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# Disposal of Secondary Energy Resources in the Gas andAir Treatment of the MubarekTPC

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**ABSTRACT.**This article discusses the issues of energy saving in combined heat and power plants with the improvement of oil supply systems for gas-air ducts based on the utilization of low-potential thermal energy. The main indicators of the gas-air path are analyzed and the main sources of secondary energy resources at the Mubarek TPP are identified. The schemes of utilization of low-potential thermal energy using heat pumps are proposed.

**KEY WORDS:** Cogeneration Plant, Utilization of Secondary Energy Resources, Efficiency of Boiler Plants, Thermal Energy, Cooling Water, Combustion Products, Forced-Draft Plants, Smoke Exhaust, Blower Fan, Oil Tank, Mechanical Impurities.

## I.INTRODUCTION

The modern development of the energy sector is characterized by a significantly increased cost of energy carriers and all types of natural fuel and energy resources, as well as constantly exacerbating environmental loads from the effects of thermal power plants (TPP), and power plants using fossil fuels. Improving the technology for the production of heat and electric energy, fuel economy and increasing the energy efficiency of power units in thermal power plants are priority areas for the development of scientific research in the field of industrial heat power.

Currently, natural gas dominates in the energy balance of Uzbekistan in generating electricity, its use reaches 90%, and reserves are gradually decreasing. Natural gas possesses the properties of not only high-quality fuel for energy boilers, but also is a valuable energy carrier. Analysis of the heat balance of the operated energy boilers shows that the heat loss from the flue gases from the lower calorific value of the fuel ranges from 4% to 7.5%. In addition, the flue gas from boilers burning natural gas contains about 15% of water vapor.

## II. SIGNIFICANCE OF THE SYSTEM

The latent heat of vaporization of water vapor is up to 12% of the lower heat of combustion of the fuel. Thus, the total heat loss with flue gases during the preparation of the heat balance for the higher heat of combustion of the fuel is from 16% to 19% [1, 2, 3]. Therefore, reducing losses with the heat of the exhaust flue gases is the most promising direction for increasing the efficiency of using organic fuel in thermal power plants [1].

## III.ANALYSIS OF THE HEAT BALANCE OF A THERMAL POWER PLANT BOILER

Modern power plants convert 30-40% of the heat of fuel into useful electric energy, and the remaining 60-70% are scattered in the environment [3, 4]. Thermal power central (TPC), where the integrated generation of electric and thermal energy is carried out, have an efficiency of 1.5-1.7 times higher, reaching 60-65%. Utilization of secondary energy resources, including the heat of the flue gases, is one of the main ways to increase the efficiency of power boilers of thermal power plants. With the beginning of the massive use of natural gas in boiler plants, the task of the

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beneficial use of flue gas heat has gained particular importance. One of the features of the operation of a TPC on natural gas or other hydrocarbon fuels is the increased content of water vapor in the combustion products. Loss of thermal energy with flue gases in the TPC is 13-21% of the total heat balance (Fig. 1).

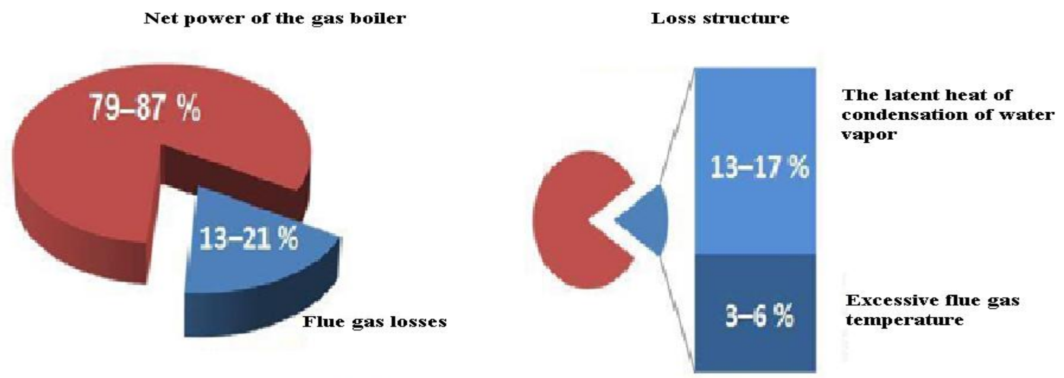


Fig. 1.The theoretical potential for the utilization of flue gas heat from natural gas boilers.

In the table. 1. Presented in percentage terms of energy loss in the elements of power plants.

Table 1.
Key indicators of energy loss

| Energy loss $\Delta E$,% | In the boiler unit $\Delta E_{boiler}$ | In a turbogenerator $\Delta E_{TG}$ | In capacitor $\Delta E$ | In the pipe wires $\Delta E_{pip.w.}$ |
|---|---|---|---|---|
| CPS | 12 | 6 | 41 | 2 |
| TPC | 12 | 4 | 20 | 2 |

## IV. METHODOLOGY

Analysis of energy loss in TPC plants shows that the total energy loss is about 38%, of which 12% in boiler units.
The aim of the study is to assess the potential of water-energy resources using the example of the Mubarek TEC and to develop a scheme for the utilization of low-potential thermal energy from an oil-cooling system with a heat pump installation.

In order to assess energy loss, we have identified the main sources of secondary energy resources (SER) at Mubarek TPC and are presented in table 2.

Table 2.
The main sources of SER at Mubarek TPC

| № | Sources SER | Consumption SER,G, t/hour | Temperature t, $^{0}$C | Thermal power Q, kW |
|---|---|---|---|---|
| 1 | 6 ata deaerator, 2 pc. | 8 | 100 | 486 |
| 2 | Deaerator make-up cycle, 2 pc.(pairs) | 4 | 90 | 200 |
| 3 | Evaporator deaerator 2 pcs (pairs) | 4 | 90 | 200 |
| 4 | Evaporator Secondary Steam Expander, 1 pc. | 6 | 100 | 356 |
| 5 | Non-condensing vapor, 16 pc. | 16 | 80 | 890 |
| 6 | High pressure boiler expanders, 1 pc. | 30 | 180 | 4530 |
| 7 | Fluegas | 60 | 180 | 9060 |

ISSN: 2350-0328
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In the oil cooling system of draft machines, there are thermal emissions in the form of low-grade heat. Tables 3 and 4 show the energy parameters of the oil supply systems for draft machines of the gas-air duct of the Mubarek TPC.

Table 3.
Characteristics of oil supply systems at Mubarek TPC

| № | Indicators | Un.dem. | Values |
|---|---|---|---|
| **1** | Bearing drain oil temperature | **°C** | 65 |
| **2** | Oil consumption (brand of oil pump SH-5-25 t/h) | $m^3$ | 5 |
| **3** | Oil tank volume | $m^3$ | 0,5 |
| **4** | Oil temperature before filter | °C | 38-45 |
| **5** | Heat exchanger inlet oil temperature | °C | 65 |
| **6** | Heat exchange roil temperature | °C | 38-45 |
| **7** | Cooling water temperature | °C | 25-33 |
| **8** | Cooling water consumption | t/hour | 60-80 |
| **9** | Condensate consumption for heating oil (in winter) | t/hour | 60-80 |

Table 4.
The main parameters of draft machines of the gas-air duct MubarekTPC

| № | Name of power plant | Stamps Type | Electric power |
|---|---|---|---|
| **1** | Blow fan brand | BDH-25x2 | DAZO-2-18-59 6/8У1 with power 685/1600 kW |
| **2** | Brand of the smoke exhaust (electric motor) | DOD-28,5-GM | 1600 kW |
| **3** | Brand flue gas recirculation smoke exhauster (electric motor) | G-20-500 | 630 kW |
| **4** | Oil pump blower fan, exhaust fan, flue gas recirculation exhaust fan | SH-5-25 | 4,5 kW |
| **5** | Process water pump brand, electric motor | K-290-175 | 30 kW, 1410 rpm |
| **6** | Brand cycle feed pump, electric motor | KCB-500-150 | 175 kW, 1410 rpm |

Data analysis table 3 and 4 shows that the cost of electricity on the gas-air path of the station is high and is in the range of 3500-4000 kW.

**Dataset Description**

In the existing system of draft facilities of the Mubarek TPC (bearings of the exhaust fan, blow fan, and exhaust fan for recirculation of flue gases, their electric motors), bearings are cooled by TP-22c oil. During the cooling process of the bearings, the oil heats up to 65 °C. This temperature of the oil requires cooling to prevent high-temperature wear of the metal part of the bearings. At the same time, all the oil flows into the crankcases, then enters the oil tank, where it is clarified from mechanical impurities (mechanical impurities are sent to sedimentation tanks). The purified oil is absorbed by the Sch-5-25 oil pump. In an oil tank, the oil is refined but not cooled. In this tract, after the pump, an oil filter is installed, where the oil is filtered and purified from fine compounds. After the filter, the oil enters the cooler, where it is cooled with industrial water. The cooled oil is returned to the bearing system of draft machines (DM).

**A) Data Pre-processing**

In the cooling system of power plants of the Mubarek TPC, a pump is used for pumping industrial water with a flow rate of 240 t/h. The main water stream is divided into four pipelines. The first pipe with a diameter of Ø159 is used to cool the electric generator, the second pipe of the same diameter is used in oil coolers for lubrication systems and steam turbine sealing systems, the third stream is sent to the pipes Ø108, to the gas coolers of the feed pump, and the last water stream with the pipe Ø32 is used to cool the oil in the oil system DM.

**B) System Design**

The first three streams of industrial water after being used in the cooling system of power plants are sent for cooling to the cooling tower (Fig.2).

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Vol. 7, Issue 5 , May 2020

And the fourth stream of water is used in the cooling system of the DM oil system, where after use it is discharged into the sewer system. Thus, in the existing system, a large consumption of water and electricity is required to drive draft machines.

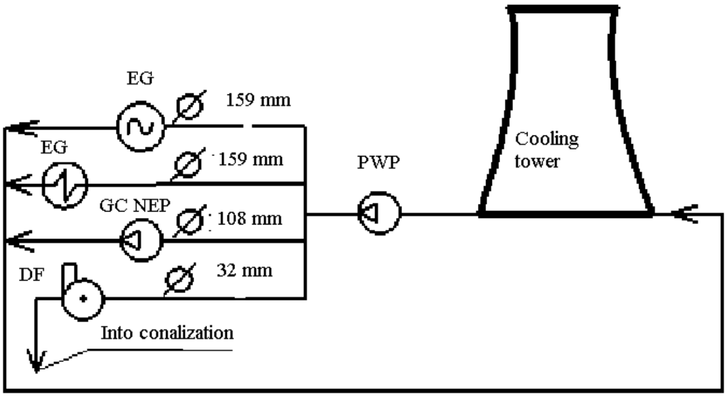


Fig.2. The technical water supply system for power plants in the Mubarek TPC.

In the existing system (Fig. 3), for cooling the oil, process water is used as a cooler with a flow rate of $G_w$ = 32 t/h = 8.89 kg/s. Used cooling water as a low-potential heat emission is removed into the sewer and irretrievably lost.

Calculations show that a large amount of heat is lost with cooling water

$Q = Gw \cdot c_p \cdot \Delta t = 8.89 \cdot 4.18 \cdot 30 = 1115$ kW.

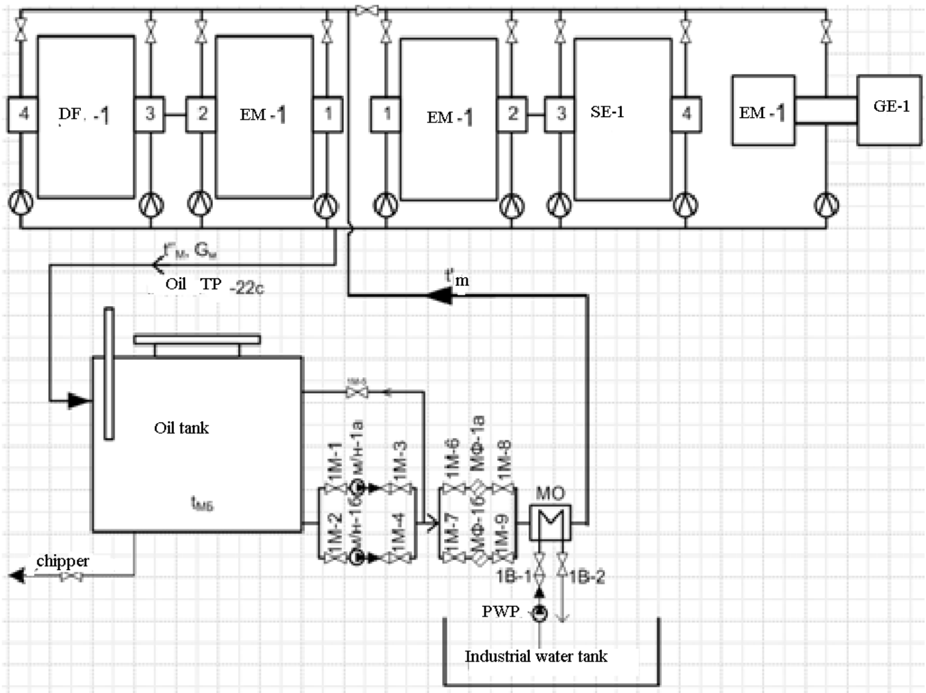


Fig. 3. The existing oil supply system for draft machines (DM) of boiler unit №1 of the Mubarek TPC.

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Vol. 7, Issue 5 , May 2020

## V. EXPERIMENTAL RESULTS

The authors proposed a new system for using low-grade heat emitted with cooling water from the DM oil-cooling system. In the proposed system for the disposal of low-grade heat systems DM heat pump is installed. A heat pump is a device for transferring thermal energy from a source to a consumer. Unlike spontaneous heat transfer, which always occurs from a hot body to a cold one, a heat pump transfers heat in the opposite direction [5]. The most common heat pump design consists of a compressor, a thermal expansion valve, an evaporator, and a condenser. The coolant circulating inside these components is called the refrigerant [6,7,8].

We have developed a thermal diagram of the oil supply systems of the boiler unit No. 1 of the Mubarek TPC with a heat pump installation (for heat recovery) (Fig. 4). In the proposed system, the heat pump evaporator is located in the oil cooler body, and the condenser in the air duct of the heater.

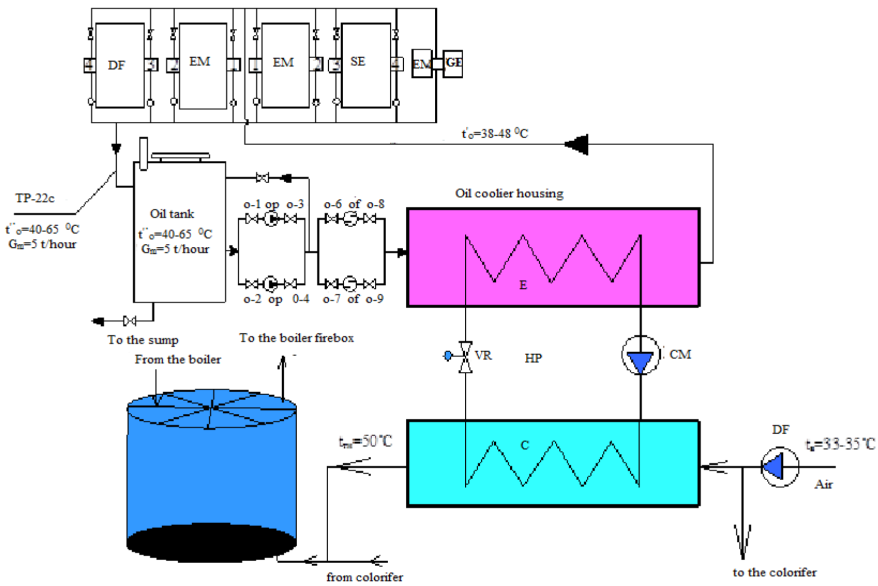


Fig.4. SEC utilization scheme in oil supply systems

During cooling, the oil in the heat evaporator is taken to the refrigerants, then the compressor compresses the refrigerant and the heat heated by the refrigerant is transferred to the air flowing into the boiler furnace.

Heated air is used in the steam boiler for fuel combustion, and the cooled refrigerant again enters the heat pump evaporator.

## VI. CONCLUSION AND FUTURE WORK

The use of a heat pump for the utilization of low-grade waste heat from DM oil cooling systems allows the oil to be cooled to a temperature of 35-48 °C, while simultaneously heating the air going into the boiler furnace. Preliminary calculations show that due to the utilization of thermal emissions using heat pumps, the savings in heat energy are 70-75 kW.

Thus, when using heat pump in the oil supply system at the same time it allows cooling the oils and heating the air, to ensure the utilization of low-grade heat and save energy in the DM system.

ISSN: 2350-0328
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