Технические науки

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Possibility of using of thermal pumps at thermal power plants and heat boiler stations

Annotation. *Different diagrams of thermal pumps operation at thermal power plants are considered in the article. Thus, installation diagrams are considered for thermal pump based on the use of low-grade heat of turbo-unit lubricating system oil and blow-down water of a steam generator.*
Key words: *thermal pump, blow-down water of steam generator, low-grade rejected heat, deaerator.*

Energy and resource saving is one of the most serious tasks of the 21-st century. The place of our society in a number of economically developed countries and the standard of living of citizens depends on the results of solving this problem. Kazakhstan has all of the necessary natural resources and intellectual potential to solve its energy problems successfully, but the redundancy of fuel and energy resources in our country should not include the energy waste.

At the present time, both our country and foreign countries place greater focus on the use of secondary energy resources.

Particular attention was paid to the so-called «rejected heat», which is often used as low-grade heat for the operation of thermal pumps. In most cases, it is proposed to use the heat of ground, artesian, thermal waters, rivers, lakes, seas, water and heat supply systems and, less commonly, industrial and treated domestic wastewater, process water and generally any rejected heat as a low-grade heat source for thermal pumps. For that matter, a new idea of recycling of heat of blow-down water of steam generator and using it in the deaeration process has started up.

There is a common method of rejected heat of power plants recycling, carried out by using the heat of the blow-down water of a steam conversion plant to heat chemically purified water, sent to a deaerator later on [1, P. 57]. The disadvantage of this method is that the amount of heat transferred to chemically purified water is small, respectively, the consumption of heating steam (to ensure the saturation temperature of deaerated water) is large. And, as it is known, the efficiency of the deaerator depends significantly on the temperature supplied for deaeration of water, and the higher it is, the more efficient the deaeration process is.

The technical result of the proposed method is the effective use of a source of low potential heat - blow-down water for the implementation of the deaeration process.

This is achieved due to the known method of recycling of rejected heat of blow-down water of the steam generator by transferring heat from the water to the heated substance in the utilizer, when it is proposed to use a thermal pump as a utilizer, and chemically purified (additional) water exposed as a heated substance further to the deaeration process.

The installation diagram for recycling of rejected heat of the steam generator of blow-down water using this method is shown in Figure 1.

The installation of recycling of rejected heat of the steam generator of blow-down water consists of a thermal pump containing an evaporator 1, a compressor 2, driven by a motor 3, a condenser 4, a flow-regulating valve (throttling valve) 5, interconnected by a piping system 6 for circulating of the thermal pump fluid. A pipe 7 is connected to the evaporator 1, through which the blow-down water of the steam generator 9 is supplied from the second stage of the continuous blow down separator 8. The pipe 10 serves to drain the cooled blow-down water into the sewer. In the liquefier 4, the fluid of the thermal pump is cooled by transferring heat to chemically purified (additional) water located in the pipe 11, which is sent to the deaerator for deaeration process (not shown in the figure).

The method of heat recycling is as follows: as a result of supplying a low-grade heat source - blow-down water of the steam generator 9, the boiling fluid of thermal pump occurs through the pipe 7 to the evaporator 1, as a result of which the blow-down water of the steam generator 9 is cooled and sent through the pipe 10 down the sewer. The fluid steams of thermal pump is compressed in the compressor 2 with increasing enthalpy and temperature due to the compression. In the liquefier 4, the heat of the phase transition of the fluid is transferred to chemically purified water, which is sent as additional water to compensate for internal and external losses for the deaeration process through pipeline 11. After the liquefier 4, the fluid of thermal pump is throttled in the flow-regulating valve 5, as a result of which the temperature and pressure decreases to the pressure in the evaporator and the thermal pump cycle is repeated. The higher the final compression pressure of the compressor, the higher the temperature of the fluid of thermal pump, respectively, a greater amount of heat is transferred to the liquefier of thermal pump with chemically purified water. This increases the temperature of the water supplied to the deaerator and the efficiency of the deaeration process, reduces the consumption of heating steam.

As a result of using of rejected heat of blow-down water of the steam generator, low-grade heat is converted into the heat of the additional chemically purified water supplied further to the deaerator. Thus, its significant preheating is achieved, which allows to reduce the consumption of heating steam to the deaerator.

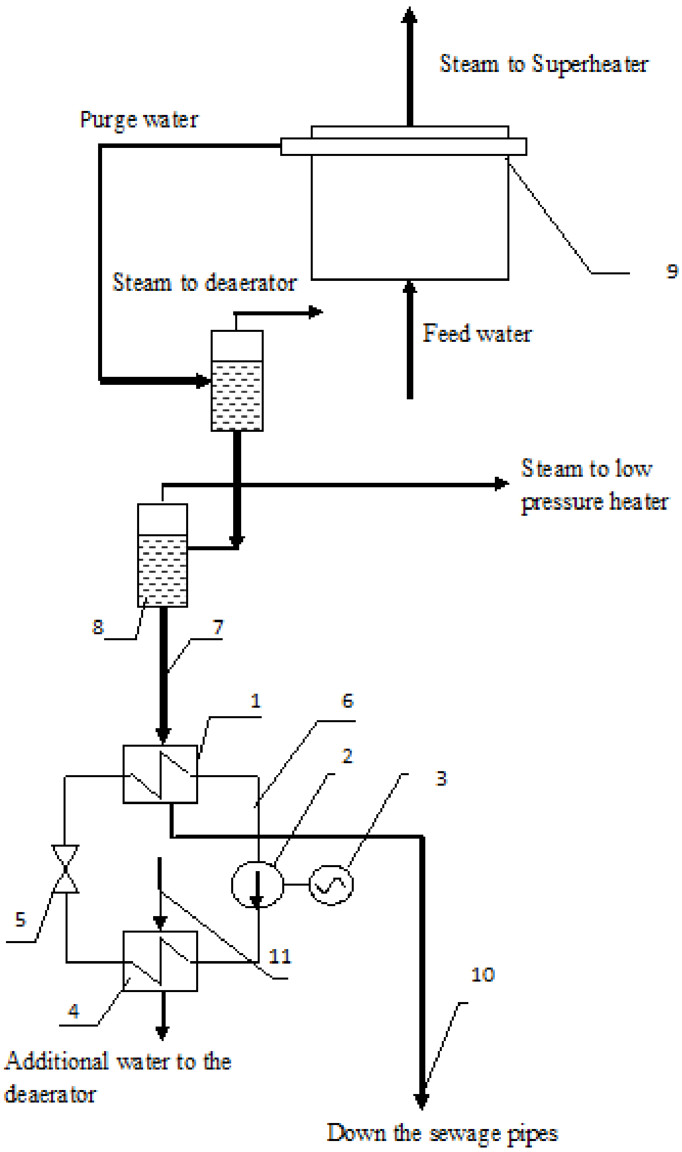

Figure 1 – Method of recycling of rejected heat of the steam generator

The installation diagram for recycling of rejected heat of turbine oil coolers using the inventive method is presented in Figure 2.

The installation for recycling of rejected heat of turbine oil coolers using the inventive method consists of a thermal pump containing an evaporator 1, a compressor 2, driven by an electric motor 3, a liquefier 4, a flow-regulating valve (throttling valve) 5, interconnected by a piping system 6 for circulating of the thermal pump fluid. A pipe 7 is connected to the evaporator 1, through which heated oil is supplied from the turbo-unit lubricating system (not shown in the figure). The pipe 8 serves to drain the cooled oil into the turbo-unit lubricating system. In the liquefier 4, the fluid of thermal pump is cooled by transferring heat to the blow-down water circulating in the pipeline 9 of the district heating system.

The method of heat recycling is as follows: as a result of supplying a low-grade heat source – turbo-unit lubricating system oil through pipeline 7 to evaporator 1, the fluid of thermal pump boils, as a result of which the oil is cooled and sent through the pipeline 8 to the turbo-unit lubricating system. The fluid steams of the thermal pump are compressed in the compressor 2 with increasing enthalpy and temperature due to compression. In the liquefier 4, the heat of the phase transition of the fluid is transferred to the return blow-down water of the district heating system circulating in the pipeline 9 of the district heating system. After the liquefier 4, the working fluid is throttled in the flow-regulating valve 5, as a result, the temperature and the pressure decreases to the pressure in the evaporator, after which the thermal pump cycle is repeated.

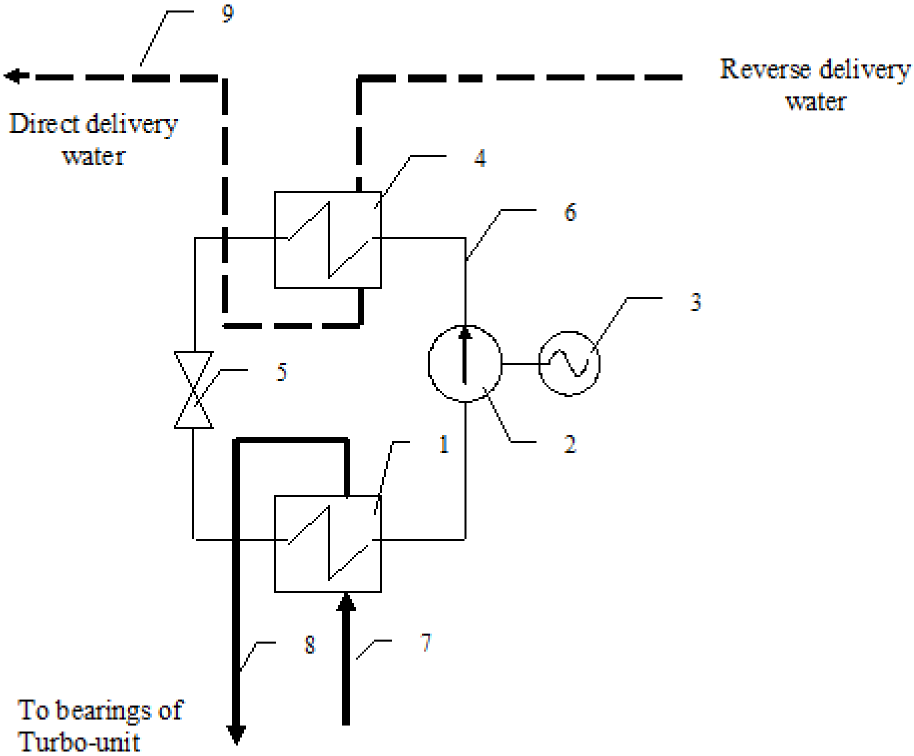

Figure 2 - Installation diagram for recycling of rejected heat of turbine oil coolers using the claimed method

As a result of using of the method of using of rejected heat of turbine oil coolers, the low-grade heat of the turbo-unit lubricating system oil having a temperature of 55-60 ℃ is transferred to the heat of blow-down water . Thus, heating of blow-down water to a temperature of 90-100 ℃, suitable for heat supply, is achieved.

Analysis of the operation of the first industrial thermal pump in the Republic of Kazakhstan, which operates at Kazzinc JSC on low-potential heat of circulating water [2, P. 26], shows its efficiency, which suggests the same efficiency of its use in thermal power plants. Thus, it is absolutely necessary to develop work in this direction with the aim of creating designs of a different series of modern thermal pump units for various purposes and schemes for using of «rejected» heat in industry with the aim of introducing energy-saving technologies.

Currently a great attention is paid to the issue of application of the waste heat on thermal power plants. The certain scheme of thermal power plant [3] is well-known, where the waste-heat recovery of power plants method is realized by means of recovery of turbine condenser water for heating the condensed water, next directed into a digasifier. But the disadvantage of this scheme is that the heated medium of heat-pump system condenser connected with the supply of the main condenser of low - pressure feed-water preheater concurrent to feed water preheater of the second stage. This allows excluding one of the feed water preheaters, that leads to temperature and pressure boost on turbine exit which in its turn depraves vacuum environment in the condenser.

The most congenial to the suggested method, which is taken as a prototype, is the waste heat recovery of turbine condenser water method by means of transferring heat of condensing water in heat exchanger surface functioning as utilizer, to the air directed on the steam generator for fuel burning. Thereby the heat which condensing water gets in a condenser while steam condensation returns to the steamers.

But this scheme disadvantage is that while utilization of natural gas in summer period of initial air and condensing water temperatures are close so much that it decreases the efficiency of the present scheme, i.e. transferring the heat from warming to heating substance, besides when the heating atmosphere temperature is about 30 ^{0}C the utilization of waste heat in heat exchanger is supposed to be inefficient because of the irreversibility of heat exchange.

The task on realization the heat process of the air burning by means of utilization of those low grade heat sources which are present on electric power plants particularly the circulation water of turbine condenser, was set.

This method is realized by heat removal from circulation water of condenser with the help of heat pump and it’s transferring to the air burnt in steam generator, with definite equipment application, which is depicted in Figure 3 and includes the following: 1. heat pump with flash chamber; 2. condenser; 3. choke (regulation valve);

4. Interconnected duct system for circulation of working medium of the heat pump. The flash chamber 1 is connected to the pipeline 6. from which the circulation water is pumped.

After flash chamber of heat pump the circulation water is pumped into cooler 8, from where it returns to the condenser. In condenser 3 heat pump of the working medium is cooled by transferring heat to the air which delivers to burning in burner 9 of steam generator 10. The generated steam in steam generator 10 delivers to turbine 11 where it extends and after completing its work goes for condensation to the condenser 7.

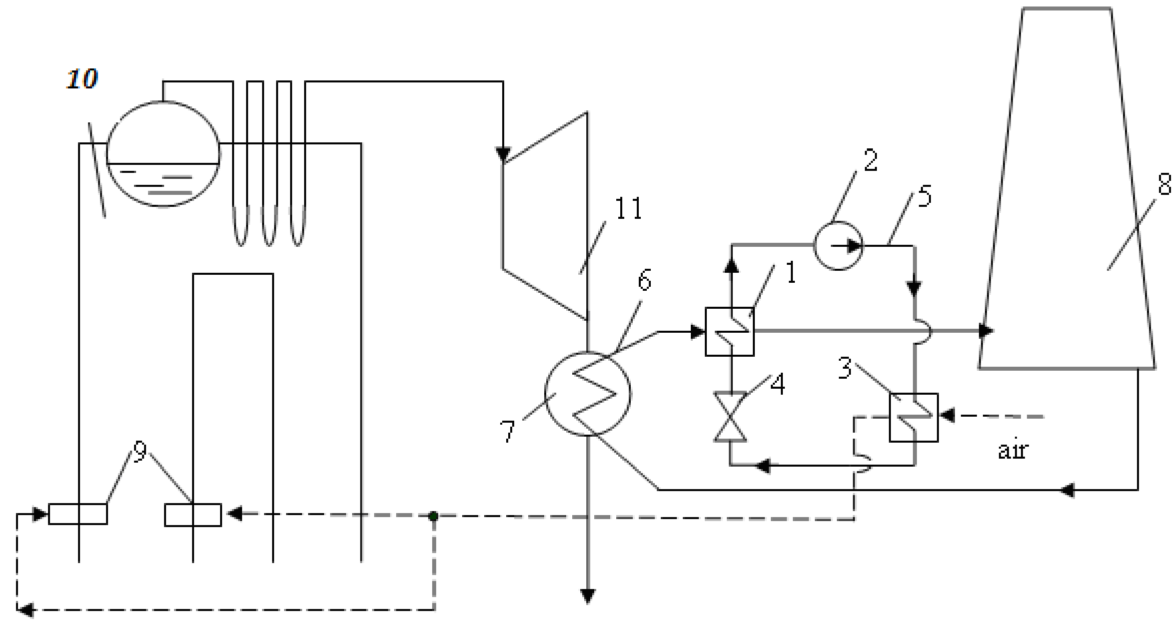

Figure 3 – Basic circuit of heat pump switching on at CHP by utilizing the rejected heat of circulation water

As a result of low grade heat source intake that is circulation water of condenser 7 over the pipeline 6 to the flash chamber 1 the working medium of heat pump is boiled, resulting in circulation water cooling and directing to cooler 8, after which it returns to the condenser 7. The heat pump working medium steam is compressed in condenser 2 with enthalpy and temperature increasing by means of compression. The heat of working medium transformation is transferred to the air in condenser 3; the air is directed further for fuel burning in burner 9 of steam generator 10. After condenser 3 the working medium of heat pump restricts the flow in regulation valve 4 as a consequence the temperature and pressure are reducing to pressure in flash chamber and the heat pump cycle repeats. Due to the fuel burnout the steam is generated in steam generator 10 and transferred into turbine 11. The steam in turbine completes the useful work and after that transfers into condenser 7.

Consequently the transit of low grade heat circulation water of turbine condenser into the air heat is completed, and the air is further delivered to the steam generator for burning.

Different methods of recycling of rejected heat from thermal power plants and heat boiler stations, such as: heat of the blow-down water of the steam generator, a turbo-unit lubricating system oil and circulating water of the turbine condenser are proposed in the article [4, 5, 6]. Considered methods allow to increase the technical - economic indicators of enterprises.

REFERENCES

1 Соколов Е.Я. Промышленные тепловые электрические станции. – М.: Энергия, 1979. – С. 57.

2 Алимгазин А.Ш. Применение теплового насоса в металлургическом производстве ОАО «Казцинк» – одно из перспективных направлений энергосбережения в промышленной теплоэнергетике: Тезисы докладов Международной научно-практической конференции «Энергосберегающие технологии Прииртышья». – Павлодар: Изд-во ПаУ, 2001. – С. 26-33.

3 Патент № 2269011 РФ: МПК^8 F01K 17/00. Тепловая электрическая станция / Шарапов В.И., Подстрешная Н. С., Замалеев М. М., Сабирзянов Д. Р. – заявка № 2009144571/06; заявл. 01.12.2009; опубл. 10.06.2011, Бюл. № 16. – 4 с: ил.

4 Инновационный патент № 89288 РК: МПК^8 F25B30/06. Способ утилизации сбросного тепла циркуляционной воды конденсатора турбин / Плевако А.П. – заявка № 2014/0824.1; заявл. 16.06.2014; опубл. – 17.08.2015, Бюл. № 8. – 4 с: ил.

5 Инновационный патент № 21029 РК: МПК^8 F25B30/06. Способ утилизации сбросного тепла продувочной воды парогенератора / Плевако А.П. – заявка № 2008/0156.1; заявл. 18.02.2008; опубл. 16.03.2009, Бюл. № 3. – 4 с: ил.

6 Предварительный патент № 18799 РК: МПК[8] F25B 30/06. Способ утилизации сбросного тепла маслоохладителей турбин / Плевако А.П. – заявка № 2006/0307.1; заявл. 15.03.2006; опубл. 17.09.2007, Бюл. № 9. – 4 с: ил.

REFERENCES

1 Sokolov Ye.Ya. Promyshlennye teplovye elektricheskiye stantsii. – Moscow: Energiya Publ., 1979. – S. 57.

2 Alimgazin A.Sh. Primenenie teplovogo nasosa v metallurgicheskom proizvodstve OAO «Kazcink» – odno iz perspektivnih napravlenii energosberejeniya v promishlennoi teploenergetike// V kn: Tezisi dokladov Mejdunarodnoi nauchno_prakticheskoi konferencii «Energosberegayuschie tehnologii Priirtishya», Pavlodar, PaU, 2001. – S. 26-33.

3 Patent № 2269011 RF: MPK[8] F01K 17/00. Teplovaya elektricheskaya stanciya/ Sharapov V.I., Podstreshnaya N. S., Zamaleev M. M., Sabirzyanov D. R. - zayavka № 2009144571/06; zayavl. 01.12.2009; opubl. 10.06.2011, Byul. № 16. - 4 s: il.

4 Innovacionnyj patent № 89288 RK: MPK[8] F25B 30/06. Sposob utilizacii sbrosnogo tepla cirkulyacionnoi vodi kondensatora turbin / Plevako A.P. - zayavka № 2014/0824.1; zayavl. 16.06.2014; opubl. 17.08.2015, Byul. № 8. – 4 s: il.

5 Innovacionnyj patent № 21029 RK: MPK[8] F25B 30/06. Sposob utilizacii sbrosnogo tepla produvochnoi vodi parogeneratora / Plevako A.P. – zayavka № 2008/0156.1; zayavl. 18.02.2008; opubl. 16.03.2009, Byul. № 3. – 4 s: il.

6 Predvaritelnyj patent № 18799 RK: MPK[8] F25B 30/06. Sposob utilizacii sbrosnogo tepla masloohladitelei turbin / Plevako A.P. – zayavka № 2006/0307.1; zayavl. 15.03.2006; opubl. 17.09.2007, Byul. № 9. – 4 s: il.

ТҮЙІН

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Жылу электр станциялары мен қазандықтарда жылу сорғыларын пайдалану мүмкіндігі

Осы мақалада электрлік жылулық станцияларда әр түрлі жылу сорғылардың қолдану схемалары қарастырылған. Төмен потенциалды май жылуының қолданылуы, турбогенератордың майлау жүйелері, бу генератордың үрлеп тазалау су жүєлері осылайша көрсетілген.

Кілт сөздер: *жылу сорғысы, бу генераторын тазартатын су, төмен потенциалды жылу мөлшері, деаэратор.*

РЕЗЮМЕ

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Возможность использования тепловых насосов на ТЭС и котельных

В статье рассматриваются различные схемы работы тепловых насосов на тепловых электростанциях. Так, приводятся схемы установки теплового насоса, основанные на использовании низкосбросного тепла масла системы смазки турбоагрегата и продувочной воды парогенератора.

Ключевые слова: *тепловой насос, продувочная вода парогенератора, низкопотенциальное сбросное тепло, деаэратор.*