Part 6

ADVANCED TECHNOLOGIES AND POWER INSTALLATIONS FOR THERMAL AND ELECTRIC ENERGY GENERATION

6.4. Application of air condensers in power industry

6.4.3. New generation air condensers (NGAC)

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In recent years the efforts of researchers have been directed to improvement of air condensers design; however, AC drawbacks, listed above, are not eliminated until now.

In this connection a search of new ways of the condensation process arrangement, and intensification of heat exchange from cooling air side, remain actual. An air condenser was developed in MPEI (Moscow Power Engineering Institute). It consists of the following: a mixing condenser, connected to a steam pipeline exit, a dry cooling tower, connected to a cooling water system, a fan, located on its vertical axis, a pump, included in a circulation system [10]. The cooling tower is constructed as a bundle of vertical coaxial tubes, limited from the above by a three-level collector, and from the bottom - by a ring collector. In a middle level of the three-level collector the ejectors — condensers are installed. Their active nozzles are connected with a top-level collector and the diffusers are connected with a cavity of the collector bottom level. The fan is installed on an axis of a tube bundle. Besides, the ejectors-condensers can be located in regular intervals along a ring in one or several rows.

The proposed NGAC design is presented in Figs. 6.25—6.27.

A system consists of the vertical ring tube bundle *1*, located between the ring collectors *2* and *3* (Fig. 6.25).

Cavity of the top three-level collector *3* is divided into three levels — top *4*, middle *5* and bottom *6*. In the cavity of the middle level *5* of the ring collector, the ejectors — condensers *7* (mixing condensers) are located. Their diffusers *8* are connected to the bottom level *6* of the ring collector *3*. Branch pipes *9*, *10*, *11* and *12* are connected to each collector *2* and *3* and in levels *4*, *5*, *6*.

The middle level *5* of a three-level collector can contain an additional collector *13* with nozzles *14*, and the ejectors — condensers *7* can be provided with additional confuser *15* (Fig. 6.26).

Radially dispersing ring tube bundle (Fig. 6.27) contains vertical pipes *16*, which longitudinal rows are directed to radiuses of coaxial circles and a fan *17*, installed on an axis of a ring bundle.

An air-condensing installation works as follows.

Exhaust steam from the steam turbine is supplied through a branch pipe *10* to a middle level *5* of a ring collector, where the ejectors-condensers *7* are located, then it is distributed through a collector and condenses on cold streams. Complete condensation of steam occurs in diffusers of ejectors and a condensate flow together with the grasped not-condensed gases (air) enters the bottom level 6 of a three-level collector, whence under a pressure of streams is distributed through the pipes of a tube bundle *1*. Through the branch pipe *11* a part of a hot condensate is directed to the power installation system input.

The cooled condensate is collected in the ring collector *2* and then directed to the circulating pump input through the branch pipe *12*, then it is supplied to the upper level *4* of the three-level collector *3*, distributed through nozzles of the ejector-condensers and supplied in streams to a steam cavity

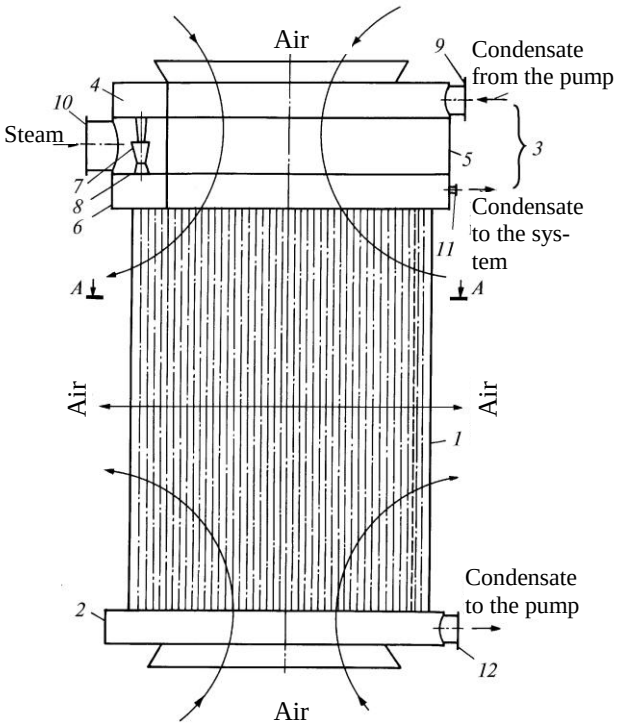

Fig. 6.25. NGAC design (section *A-A* ref. to Fig.6.27)

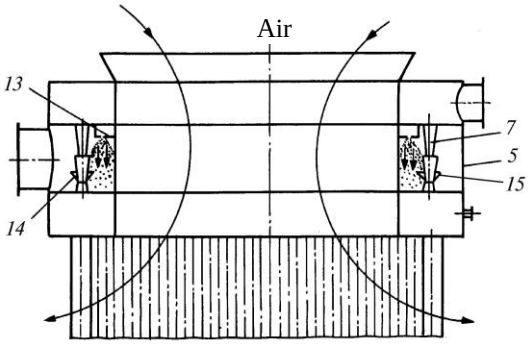

Fig. 6.26. Design of a three-storage collector

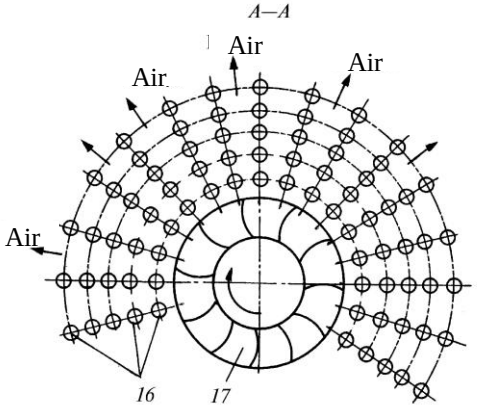

Fig. 6.26. Radially-dispersing ring tube bundle

of a collector of the middle level *5*. The cycle repeats.

In summer at high cooling air temperature the ejectors-condensers fail to provide a necessary condensate (steam) productivity. In this case spraying devices are put into operation. They are located in an additional collector *13* which is connected to the top level *4* of the three-level collector. When water is supplied in a form of a thin water film (radial water jet) ,the condensation surface increases, and productivity of the condenser increases as well. The additional stream of condensate is collected in the bottom part of a steam collector. When condensate reaches a level correspondent to a height of intake of the confuser *15*, the ejectors-condensers additionally soak up the condensate, providing level self-regulation.

In comparison with a prototype, the offered installation provides the following advantages:

1. Decrease in overall sizes due to connection in one unit of an air water cooler (a dry cooling tower) and a mixing condenser. Use of several ring installations instead of one tent design yields saving of the construction areas, increases wind resistance and raises seismic stability of all design.
2. Increase in specific thermal and mass loadings at elements of the installation due to activating of heat and mass exchange, connected with turbulization of a flow with ejectors and jets.
3. Increase in thermodynamic efficiency due to pressure difference between the steam and hot condensate collector.
4. Increase in power efficiency of an air water cooler due to arrangement of diffusing currents in a radial-dispersing ring tube bundle with the lowered aerodynamic resistance.