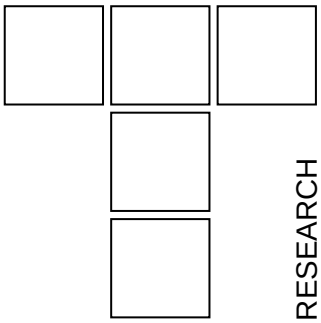
B. JEREMIĆ

Energy Efficiency Through Improved Mintenance



Inappropriate maintenance of technical systems is the main reason of unnecessary losses and low energy efficiency. Appropriate strategy and technology of maintenance has the key importance for energy efficiency and preservation of energy resources. On the other hand, improvement of maintenance system in order to increase energy efficiency is task that demands long term preparations and noticeable financial investments that shortly produces measurable benefits. In this paper systematic approach to dependance analysis of technical system maintenene and energy efficiencey as well as experience of Center for Terotechnology is given. The results from different projects in different industry branches point that beside losses in technical systems, large and unnecessary dissipation of energy appears as a result of inappropriate maintenance of a part of energy transmition system (thermal energy and steam energy pipes, electro lines...). All mentioned problems exist in industrially developed countries, but they are anticipated, and national strategies are developed. In our country, importance of maintenance of technical system and influence on energy efficiency has not been realized yet, so there is no adequate strategy of our Government departments.

Keywords: *Energy efficiency, maintenance*

1. INTRODUCTION

Positive changes in our economy and industry, comparing last 10 years, were expected after the year 2000. During last 5 years new criteria were introduced and large improvements were made in the world and in the same time degradation of our economy and industry was continued. Most of our companies still reduce amount of production. This is accompanied by inappropriate maintenance of technical systems and shortage of resources for their modernization, so specific usage of energy in our industry even increased.

Considering the fact that equipment is mostly old and almost completely technologically old fashioned; and this equipment in all period is mostly used for corrective exploitation, it is clear that the first step should be made in changes of strategy of maintenance and elimination of large energy losses.

Predicted increase of energy efficiency of our industry for 20% until 2010 is absolutely unsatisfactory because it will produce even wider gap between us and Western European countries. The authors of this strategy surely failed to estimate our present condition. Losses of energy in almost all industry branches are extremely high. In order to overcome existing gap between us and Western Europe we need fast, well organized and aggressive approach on all levels. This is one of preconditions for our economic improvement, and in the same time, large challenge for our scientific and expert community. We must not neglect complementary component that refers to even more dangerous and important restrictions connected with international standards in the field of environment protection where maintenance of technical systems has dominant place.

All listed problems, on global level, are solved in industrially developed countries. They have continuous increase of energy efficiency trend (Figure 1.) realized through implementation of modern concept of maintenance, new technologies and technical solutions and elimination of unnecessary energy losses even on micro level [1].

The actual criteria for European Union are annual increase of energy efficiency of 3%. In our country [2], on contrary, trend of energy efficiency decreases (Figure 2).

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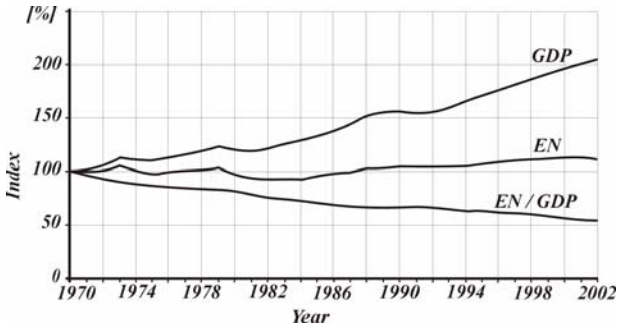

Figure 1. Trend of energy efficiency indicators in Great Britain

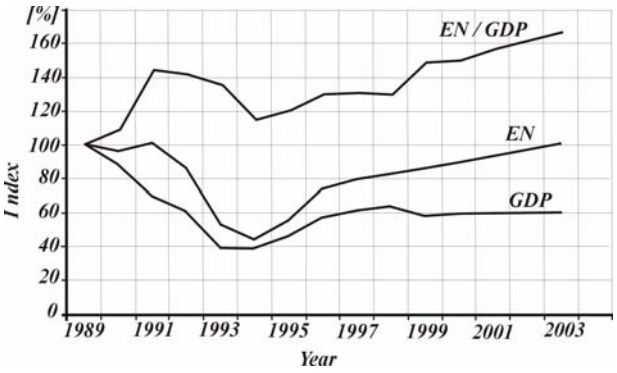

Figure 2. Trend of energy efficiency indicators in our country

Indicators on Figures 1 and 2 are: GDP- Gross Domestic Product, EN- Primary energy consumption and EN/GDP- Energy ratio.

Through characteristic example presented in this paper, it is emphasized that business philosophy and understanding of role and importance of maintenance in the field of energy efficiency must be changed. As the first step reality about level of energy losses, (in some cases they could be more that 50%) must be accepted. The most common activities in reduction of such large losses are not connected with financial investments but motivation of employees for more rational business activities. The second problem is who and what could motivate employees to make their maximal contribution in improvement of energy efficiency. Process of economic transition has real characteristics, so in our area there are four categories of business entities with different approaches in strategy of maintenance and energy efficiency. These entities are:

- multinational private companies, with business philosophy similar to their branches in the world (maintenance activities for energy saving and reaching the goal of "zero defect"),
- privatized companies as stock companies or through partly investment of domestic or foreign financial resources (with investments in maintenance and energy efficiency and approaching to European criteria in this field in the period of maximum 5 years)
- communal and public companies (unsatisfactory improvement in maintenance with existing declaration about rational consumption of energy but with verz low results) and
- private companies (in ownership of our citizens) with strategy of rapid payoff of investments with changing of activities or company selling (with the lowest investments in maintenance and without any care about energy efficiency).

From previously mentioned facts, it is clear that business entities do not share common view on issues of influence of maintenance on energy efficiency.

2. SYSTEMS WITH POTENTIALLY LARGEST SAVINGS OF ENERGY THROUGH MAINTENANCE

In following discussion installation or technical systems where is possible to improve energy efficiency without large financial investments were analyzed. This mainly refers to:

- Production and distributive system of hot water and heated steam,
- Electro motors and electro distributive systems and,
- System for production and distribution of compressed air.

2.1. Production and distributive system of hot water and heated steam

Larger cities in our country have central heating systems with many boiler rooms for specific parts of the cities. Boiler rooms have specific purpose in some cases (hospitals, kindergartens, larger companies). Heating expanses are usually donated from republic sources or there are large debts for spend energy resources (crude oil, gas, coal). The business effects are far away from profit, and one of the reasons is low energy efficiency.

On the project of technical diagnostics [3]. that we performed in the condition of low temperature after complains of citizens on inappropriate heating in their homes, we come with results presented on Figure 3.

As the result of inappropriate maintenance of pipe distribution system of hot water (damaged isolation, and important losses due to leaking of hot water), producer of thermal energy, in the period of low

outside temperature, was forced to switch on more pumps in order to increase flow. Maximal flow (which is only 15% higher that flow produced with basic setting of pump) is produced at more that doubled consumption of electric energy (Figure 3). Flow of 345 m3/h is produced with 0,32 kW/(m3/h) consumption of electrical energy on flow unit, and flow of 395 m3/h with 0,71 kW/(m3/h). Considering leaking of hot water on pipes of 6.6% it could be concluded about activities necessary for improvement of energy efficiency.

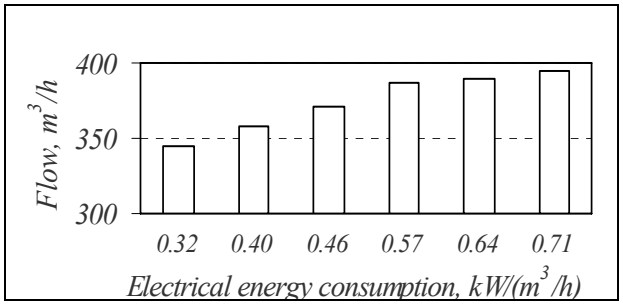

Figure 3. Electric energy consumption in correlation with flow of hot water on one main heat direction

The next example from our practice [4] refers to diagnostic of losses in steam distribution system of 800 m length and high thermal power. Modern sophisticated systems for simultaneous monitoring of parameters of steam (pressure, temperature, thermal power, etc) were used in producer of thermal energy and consumer. Beside mentioned, infrared thermograph was used for diagnostic of isolation of pipe system. Defined losses in the regime of normal production and consummation of steam are approximately 3.4 MW. For explanation of causes of this, very high thermal losses we present Figure 4.

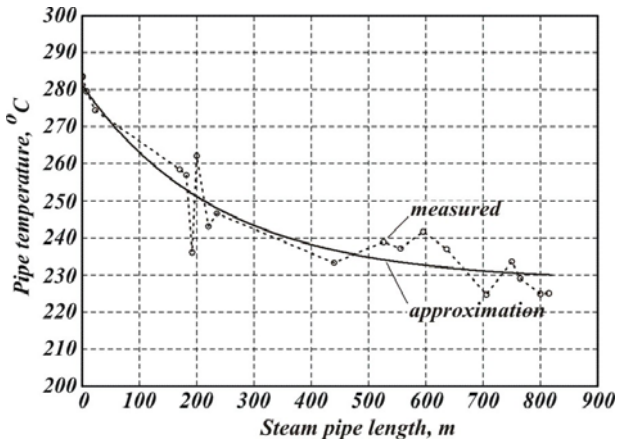

Figure 4. Changes of pipe temperature in a function of steam pipe length

Total decrease of temperature on complete length of pipe is 55 0C which is presented on the Figure 4.. This is verification of starting hypothesis about important thermal losses of steam in transport between producer and customers.

Mentioned steam distribution system is inappropriate maintenance. Reason for this is that pipes do not have isolation on some sections or isolation is partly damaged. During the rain season isolation material absorbs water and it changes homogeneous and isolation characteristics in damaged (broken) isolation shield and lead to deformation of isolation material. Space between pipe and shield behave as ventilation and increase losses.

Everything mentioned above was used for definition of tasks for maintenance service, in order to decrease losses and increase energy efficiency of distribution system.

The most important results in improvement of energy efficiency of production and distributional systems of hot water and heated steam could be achieved through: changing of isolation on pipes during the intervention of maintenance service, improvement of isolation and reduce of leaking (permeability).

Such as Murphy's lows, similar rules exist in intervention of maintenance services on distribution system of water or steam. Isolation is never changed. After some time isolation becomes fragile or rotten and it is necessary to change isolation to improve saving of energy. Energy efficiency is even higher if staff from maintenance service uses thicker isolation layer shield or material with better isolation characteristics.

The most relevant factors in selection of isolation material are: low thermal conduction, stability of dimensions during temperature changes, resistance on water absorption and resistance on burning. Some examples from practice points that valid selection of isolation material could decrease energy losses for 90%.

There is no distribution system of hot water or heated steam in our country without losses caused by leaking. In energy plants, during the heating seasons, as well as on distribution systems for hot water or steam, from very long distance we can notice "clouds", resulted with inappropriate sealing and leaking. It is well known that 3% of energy is lost due to small leaking, so the main task of maintenance, in situation of larger losses, are losses on joints or valves. It is estimated that investment

in improvement of sealing in distribution systems of hot water or steam pays off after 4 months.

2.2. Electromotors and electro-distributive systems

Electro-motors is the most dominant drive systems in all industry branches. Considering that fact electromotor are the main consumers of electric energy – Figure 5.

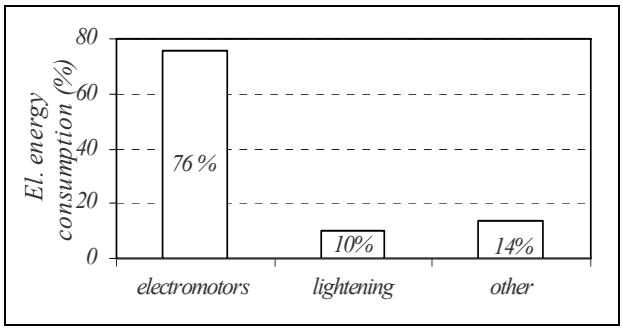

Figure 5. Distribution of electric energy consumption in industry

Personal experience as experience of other associates of Center for Terotechnology, in all branches of our industry on jobs of technical diagnostics, points that maintenance services do not pay attention on this drive systems. In most of the cases, especially when the power of electromotor is from few hundreds of KW up to few MW, even the smallest action on preventive maintenance referring to clearing has not been taken.

Effective electromotor system management develops synergies between preventive and predictive maintenance programs, equipment operation and process productivity to establish a repair/replace policy based on a commitment to energy-efficient equipment selection and operation.

Electro distributive system has large influence on energy efficiency and performances of electromotor. The starting activities in elimination of problems of low efficiency of electro motors are connected with detection and correction of bad contacts – electro contacts. These contacts, beside other things, lead to catastrophic failures and possible fire situations. The next phase is definition of voltage disbalnce, condition of isolation and detection of sub-dimensioned conductors.

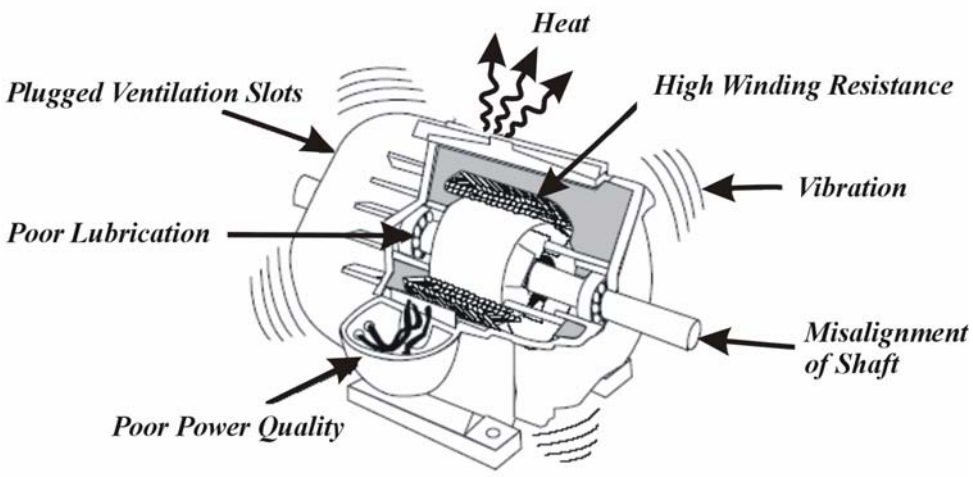

Figure 6. Sources of potential losses of efficiency in electro motors which could be eliminated with proper maintenance

It is obvious, according to Figure 6, that most of negative causes (closed ventilation holes, insufficient lubrication, low quality of voltage and electric power, vibration, problems associated with shaft) lead to heat or over heat of electromotor, and significant decrease of energy efficiency [5]. Potential causes of decrease of energy efficiency mostly could be reduced if employees on maintaining activities perform the following tasks:

- Cleaning – clean electromotor has lower temperature and lower possibility of failure due to influence of contamination material,
- Lubrication- inappropriate lubrication influence on friction losses as well as reduce life cycles of bearings,
- Shafts alignment – increased vibration and potential failures of bearings in most cases are resulted by insufficient adjustment of drive shaft of electromotor and driven shaft,
- Vibro-diagnostic and diagnostic of thermo conditions- increased level of vibration and working temperature directly influence on duration of components and energy efficiency,

- Monitoring of working parameters – stability of number of revolutions, voltage, electric current and characteristic of power factors have dominant influence on energy efficiency and
- Isolation test – degradation of isolation of windings influence on level of losses and efficiency of electromotor.

2.3. System for production and distribution of compressed air

Compressed air is probably the most expensive working medium in industry, because compressed air is produced and distributes with very low energy efficiency/ typical efficiency in the chain from the start (producer) to the end (consumer) is bout 10%. Inappropriate maintenance is the main reason of low energy efficiency and large losses due to imperfection of joints and leaking of air on lines and equipment. Available methods for reduction of energy in production and distribution of compressed air are not very expensive. With well prepared programs and rational maintenance of all resources in maintenance service, period of return of investments in improvement of energy efficiency of systems for production and distribution of compressed air is less than a year.

3. CONCLUSION

Good strategy and maintenance technology have key importance for energy efficiency and care for preservation of energy resources. The most common activities in our industry considering reduce of high energy losses are not related to high financial investments but motivation of all employees for more rational business processes.

Our industry possess equipment or technical systems where maintenance services could ad-hoc and very quickly increase energy efficiency, without considerable financial investments and save more then 50% of energy. This is mostly referring to: production and distributive system of hot water and heated steam, electromotors and electro-distributive systems and systems for production and distribution of compressed air.

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