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Energy Efficiency of Technological Equipment at the Economic Agent by Identifying the Points with Recoverable Heat Potential

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For an energy-efficient future, the EU needs to step up its efforts to maximize energy savings. In this context, the paper addresses the steps needed to establish energy efficiency measures and proposes effective measures to reduce consumption by recovering large amounts of energy lost to industrial consumers. The points with the highest recoverable energy potential have been identified and it is proposed to install the heat recovery systems on the flue gas exhaust circuits and polluted air from Industrial Technological Equipment (ITE) such as dyeing/drying cabins (DDC). Therefore, whenever possible and as small as energy saving, energy recovery solutions at any level, but especially at local level, need to be applied. In conclusion, by concentrating all the energy-saving efforts that are still being wasted, Europe can contribute, by saving energy, to ensuring a sustainable energy future.

Keywords: *energy, recovery, industrial consumers, efficiency, resources*

1. Introduction

Through the 2020 strategy, the European Union (EU) has proposed increasing the use of renewable energies and building smarter and more diverse energy grids in order to ensure sustainable energy supply and support for economic growth. Therefore, by making more efficient use of energy and resources, by encouraging research and innovation, by modernizing the industry and using smart grids more efficiently, an energy-efficient Europe can be achieved [1].

In recent years, due to the major energy challenges caused by high energy imports, the EU has had to take measures to reduce energy losses generally caused by inefficiency [1]. The main orientations have been focused on reducing fossil fuel consumption and its impact on climate change.

Simultaneously with the application of innovative and competitive measures in the economy through energy-intensive technologies development, products and services, progress has been made in the EU towards increasing energy efficiency. Energy saving can help to achieve the EU target of 20% primary energy consumption and carbon emissions reduction by 2020 [1], [2], [3].

Policy and action policies have been established for each sector, international investment and collaboration has been achieved, but the EU has only three years to reach its energy savings target. In order to ensure energy efficient present and future, the EU needs to step up its efforts to maximize energy savings. Major energy savings can be made in the energy and end-use sector. Many end-users of energy already consider energy efficiency and environmental impact when purchasing goods, services and works. However, additional energy savings are needed in all sectors (energy supply and final use).

On the other hand, it is necessary to step up the efforts of the EU Member States to increase the efficiency of the energy production and distribution sector because a large amount the energy used in the EU is lost during the transformation. Thus, the determination of losses recorded in this sector of activity is a European priority. Therefore, energy programs for the recovery of waste energy must be applied in all sectors of activity.

Energy is still being wasted at all levels of consumers, ranging from home and industrial consumers.

One of the main applicable measures in the industrial sector, which can help maximize energy saving, is to identify the recoverable potential of each consumer, to establish and apply solutions locally.

Worldwide, the economic crisis has helped to reduce total energy consumption but has delayed and even prevented the introduction of energy efficiency measures. By raising consumers' awareness regarding the need of energy consumption reduction through the diversity of programs and tools designed to help the energy saving potential release, Europe will be able to reduce fuel consumption and meet its 2020 targets.

As far as Romania is concerned, the ANRE (National Regulatory Authority for Energy) report of April 2016 presents data indicating that in Romania the primary energy consumption decreased in 2014 compared to the previous years, in the conditions of GDP growth (Figure 1), which leads to the conclusion of an increase in energy efficiency in the final consumption sectors (Figure 2a). [3].

Even if energy consumption in the industrial sector increased in 2014 compared to 2013 (Figure 2b), it cannot be considered as a decrease in energy efficiency because the added value applied to the production in this sector increased by 2013.

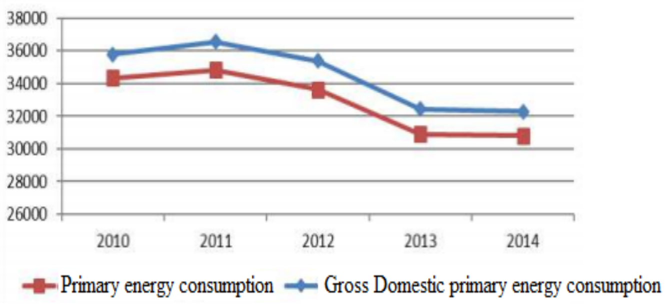
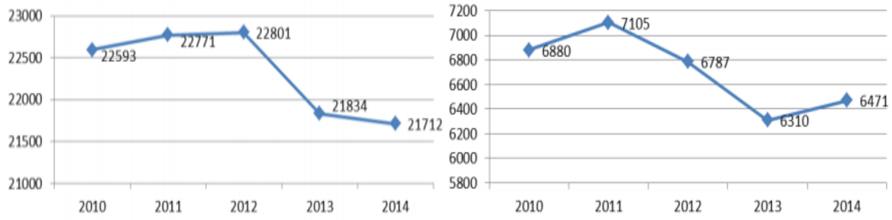


Figure 1. Evolution of gross domestic consumption of primary energy and primary energy consumption - in thousands tep (tone equivalent petrol) (Source: https://ec.europa.eu)



a) b)

Figure 2. Evolution of final energy consumption - - in thousands tep (tone equivalent petrol) (Source: https://ec.europa.eu)
a) total, b) in industry

2. Stages required in order to establish energy efficiency measures

The main measure in order to improve the energy efficiency is to increase the production of energy from exploited and less exploited renewable resources. On the other hand, energy efficiency can be achieved by reducing consumption especially to the industrial consumers, who are identified as big energy consumers, but also large wasted energy producers.

In this regard, the paper presents the required steps to be taken to establish measures in order to reduce energy consumption to the industrial consumers [4]:

- mounting of the measuring devices and equipment required for energy consumption monitoring systems (electrical, thermal and gas) for industrial consumers with high consumption;

- mounting of sensors and control equipment for measuring and monitoring the parameters of industrial processes;
- sett-up of data acquisition systems with which to create databases useful for identifying solutions in order to maximize energy savings;
- comparative analysis of the identified solutions and optimal solutions selection and implementation.

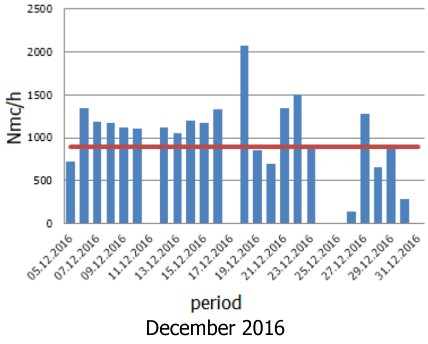
Following these steps contributes to:

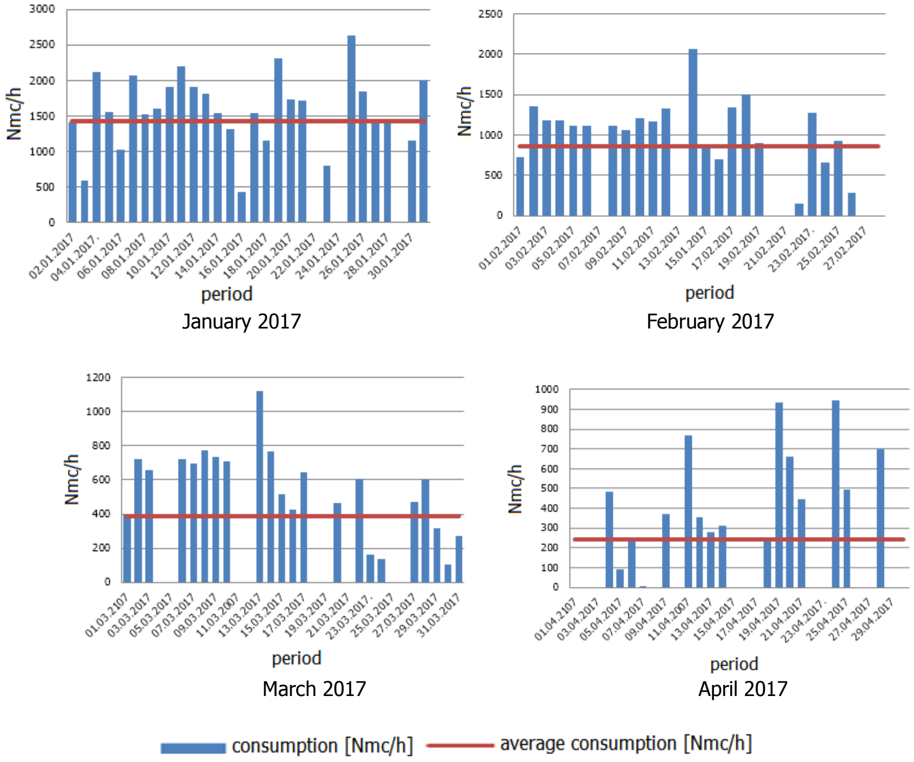
- recoverable potential identification and quantification;
- establishing processes with the highest recoverable potential in order to reduce the energy losses immediately;
- identification of optimal solutions for recovering any type of wasted energy;
- establishing measures in order to increase energy efficiency that can be applied to the consumer.

3. The recoverable thermal potential identification to the technological equipment such as dyeing/drying cabins (DDCs)

In order to identify the recoverable heat potential required to establish energy consumption reduction measures for the ITE (Industrial Technological Equipment) of DDC (Dyeing/Drying Cabins) type, were installed FMG 160 meters with rotary pistons of FMR series for measuring the natural gas fuels consumption, hourly counters type AEGUWZ 48 for recording the operating hours and temperature sensors PT 100 connected to the YCT R1-6111Temperature + RTD Temperature Data Logger [5], [6].

The results of monitoring consumption in the first phase of October-November were reported and disseminated in articles published in conferences with international participation [5], [6] [7]. For this reason, the paper presents the results obtained in the next monitoring phase, namely December 2016-April 2017 [4]. Due to the fact that the paper addresses the measures for recovering the waste heat, in Figure 3 is plotted the monthly fuel consumption recorded during this period.





January 2017

February 2017

March 2017

April 2017

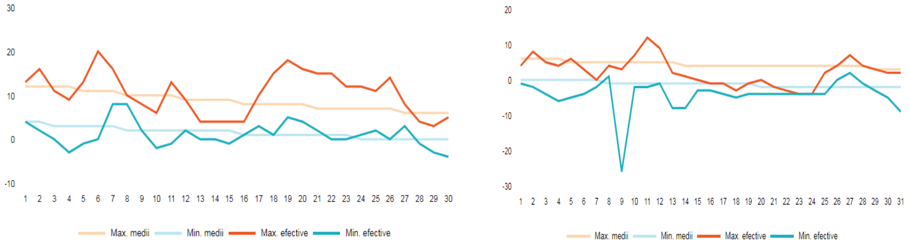
Figure 3. Monthly combustible natural gases consumption between December 2016 and April 2017

Between December 2016 and April 2017, the operator recorded a total consumption of 109496 Nm^3, according to the graphical representation in Figure 3, which corresponds to a daily average consumption of 1,032.98 Nm^3/day and a global hourly average of 2, 33 Nm^3/h.

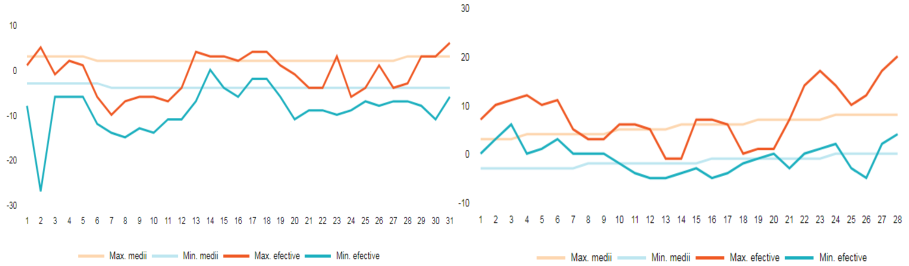
The daily average consumption recorded during this period (cold period of the year) compared to the one recorded in the previous period (October-November) is higher due to the fact that the heating system for the production, storage and office areas, supplied with gaseous fuel, was put into operation.

In order to establish the solutions for the wasted heat recovery, the flue gas and polluted air circuits were subjected to thermography. Between October and November, the flue gas exhaust circuit recorded temperatures of 135°C, and on the polluted air output circuit temperatures were between (13.5-15.3)°C [5], [6].

The indoor temperature in the area where the DDC are located is significantly influenced by the outdoor air temperature. Within the DDC, a minimum temperature of 6.8ºC [5] was measured during their non-operating period on November 29 [6]. Thus, in order to check the influence of the air temperature outside the DDC on the recoverable heat amount, the outdoor temperature weather records (Figure 4) [8] were analyzed.



November 2016 December 2016



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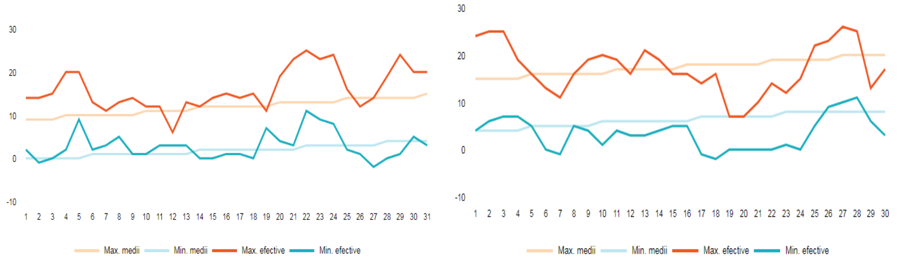
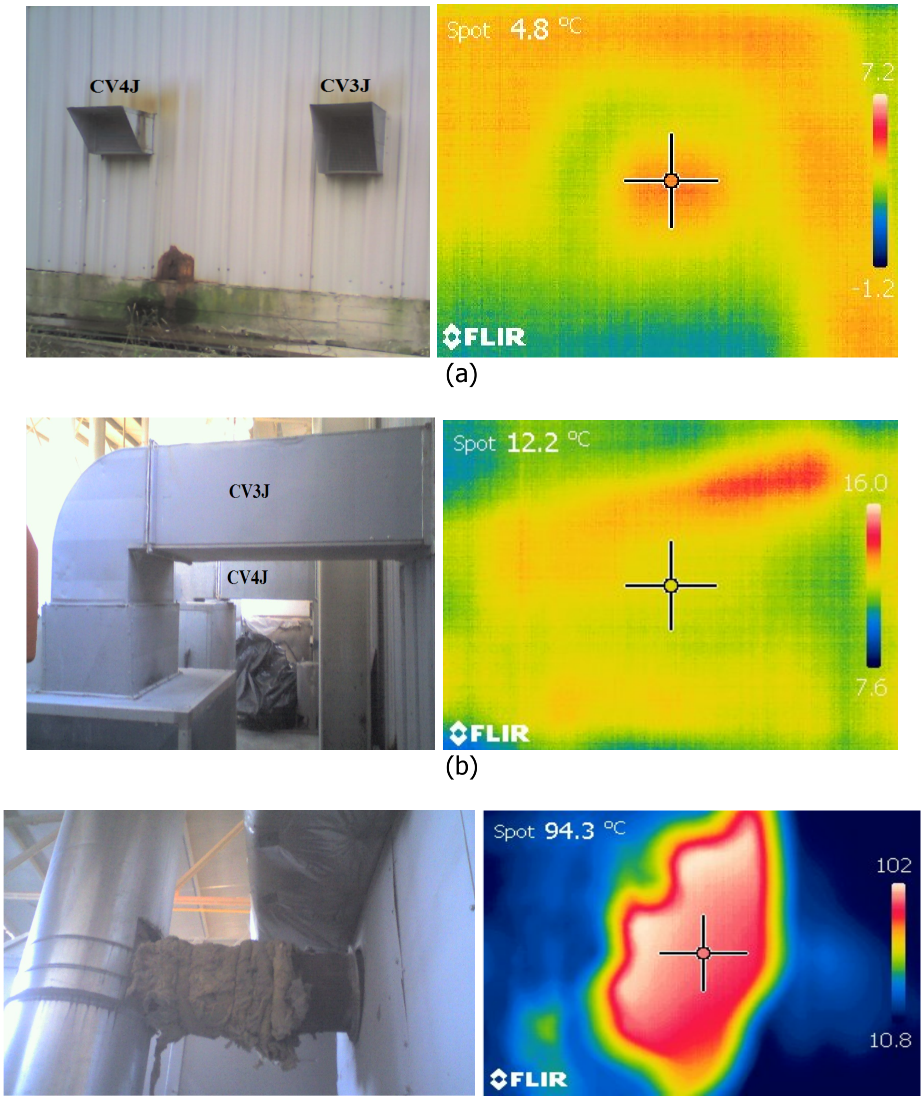


March 2017 April 2017

Figure 4. Meteorological recordings during November 2016-April 2017 (Source: http://www.accuweather.com/ro/ro/biled)

From Figure 4, it can be seen that in November average outdoor temperatures are slightly above 0°C, between December 2016 and February 2017 they fall below 0°C, and from March 2017 they rise between 0°C and 10°C.

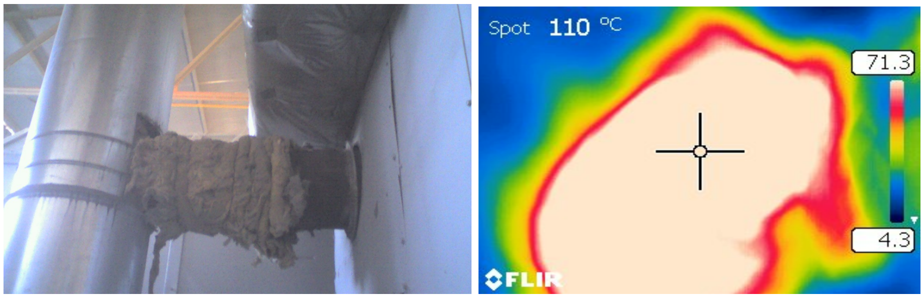
The exhausted circuits were re-subjected to thermography during January and April (Figure 5).



(a)

(b)

(c)



(d)

Figure 5. Exhaust circuit thermography from CV3J
a – Minimum temperature in the polluted air exhaust grid
b – Minimum temperature in the polluted air exhaust circuit
c – Minimum temperature into flue gases exhaust circuit (Dec2016-Feb2017)
d – Minimum temperature into flue gases exhaust circuit (Mar2017-Apr2017)

From the thermography of the exhaust circuits (Figure 5) carried out in 2016 between October-November [6] and 2017 respectively during the January-April period, it can be noticed that the flue gas temperatures and vapors variation depend on the outdoor temperatures, which means that these temperatures influence the recovered heat amount. On the flue gas outlet circuit, it was recorded a temperature decrease of 40.7°C between December 2016 and February 2017 and of 25°C between March 2017 and April 2017. On the polluted air circuit the recorded temperature difference has a variation of (1.2 – 8.7)°C.

Part of the wasted heat is dissipated in the environment where the DDCs are located due to the fact that the piping of the evacuation circuits is not isolated. On the other hand, the area in which the DDCs are located is not equipped with a heating system, which leads to an increase in energy consumption due to the fresh air supply into the heat exchanger with a temperature close to the outdoor one.

Due to the low temperatures recorded inside the DDC during non-operating periods, a longer burner operation and, implicitly, an increase in energy consumption are achieved to reach the temperatures required for optimum dyeing / drying processes.

Therefore, the recovery of the wasted heat on both the exhaust and the vaporous exhaust circuit contributes to reducing the number of operation hours of the DDCs burners and implicitly the combustible natural gas consumption. For the analyzed ITE, this solution can be improved by insulating the polluted air exhausted piping and those for supplying air into DDCs. On the other hand, the insulation of the DDC walls will maintain the temperature inside the cabins.

From the presented data analysis, the recovery of the wasted heat by mounting heat recovery heat exchangers [9] on the flue gas outlet was identified as an optimal solution. In the cold period of the year, the solution can be supplemented by mounting heat exchangers also on the polluted air exhaust circuit.

5. Conclusions

In order to reach the 2020 targets, Europe can no longer afford to lose energy. Consequently, end-users need to maximize their energy-saving potential. In most end-user sectors there are still large energy losses that are not recovered. For this reason, energy saving should start by recovering and capitalizing the wasted energy.

For proper energy management and the application of optimal energy recovery measures, it is necessary to know and observe certain stages.

Technological facilities of the DDCs type identified as energy-intensive consumers to the industrial agent evacuate into the atmosphere with the exhaust gases and the polluted air, a large amount of heat that is not being utilized. From the analysis of the presented data, it can be argued that the highest wasted heat recovery potential for technological equipment such as DDCs is provided by the flue gases, but for the cold periods of the year also the exhausted polluted air circuit represents a significant potential.

The conclusion is that energy efficiency measures need to be addressed to every end - consumer, and it is necessary to think globally but to act locally and learn from other countries' relevant energy saving actions.

Acknowledgment

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