JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS

VOLUME 5, ISSUE 03
MONTHLY JOURNALS

ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

DEVELOPMENT OF A COMPLEX OF ENERGY-SAVING MEASURES AND TECHNICAL AND ECONOMIC ASSESSMENT OF THEIR EFFECTIVENESS

Khafizov Islom Ikramovich*, Ph.D., dotsent,*
Asia International University

Abstract

Annotation. This article analyzes a comprehensive assessment of the current state of energy consumption, identifies losses, and identifies ways to improve resource efficiency. During the company's energy audit, potential for reducing fuel and energy consumption and improving equipment efficiency was identified. Based on the data obtained, a set of organizational and technical measures was developed to reduce energy losses, streamline operating modes, and implement modern energy-efficient technologies.

Keywords

energy audit, technical and economic assessment, energy saving, energy efficiency, heat exchanger, variable frequency drive, boiler and pumping equipment, heating mains, metering and automation systems.

Introduction

In the context of implementing state energy conservation and energy efficiency policies in the Republic of Uzbekistan, special attention is being paid to heat supply systems, as major consumers of fuel and energy resources. Energy audits are a key tool for comprehensively assessing the current state of energy consumption, identifying losses, and identifying ways to improve resource efficiency.

Although ISO 50002:2014 is not a mandatory document in Uzbekistan, it is actively used as a methodological basis for preparing energy audits. ISO 50002:2014 ensures professional quality and international comparability of audit results, while local legislation ensures the regulatory and legal admissibility of the conducted survey.

Energy balances are a key stage of energy surveys, providing a quantitative understanding of the supply, distribution, conversion, and losses of all types of fuel and energy resources at facilities. An energy balance shows how much energy is supplied to a facility, how it is used, where and how much is lost, and where potential for energy efficiency improvements lies [1]. It covers both primary process equipment (boilers, pumps) and auxiliary systems (ventilation, lighting, automation, etc.).

The purpose of energy balances is to ensure complete transparency of energy flows at the facility and provide a basis for assessing energy efficiency. Key functions:

1. Identification of unaccounted losses and deviations from standards;

2. Establishing the share of each type of consumption;

3. Identifying priority energy conservation zones;

4. Justification and calculation of the effects of implementing energy conservation measures.

During the company's energy audit, potential for reducing fuel and energy consumption and improving equipment efficiency was identified. Based on the data obtained [2], a set of organizational and technical measures was developed aimed at reducing energy losses, streamlining operating modes, and implementing modern energy-efficient technologies.

The proposed measures encompass both low-cost and quickly implemented solutions and investment projects requiring additional capital investment. A feasibility study was conducted for each measure, including calculations of potential energy savings, reduced emissions, expected annual monetary savings, and payback periods [3].

The purpose of this article is to systematize the identified measures, present their feasibility study, and determine implementation priorities based on their maximum effectiveness for the company.

The development of a set of energy-saving measures is based on the results of an instrumental survey, analysis of equipment operating modes, and identified deviations from standard energy efficiency indicators [4]. The following principles were taken into account when developing the list of measures:

1. Priority of organizational and technical solutions that do not require significant capital investment and ensure rapid returns by optimizing equipment operating modes and eliminating identified losses.

2. Feasibility of investment measures aimed at modernizing and replacing obsolete equipment with poor technical and economic characteristics, with a mandatory assessment of payback periods and expected economic efficiency [5].

3. A comprehensive approach encompassing all major enterprise systems: boiler and pumping equipment, heating mains, metering and automation systems, electrical installations, and lighting.

4. Compliance with current regulatory requirements of the Republic of Uzbekistan and international energy efficiency standards.

5. Realistic and phased implementation, allowing the enterprise to systematically implement measures taking into account production specifics, financial capabilities and operating conditions.

Thus, the proposed set of measures is focused on both quickly implemented, low-cost solutions and long-term investment projects that ensure sustainable reductions in energy consumption and improved plant efficiency.

Based on the results of the plant's energy audit, a list of measures was developed to reduce fuel and energy consumption and improve overall equipment efficiency. This list was compiled taking into account actual measurement data, energy balance analysis results, and identified technical and organizational deficiencies in equipment operation [6].

Recommendations:

1. With an annual operating time of boiler #4 of 4,320 hours and an actual hourly fuel consumption range of 3,400–5,000 m³, the estimated savings at 0.5% range from 73,400 m³/year to 108,000 m³/year. The average fuel savings are estimated at approximately 90,700 m³/year. 2.

With each boiler operating for 4,320 hours annually and an hourly natural gas consumption range of 3,400–5,000 m³, the estimated fuel savings due to a 2% efficiency increase for one boiler range from 293,800 m³/year to 432,000 m³/year, and for two boilers combined, from 587,500 m³/year to 864,000 m³/year. The average expected savings are estimated at approximately 726,000 m³ of natural gas per year.

3. Scheduled maintenance of blower fans (bearings, lubrication, cooling) helps reduce mechanical losses and energy consumption by the fan equipment. With a single fan installed at 7.5 kW, four to six units operating simultaneously, and an annual boiler service life of 4,320 hours, the estimated energy savings from this measure range from 2,600 to 3,900 kWh per year. The average expected effect is estimated at approximately 3,200 kWh/year, confirming the technical feasibility of this measure.

4. With the NUV 350D-90 pump's nominal capacity of 630 kW and an actual variable load of 35–45%, the power consumption ranges from 220.5 to 283.5 kW. With an annual service life of 8,640 hours (360 days), the base annual energy consumption ranges from 1,905,120 to 2,449,440 kWh. With the implementation of a variable frequency drive and a 10% reduction in specific consumption, the estimated annual energy savings will be 190,512–244,944 kWh. The average expected effect is estimated at approximately 217,728 kWh per year.

5. Scheduled flushing and cleaning of heat exchangers will improve heat transfer and reduce hydraulic resistance. With an annual heat output of 727,631 Gcal in 2024 and an expected savings effect of 1%, the estimated reduction in fuel consumption will be approximately 7,276 Gcal per year, equivalent to approximately 897,000 m³ of natural gas per year (with a net calorific value of 8,114 kcal/m³).

6. The restoration and installation of thermal insulation on main and distribution sections of heating networks, as well as on shut-off and control valves, ensures a reduction in surface heat loss and stabilization of temperature conditions. With an annual heat output of 727,631 Gcal in 2024 and an adopted loss reduction potential of 2%, the estimated savings amount to approximately 14,553 Gcal/year. In terms of natural gas with a net calorific value of 8,114 kcal/m³, this is equivalent to approximately 1,793,520 thousand m³/year.

CONCLUSION

As a result of measurements in Selnikel steam boilers, it was found that the concentration of CO and nCO is higher than the norm, the temperature of the flue gases is at the level of 142–145 °C, and the air-gas mixture is not brought to the optimal ratio. These factors indicate incomplete combustion, partial combustion of the fuel, and a decrease in thermal efficiency. During the mode adjustment process, air consumption, gas consumption, fan frequency, valve opening angle, and all burner operating stages are adjusted to the actual boiler load.

Annual natural gas economy: Annual gas consumption*1.5%=2209300*0.015=33 140 m3/year

A total of 92 meters of steel pipes with a diameter of 32 mm to 200 mm leading from the boiler room to the steam and heating systems are currently operating without insulation. In pipes without thermal insulation, convective and radiant heat losses are high on the surface, resulting in a temperature drop in the steam line and excessive fuel consumption of the boiler. By covering the pipes with completely new mineral wool-based insulation, heat losses are reduced.

Annual natural gas savings: 34,082 m3/year.

A total of 866 meters (d25–d150) of heat pipes in the dyeing, washing, drying, packaging and finishing shops are currently operating without insulation, resulting in a heat loss of 165.45 kW. These losses lead to excess steam production in the boiler, which causes an inefficient consumption of approximately 151,840 m³ of natural gas per year. By fully insulating the pipes, these losses are stopped and the heat load of the boiler room is reduced.

The existing condensate collectors at the enterprise are technically outdated, their internal mechanisms are clogged, and the steam traps cannot fully perform their opening and closing functions. As a result, the transfer of condensate to the central return system is slowed down, the steam pressure is not maintained at the same level, and a certain part of the condensate is lost in the production area. Due to the technical malfunction of the condensate collectors, the boiler load increases, and the annual natural gas consumption increases.

In order to eliminate these shortcomings, it is planned to replace 5 condensate collectors installed in the enterprise's steam system with new, highly efficient float-type or thermostatic condensate collectors. The new devices will ensure continuous and stable return of condensate, prevent unnecessary steam leakage, and increase pressure stability within the system.

Annual natural gas economy: Annual gas consumption*1%=2209300*0.01=22,093 m3/year

The RDUK-200 gas distribution and pressure reduction equipment available at the enterprise has been in use for a long time. During operation, the internal valves, membranes and sealing elements of the equipment have worn out, and interruptions, micro-leakages (gaps) and inaccurate adjustments are observed in ensuring gas pressure stability. This situation leads to an excessive increase in natural gas consumption, especially in unstable operating modes of boiler rooms, steam generators and technological heating equipment.

As part of this event, it is proposed to replace the existing RDUK-200 gas distribution unit with a new model with modern, high-precision, two-stage protection. The new equipment accurately and stably controls gas pressure and completely eliminates micro-gaps. This reduces the company's overall gas consumption by an average of 2%.

Literature

1. I.I.Khafizov. Development of a system of automatic change of working modes of group control stations. Web of Semantics: Journal of Interdisciplinary Science, 3(2), 29, (2025). ISSN: 2960-9550.
2. I.I.Khafizov. Calculation of transient processes during the start-up of an electric drive with an asynchronous motor connected directly to the network. Journal of Applied Science and Social Science, 15(9), (2025).
3. I.I.Khafizov. Advancements and practical deployment of frequency-controlled drives in pumping infrastructure. Journal of Applied Science and Social Science, 15(10), (2025).
4. I.I.Khafizov. Methods for automatically changing the operating modes of group control centers. Journal of Multidisciplinary Sciences and Innovations, 4(10), (2025).
5. I.I.Khafizov. Mathematical modeling of ion implantation processes into a GaAs(001) single crystal to increase the efficiency of solar cells. Journal of Multidisciplinary Sciences and Innovations, 4(11), (2025). ISSN: 2751-4390.

6. X.I.Hafizov, and S.J.Nimatov. Fundamentals of developing an intellectual model for controlling electricity consumption in the energy system. In Proceedings of the Republican Scientific and Practical Conference "Problems of Energy and Energy Saving", (2025).