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Estimative analysis of investment payback for industrial spaces heated with radiant tubes

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Abstract: Currently, energy consumption reduction can be considered a priority due to high fuel prices used for space heating. Therefore, for industrial buildings where technological processes which are taking place require specific climate conditions, the energy consumption reduction is achievable through the implementation of efficient heating systems in terms of energy.The paper presents an analysis of the radiation heating systems in terms of economic efficiency. In this regard, there are considered two types of radiant tube heating systems powered by three fuel types, in order to assess the investment payback. Thus, there were compared both the annual fuel consumption during the system operation and installation costs. Based on the obtained results, there was revealed the best version of the heating system for the considered industrial space.

Keywords: radiant tube, consumption, investment, energy saving

1. Introduction

One of the main condition that must be met by a heating installation is the thermal comfort inside the area served by the installation. Simultaneously, there has to be provided a more uniform air indoor temperature, without high temperature differences on vertical direction.

In addition, in order to obtain the global factor of thermal comfort is necessary that the relative humidity and air flow speed values to be within the environmental comfort limits of [1], [2], [3].

On the other hand, in order to provide heating system optimum operation and energy consumption cost reduction, it is required in addition to hydraulic balancing of the network, the adjustment of the thermal load and endowment with measurement and control devices, also to ensure the extension or partial operation. However, heating must meet all quality requirements imposed by law on construction quality [4].

A significant building category that records high consumption and costs is the industrial building. To meet the demands of indoor thermal comfort while reducing energy consumption, it is necessary to implement more efficient heating systems. In this regard, radiant tube heating systems meet these goals, especially for areas with large heights [5], [6], [7].

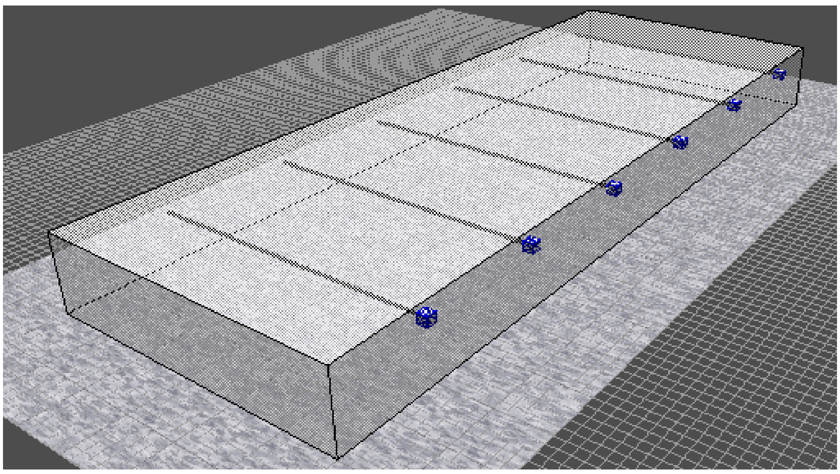
2. The approach mode

For industrial buildings, the heating system selection is influenced by destination and space dimensions, and also by the activity type. Radiant heating systems are recommended for heating large areas with high and medium height with discontinuous operation mode [8 - 9].

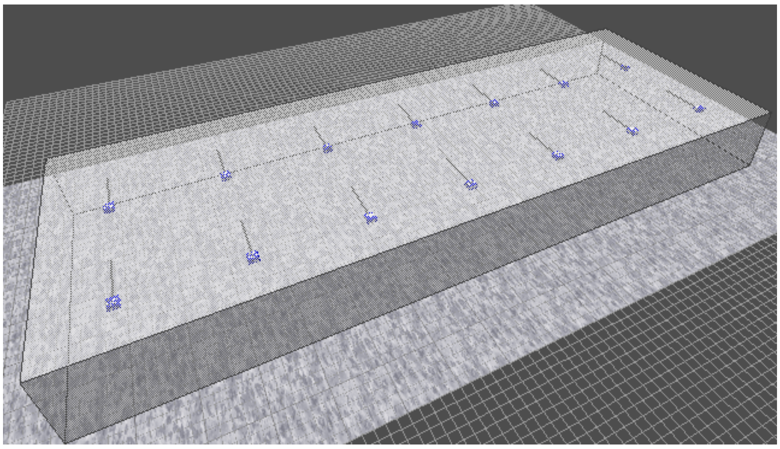
In order to choose the optimal solution in terms of investment and reduced energy consumption there are comparatively analyzed OHA and INFRA radiant tube heating systems. For this purpose, their layout is modeled (Fig. 1) [10] inside an industrial building with the following geometric dimensions: 80m length, 30m width and 8m height, located in Timișoara. The hall walls are made of sandwich panels and the floor of concrete.

The heating systems constructive solutions are generated based on input data required by the Systema software, as follows:
- the type of construction materials;
- environmental parameters (-15ºC - outdoor air temperature, 16°C - indoor air temperature, 0,1m/s - indoor air relative speed and 60% - relative humidity, 0,5 air changes/hour);
- the parameters specific to people (125W/m^2 - metabolic activity, 0,7 - activity yeld and 1 – cloth resistance).

Modelling was carried out with Systema software and as result, the layout optimum solution to provide global thermal needs of 128,47kW was obtained [10]. In order to cover this value there are required 6 equipments OHA 100-100U, respectively 14 INFRA 6Plus, placed so that the temperature cones to provide a uniform temperature distribution at ground level.



a)



b)
Fig. 1 - The layout of radiant tubes systems
a) OHA-U; b) INFRA-6Plus

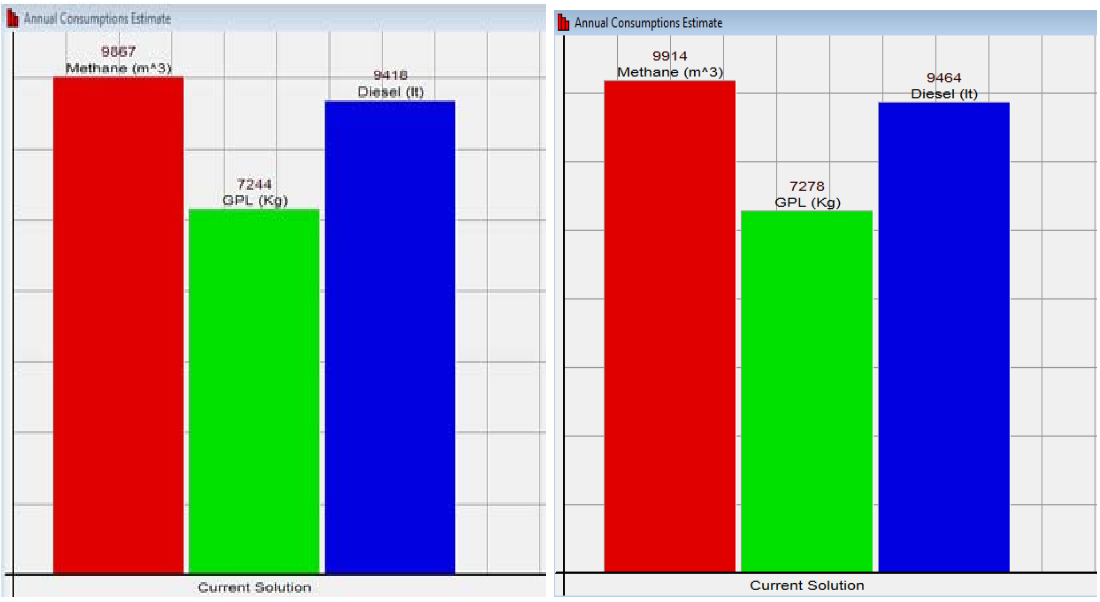
In order to assess the installation economic efficiency there were considered three types of fuel (methane, LPG and diesel).

This analysis aims to choose the most efficient fuel in terms of annual fuel consumption and annual operation costs.

The results of this analysis allow the assessment of fuel consumption and costs savings.

3. Results and discussion

For the comparative analysis of the two heating systems, in Fig. 2 [10] are shown consumptions during its operation with three type of fuels.



a) b)
Fig. 2 - The annual fuel consumption assessment
a) OHA-U; b) INFRA-6Plus

By analyzing Fig. 2, it is observed that the lowest values in terms of fuel consumption is recorded for heating installations powered by LPG. When using methane and diesel fuel, the differences in consumption are relatively small, but significantly higher compared to LPG.

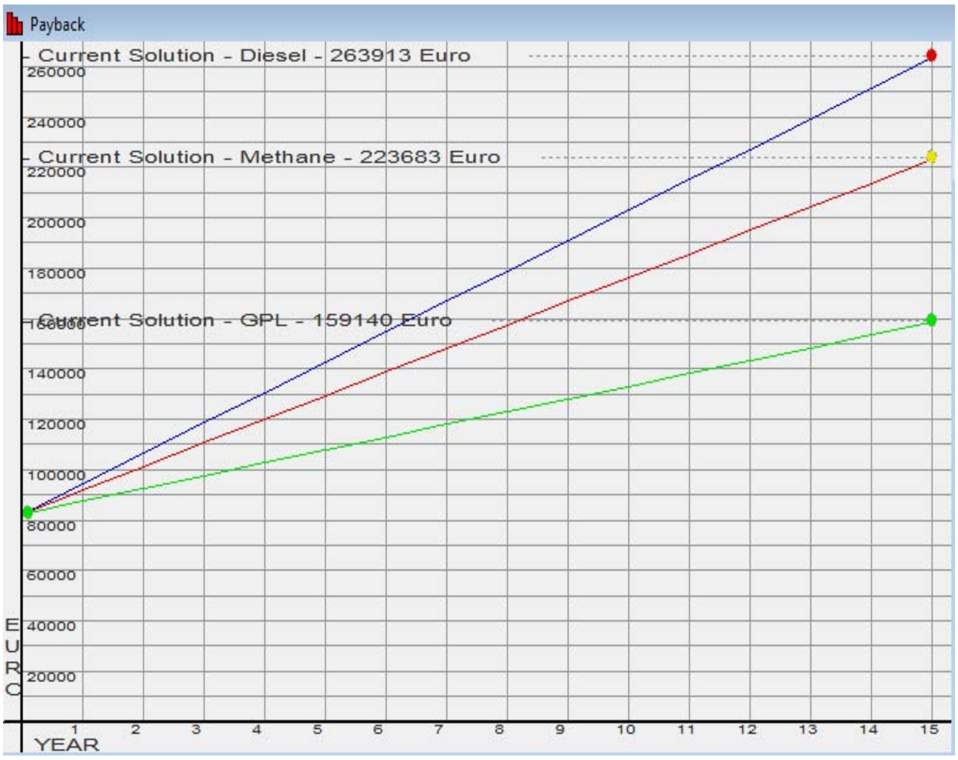
The operating costs for the two types of systems powered by these three fuels are comparatively shown in Fig.3 [10].

a) b)

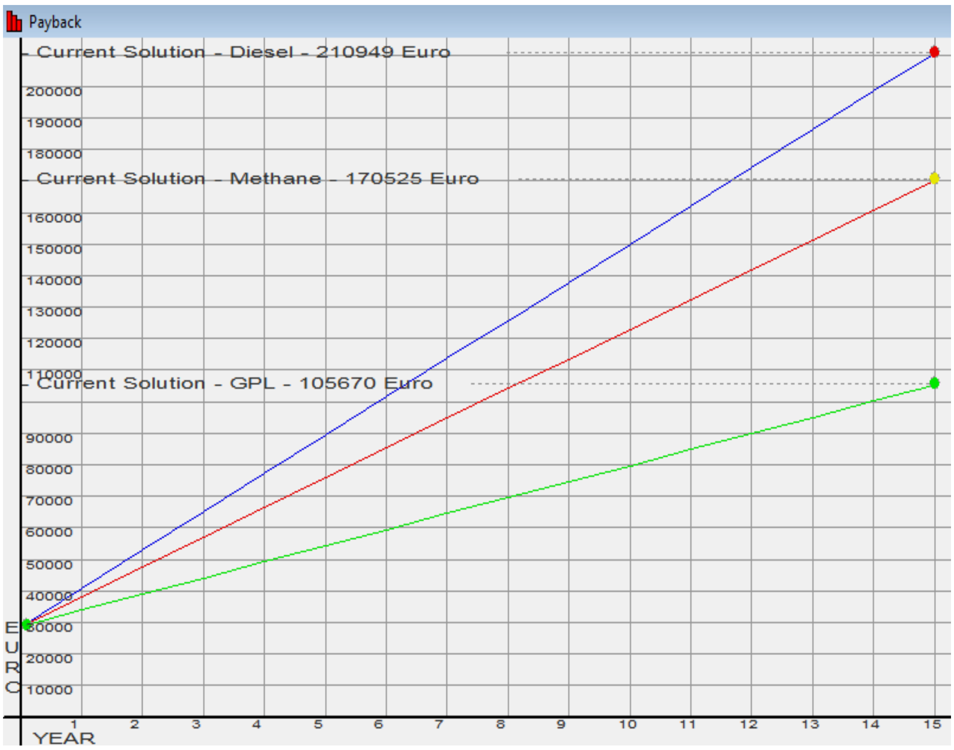
Fig. 3 - Operating annual costs assessment
a) OHA-U; b) INFRA-6Plus

Compared to other fuels, it is noted that the lowest annual cost is recorded for LPG for both heating systems.

Although the differences between the methane and diesel consumption are reduced, the diesel high price determines an annual cost much higher than the methane one. Based on these results, an analysis on investment payback during 15 years was performed (Fig. 4) [10].



a)



b)

Fig. 4 - Investment payback
a) OHA-U; b)INFRA-6Plus

From Fig. 4, it can be observed that there is a long time lag between investment and payback. Thus, the highest lag is recorded when diesel fuel is used and the lowest one for the operation with LPG.

When there are gas supply networks, it will be analyzed the best supply option between methane and LPG.

Comparing the two heating systems in terms of consumption, costs and investment payback, it appears that when choosing the system it is also necessary to take under consideration the system version.

On the other hand, for new buildings, in order to choose the heating system, it is sufficient to consider the total cost of the investment (C_{t1}), calculated with equation (1), which includes both the installation cost (C_1) and operating costs (C_2).

$$C_{t1}= C_1+C_2 \tag{1}$$

The term C_1 includes the entire heating system cost and the assembling one.

For installations operating with LPG, the relation of the total cost will be completed with the supply tank cost, $C_{R,}$ according to relation (2):

$$C_{t2}= C_1+C_2+C_R \tag{2}$$

If installations such those analyzed are used for heating buildings which are equipped with other types of heating systems, the investment total cost (C_{t3}) increases with the one for the old installation dismantling, C_{Dez}.

$$C_{t3}= C_1+C_2+C_R+C_{Dez} \tag{3}$$

The total cost Ct3 may or may not include the CR cost depending on the type of the selected fuel.

Conclusions

The comparative analysis of heating systems with radiant tubes, OHA and INFRA revealed that OHA systems are the best solution for heating industrial buildings, both in terms of costs and investment damping.

The LPG supply of this system is the best choice if the cost of the supply tank is low, so as not significantly affect the total cost *Ct*.

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