according with a heating system temperature chart and due to this an intermediate contour should be regulated and ought to deliver transient refrigeration load to a main contour from a source of low-grade heat. So far a regulated intermediate contour of heat pump systems has not been described. In this work one of the variants of heat pump systems regulated intermediate contour taken from (Sit B *et al*,2009) is described.

Here a variant of an intermediate contour is described. The contour consists of vaporizer 1; intermediate heat exchanger kind of water-water 2; two pumps with regulated power supply 3, 4; intermediate reservoir 5. Back net water from a district heating network is delivered on the heat exchanger of the heat transfer agent contour. In this contour nonfreezing liquid circulates, for example water with some antifreeze.

Another variant of a regulated contour can be a scheme with four pumps and two intermediate reservoirs, when liquid level is regulated independently, both in a vaporizer and in an intermediate heat exchanger. But this scheme in spite of some technical advantages consumes more energy and is more expensive. One of the hydraulic schemes of a regulated intermediate contour is shown on figure 1. On the scheme are a vaporizer and an intermediate vertical heat exchanger. The scheme works in a certain way. With variation of temperature system load both water rate through the heat exchangers (due to using of variable capacity pumps) and water level in the heat exchangers (and therefore area of surface-heat transfer) change. During this process changes on the surface of the heat transfer area and directly with heat transfer coefficients both in the vaporizer and in the intermediate exchanger take place. The reservoir serves to provide break-off of the water flow during water rate regulation in the closed loop. In this scheme pipes in the vaporizer are constantly flooded by heat transfer fluid. The shown scheme consists of vaporizer 1; intermediate heat exchanger 2; pumps 3 and 4 and intermediate reservoir 5. The level in the intermediate reservoir is regulated by capacity variation of pumps 3 and 4. Reservoir 5 is installed higher than the vaporizer (the vaporizer is under filling).

Dynamic model of a vaporizer

As a basic model the dynamic model of vaporizer has been accepted, which is described in (Tao Cheng *et al*,2004; Xiang-Dong He *et al*,2003). A vertical vaporizer has been chosen where cooling agent flow is considered as one-dimensional and heat transfer along the flow axis is negligible. Dynamics of cooling agent level variations is described by the equation:

$$\frac{dl(t)}{dt}+\frac{l(t)}{\tau}=\frac{(1-x_0)}{\rho_l(1-\bar{\gamma})A_L}\dot{m}_{in} \qquad (1)$$

$$\tau=\frac{\rho_l(1-\bar{\gamma})A_L h_{1g}}{\bar{q_l}}\bar{q}_l \qquad (2)$$

where $h_{1g} = h_g - h_l$; $\bar{q}_l$ – heat flow per unit length of a heat exchanger tube.

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