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The conditions for thermographic testing of thermal power engineering installations

Uwarunkowania termowizyjnych badań instalacji energetyki cieplnej

Abstract

Thermographic cameras are becoming increasingly popular in all kinds of diagnostic testing aiming to assess the technical state of thermal power engineering machinery, equipment and installations. The cameras provide thermograms that enable identification of various irregularities, including thermal bridges. However, it can be observed that their accuracy and reliability depend substantially on the conditions in which tests are carried out. Industrial thermographic testing, especially in thermal power engineering, is one of the most difficult procedures. Apart from the advantages of this particular technique, this paper presents an analysis of the effect of the conditions in which tests are performed on the obtained results. Attention is drawn to parameters characterizing the environment and the tested element surface, such as emissivity, reflected temperature, distance between the camera and the object, air temperature, etc. The sources of errors in the testing and in the interpretation of thermograms are indicated. Methods are also presented that enable elimination of irregularities, which improves the accuracy of the final results.

Keywords: engineering installations, thermographic testing, thermogram, emissivity, reflected temperature

Streszczenie

Kamery termowizyjne są coraz częściej wykorzystywane w różnego rodzaju badaniach diagnostycznych mających na celu ocenę stanu technicznego maszyn, urządzeń i instalacji eksploatowanych w energetyce cieplnej. Uzyskiwane za ich pomocą termogramy pozwalają identyfikować różne nieprawidłowości, a także mostki termiczne. Można jednak zauważyć, że w badaniach termowizyjnych istotne znaczenie mają warunki, w jakich są one przeprowadzane. Te przemysłowe, w tym szczególnie w energetyce cieplnej, należy zaliczyć do trudnych. W artykule, obok wskazania zalet takich badań, przedstawiono analizę wpływu warunków, w jakich są one realizowane. Zwrócono uwagę na parametry charakteryzujące otoczenie i powierzchnię badanego elementu, jak np.: współczynnik emisyjności, temperatura odbicia, odległość kamery od obiektu, temperatura powietrza. Wskazano na źródła błędów podczas wykonywania tych badań i interpretacji termogramów. Podano sposoby eliminacji nieprawidłowości, co zwiększa dokładność wyników końcowych.

Słowa kluczowe: instalacje energetyczne, badania termowizyjne, termogram, emisyjność, temperatura odbicia

1. Introduction

Thermal power installations used in the power sector important facilities such as power plants, combined heat & power plants and industrial plants, as well as boiler rooms in central heating and hot tap water preparation systems, enable conversion of primary (mainly fossil fuel) energy to a more convenient and usable form transferred as the working medium (typically: saturated or superheated steam or hot water) to appropriate receivers. This is where further energy conversion or transformation takes place. Adopting such a perspective, a thermal installation is understood as a system of various devices connected to each other (e.g. boilers, deaerators, heat absorbers and accumulators), machines (e.g. steam turbines, pumps, fans) and pipes (pipelines), together with appropriate fittings (including monitoring, control and diagnostic systems). Assuming that all subassemblies operate correctly, these elements make it possible to realize thermal technology processes [1, 2] with an efficiency level corresponding to the current state of the art. It should be noted, however, that in thermal power installations the energy conversion efficiency is limited by different factors, such as:

- specific energy conversion quality (which is specific to the applied cycle, e.g. the Clausius-Rankine cycle, and referred to as the cycle theoretical efficiency),
- specific efficiency of the thermal installation assemblies/components mentioned above,
- energy losses occurring during the process of both energy conversion and transfer.

The first two causes result, respectively, from the character of the working medium thermodynamic transitions and from technological, structural and operating characteristics of the assemblies used in the thermal installation. The energy losses (in this case: in the form of thermal losses) occur mainly during the equipment operation and are related to the heat exchange between the elements and the environment. Heat escapes through external surfaces and thermal bridges [3–7]. Even though external surfaces are usually insulated, heat losses will occur anyway because, as it is commonly known, perfect insulation does not exist (e.g. in the case of boilers, rarely considered for this case [7]). Moreover, the losses may be increased, for example, due to possible irregularities arising from the insulation assembly or because of the insulation material crumbling and ageing [5, 7]. Such effects can be classed as a kind of thermal bridges defined in [3, 5–7] as assembly- or operation-related ones. Another type includes structural thermal bridges [3–7], which are important due to the amount of heat losses they generate [5, 7]. It should be noted, however, that identification of all these thermal bridges in thermal power engineering is still incomplete (which is not the case in the building industry [8, 9]). Consequently, they are not estimated adequately. Sometimes, thermal bridges are even omitted in calculations. It may additionally be stated that such omission (though affecting the accuracy of the assessment of their impact on heat losses) is possible in the case of thermal bridges existing in a given device structure from the very beginning (which results from the need to ensure appropriate operation or control of operating parameters for example). But it can be difficult for those arising later on (e.g. due to operating irregularities). The former are usually „known" and often visible, such as elements of the pipeline support or hanging, measuring stub pipes, non-insulated inspection hatches, etc. But they can also be invisible elements embedded in the insulation material (usually adhering or being permanently connected to the insulated surface), e.g. supports of the insulation protective mantle, the insulation grips, stop blocks of the fastening devices, etc. [3, 6]. The latter, i.e. thermal blocks that may appear later on, are usually invisible under the protective mantle, e.g. the insulation material displacement (dropping, sagging), the occurrence of dampness, deformation, etc. They involve discontinuities and result in changes in the insulation thickness and/or air voids [3, 6].

The thermal installation energy losses are mainly the effect of the thermal insulation defects resulting not only from errors made at the insulation design, selection and production stage but also from irregularities appearing later on, during operation. Therefore, the following tasks are of great importance in power engineering:

- application of such a calculation methodology that enables economically efficient selection of the insulation thickness, which may produce savings for the company,
  This is made easier by the regulation now binding in Poland [10], under which the decision concerning the temperature of the insulation external surface is left to the operator. It may be added that until 2013 the only condition was to satisfy the occupational health and safety requirements. Pursuant to the repealed act [11], the temperature mentioned above could reach as high as 60°C (the two acts are compared in [12]),
- inspection of thermal installations to assess the current technical state of thermal insulation and identify thermal bridges, and, if necessary, performance of repair works (preferably – taking account of economic determinants of the enterprise),
- systematic assessment of the technical state of thermal installations with respect to heat loses they generate (in order to ensure systematic prevention of an uncontrolled rise in the losses and means of minimizing them).

Investment aiming to reduce energy losses is defined as actions taken in thermo-modernization. As a rule, these actions are the simplest method of improving energy efficiency, and they are usually associated with the possibility of making savings in energy needed to satisfy own needs of buildings. This also concerns thermal power installations in the industry. Activities related to thermo-modernization have become a popular investment in many Polish power engineering companies. The activities are conditioned by legal regulations on energy efficiency, which make the binding requirements for enterprises even stricter. One of such acts in Europe is the Directive of the European Parliament and of the Council of 2012 [13]; in Poland: the Act of 2016 [14] and the regulation and announcement [15, 16] on the tender for the selection of projects aimed at improving energy efficiency and on the detailed list of energy efficiency improving projects, respectively. To supplement the above, it should be added that considering the issues discussed herein, apart from the need to meet the legal requirements, an important factor is the awareness of the savings resulting from this type of investment and of the short periods of the investment return. Other essential effects are an improvement in the machinery and equipment efficiency and reduction in the negative impact on the environment.

In order to determine energy losses in operated thermal power installations and then select the appropriate and economically justified thermo-modernization actions, it is indispensable to perform the testing mentioned above. Thermographic testing seems to be a favourable option here, as it enables identification of places where increased heat losses occur, both through the facility insulated surfaces and through thermal bridges. However, identification only, i.e. a quantitative assessment of these places, is insufficient. In order to make an exact assessment of heat losses generated in them, it is also necessary to ensure an adequate accuracy of the testing, which is discussed further below. The elimination of errors in the use of thermographic cameras (in difficult industrial conditions of the measurement) and a correct interpretation of the results the cameras provide come down to an appropriate quantitative assessment enabling a correct estimation of the heat losses.

2. Principles of thermographic testing of thermal power installations

Any tests performed in industrial conditions, especially in conventional power plants with coal-fired boilers, have to be classed as difficult. This is due not only to the usually high temperature and pressure parameters of the working medium, but also to the fouling of the surfaces, the dust content, moisture or aggressiveness of the environment, bad lighting or lack thereof, the negative impact of neighbouring facilities, poor access, etc. These factors sometimes have an essential effect on the results of measurements made by means of thermographic cameras. Attention will be drawn to some of them and rules will be given that will enable a correct measurement, using the cameras mainly to check the thermal quality and "thermal tightness" of the thermal power facility insulation and to identify thermal bridges.

Thermographic testing makes it possible to measure the surface temperature of a device. It is known that each body with a temperature higher than absolute zero (0 K = –273.15°C) emits thermal radiation (invisible to the human eye but being felt through the skin as heat). Thermographic cameras are used to make measurements of the radiation in the range of longer wavelengths (from about 0.9 μm to ~14 μm), recording thermal radiation emitted by the „observed" objects. Based on that, images can later be created that map the temperature distributions of the „viewed" surfaces. This is possible owing to measuring transducers (detectors) installed in thermographic cameras and to specialist software that improves the capability and quality of the camera operation. It can be added that in the images specific colours are assigned to specific temperatures. A scale is created, in which the palette of colours from a given thermogram is presented together with corresponding values of temperature. It should also be noted that, unfortunately, the radiation detected by the camera includes direct radiation and radiation reflected by objects in the surrounding space, which may result in further errors. Nevertheless, tests made by means of infrared thermal imaging cameras exhibit a number of advantages over other methods, like point (contact) measurements for example. The infrared thermography is widely used in various research areas. This statement is confirmed by references [17–22], review papers [23, 24] and works related to the assessment of this method [25–27]. In particular, the favourable features include as follows (for this method):

- contactlessness of the temperature measurement of facilities to which access is difficult or which are very distant (e.g. facilities located beyond the direct reach of the inspection

team member(s), or positioned close to power engineering equipment or live electrical appliances/facilities),
- determination of the temperature distributions (fields) even for large areas, practically in many places at the same time, which shortens the testing time,
- a chance to identify places characterized by a more intense heat exchange (fast detection of thermal bridges).

In order to make a correct measurement by means of a thermographic camera and interpret the results obtained therefrom properly, special account has to be taken of the following quantities in every case:
- parameters characterizing the impact of the tested element surface – emissivity and reflected temperature in the first place,
- parameters characterizing the impact of the surroundings: ambient temperature, air humidity, air flow velocity, distance from the object and the measuring angle.

The parameters included in the first group mentioned above are analysed below.

Thermal radiation of every body is characterized by emissivity, absorptivity and reflectivity. When it comes to thermographic cameras, emissivity is one of the most important parameters that affect the quality of measurements. Correct results cannot be obtained unless the tested surface emissivity is known (estimated). The parameter is defined as the ratio between radiation emitted by the surface, here a real body, and radiation emitted by a black body. Its values are included in the range from 0 (for white bodies, emitting no thermal radiation and reflecting it completely) to 1 (for black bodies, whose thermal radiation is the strongest and which absorb the entire radiation falling onto them). Therefore, it may be stated that in the case of bodies whose surface is characterized by a high emissivity value, the radiative heat transfer is more intense. At the same time, as practice shows, under such conditions, the measurement is easier and gives more correct results. It is more difficult to perform measurements if the surface is shiny, rough or dirty. In terms of thermography, the facts presented above mean that:
- if the tested object temperature is higher than ambient, setting emissivity in the thermographic camera (if possible) to a value higher than the actual one, e.g. due to an estimation error, results in a temperature reading which is lower than actual (if, on the other hand, emissivity is set to too low a value, the reading will be inflated),
- if the tested object temperature is lower than ambient, inflating emissivity (due to reasons as above) results in temperature readings higher than the actual one (for too low emissivity values, on the other hand, temperatures will be understated),
- at lower emissivity values, the share of reflected radiation for the tested material is higher; consequently, it is more important to establish the correct value of reflected temperature.

In the case of typical materials, tabularized values can be used to find the tested object surface emissivity value. The values for some materials, including those used in industry (e.g. as a coating or protective layers of various devices) are listed in Table 1 [28, 29].

Table 1. Emissivity values for selected materials typically used for construction of industrial facilities

Material		Temperature, [°C]	Emissivity
Aluminium	polished	50–100	0.04–0.06
	with a rough surface	20–50	0.06–0.07
	highly oxidized	50–500	0.2–0.3
Sheet metal	zinc	50	0.20
	shiny zinc	30	0.23
	nickel steel	20	0.11
	rolled steel	50	0.56
Cast iron		50	0.81
Copper	polished	50–100	0.02
	oxidized	50	0.6–0.7
Pure polished silver		200	0.02
Oil paint		20	0.94
Enamel paint		20	0.85–0.95
Porous red brick		20	0.88–0.93
Gypsum		20	0.8–0.9
Paper	white	20	0.7–0.9
	black unglazed	20	0.94
Soot		20–400	0.95–0.97
Water layer on a metal surface		20	0.98

However, it should be noted that, in the industry, the surfaces of objects tested with the use of thermography are often fouled or covered with dust, and their temperature differs from values for which emissivity is given in tables. In such cases, the most accurate method is to determine the temperature values by own means. The testing procedure is facilitated by special tapes or labels (cf. Fig. 1), with a known constant emissivity value – $\varepsilon_p = 0.95$ – corresponding to a given temperature range. The tapes are characterized by low thermal resistance.

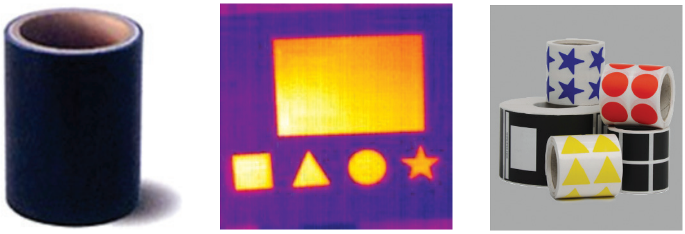

Fig. 1. Example tapes (HB-250, IR-ID Labels) with a constant emissivity value

A fragment of the tape shown in Fig. 1 should be placed on the tested object in a relevant inspection point and time should be allowed to let it heat up to the temperature of the surface. Setting the emissivity value in the thermographic camera to $\varepsilon_k = \varepsilon_p = 0.95$, the temperature measurement is performed at the place of the tape location. After the tape is removed, the emissivity value should be adjusted so that exactly the same temperature is obtained on the surface. Example thermograms obtained by means of this procedure are presented in Fig. 2 (a FLIR E60 infrared thermal imaging camera was used).

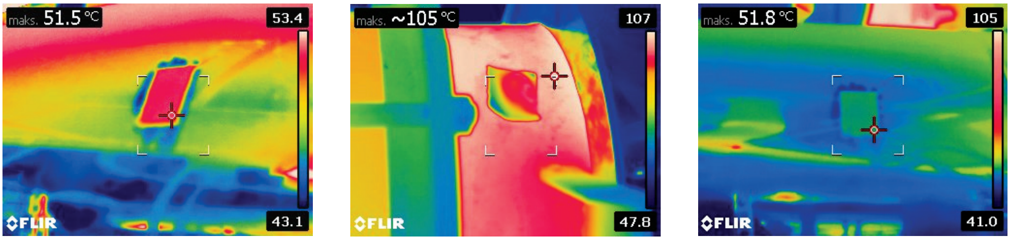

Fig. 2. Pipeline surface temperature measurement using tape HB-250

The appropriate emissivity value to be set in the thermographic camera can be determined to know the tested object surface temperature measured by means of a contact thermometer. The temperature in the inspected place should be checked using a thermographic camera in which the emissivity setting should be altered gradually until the camera reading is equal to the value measured by the thermometer.

The value of the tested object surface emissivity can be determined using the following relations [5]:

$$\dot{Q}_r = C_{1-2} \varphi A \left(T_1^{\,4} - T_2^{\,4} \right) \tag{1}$$

$$C_{1-2} = \frac{5{,}67 \cdot 10^{-8}}{\frac{1}{\varepsilon_1} + \frac{A_1}{A_2}\left(\frac{1}{\varepsilon_2} - 1 \right)} \tag{2}$$

where:

- A – radiating surface area, m^2,
- A_1, A_2 – radiating surface area 1 and 2 with temperatures T_1 and T_2, respectively, m^2,
- C_{1-2} – radiation factor, W/(m^{2}K^4),
- $\dot{Q}_r$ – thermal energy exchanged between bodies due to radiation (radiant exchange), W,
- T_1 – surface temperature of the more heated body, K,
- T_2 – surface temperature of the less heated body, K,
- ε_1, ε_2 – emissivity of surface A_1 and A_2, respectively,
- φ – angle factor.

For $A_1 << A_2$ formula (2) can be simplified to the following form:

$$C_{1-2} = 5{,}67 \cdot 10^{-8} \cdot \varepsilon_1 \tag{3}$$

If the tested object surface temperature is measured by means of a thermographic camera, a relation can be written using formulae (1) and (3), where $T_1 = T_{p(k)}$, $T_2 = T_d$, and $\varepsilon_1 = \varepsilon_k$:

$$\frac{\dot{Q}_r}{A\varphi} = 5{,}67 \cdot 10^{-8} \cdot \varepsilon_k \left(T_{p(k)}{}^4 - T_d{}^4 \right) \tag{4}$$

where:

- T_d – camera detector temperature, K,
- $T_{p(k)}$ – tested surface temperature measured by the thermographic camera, K,
- ε_k – emissivity set in the thermographic camera.

Using the surface known temperature measured by the contact thermometer, relation (4) can be expressed in the following form (where $T_{p(k)} = T_p$ and $\varepsilon_k = \varepsilon_p$):

$$\frac{\dot{Q}_r}{A\varphi} = 5.67 \cdot 10^{-8} \cdot \varepsilon_p \left(T_p{}^4 - T_d{}^4 \right) \tag{5}$$

where:

- T_p – tested surface real temperature measured by the contact meter, K,
- ε_p – emissivity of the tested object surface.

Comparing relations (4) and (5), it is possible to define the formula for the tested surface emissivity:

$$\varepsilon_p = \varepsilon_k \frac{T_{p(k)}{}^4 - T_d{}^4}{T_p{}^4 - T_d{}^4} \tag{6}$$

The effect of a wrong value of the tested surface emissivity on the results of the surface temperature measurement obtained by means of a thermographic camera is shown in Fig. 3 [5]. The tested facility was a steam pipeline whose insulation layer in the controlled area was covered with a protective mantle made of zinc sheets. The neighbouring sheets are characterized by a different technical state (surfaces with different oxidation and fouling degrees).

A VIGO *V-20 II* thermographic camera was used for the testing. The camera has a constant emissivity value adopted for the conversion of quantities – $\varepsilon_k = 0.95$. The insulation mantle temperature was measured in selected points using a *TES 1312A Limatherm* thermometer. In Fig. 3 it can be observed that the two methods produced different results. The lower values obtained by means of the thermographic camera, compared to those measured by the thermometer with a contact probe (in zones corresponding to each other they are, respectively, from ~35°C to ~45°C and from ~50°C to ~59°C), at ambient temperature of about 27°C, prove that the emissivity value set in the camera was inflated in this case (which in fact complies with the remark on thermography made above).

The obtained data made it possible, using relation (6), to estimate the emissivity value for the surfaces shown in Fig. 3. They are as follows: $\varepsilon_{(1)} = 0.63$; $\varepsilon_{(2)} = 0.69$; $\varepsilon_{(3a)} = 0.73$; $\varepsilon_{(3b)} = 0.83$ (the marking of respective surfaces is included in the subscripts, in brackets). It should be noted that the surface emissivity decreases as the surface temperature gets lower. Naturally, this also results from relation (6). It may also be added that a clean surface of the power engineering facility insulation protective mantle means smaller heat losses due to the lower value of emissivity.

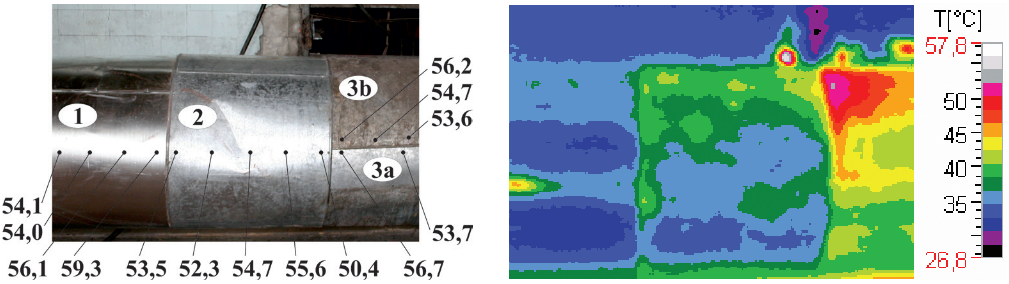

Fig. 3. Results of temperature measurements of the protective mantle of the steam pipeline insulation made by means of a contact thermometer (left side – points denote inspected places and the values corresponding thereto) and a thermographic camera (right side): 1 – new part (relatively clean), 2 – part with a low degree of oxidation (relatively clean), 3a and 3b – parts with a higher degree of oxidation, with a different fouling degree (3a – relatively clean, 3b – heavily fouled)

Another essential element of thermographic testing is an exact determination of the parameter defined as the reflected temperature compensation (RTC), which, apart from emissivity, can also be set manually in the applied thermal imaging camera. Generally, if there are no sources of interference (radiation emitters) in the vicinity of the tested facility, the reflected temperature is equal to the temperature of the surroundings, which can be measured using a thermometer. In industrial conditions, however, the environment of the testing usually includes elements of operating equipment or installations which are sources of radiation. In such a case, the temperature has to be measured using e.g. the Lambert radiator, which reflects radiation equally in all directions. The temperature measured on it using a thermographic camera is the sought value. A piece of crumpled and then smoothed out aluminium foil is commonly used for this purpose. The foil is placed on the tested object and its temperature is measured using a thermal imaging camera, setting emissivity to $\varepsilon_k = 1$. After the temperature value determined in this way is entered into the camera as the RTC, the planned testing can be performed (for emissivity specific to the tested object surface). Fig. 4 presents the practical method of the reflected temperature value determination.

The reflected temperature measurement is also absolutely necessary in on-site field inspections (in thermal power engineering this concerns e.g. inspections of the technical state of above-ground district heating or process steam pipelines, including the insulation quality and identification of thermal bridges [3, 6]). A cloudless sky emits thermal radiation with the temperature of 50–60°C, whereas sunlight reaches the temperature of about 5500°C. Due to that, the reflected temperature during measurements performed in such conditions is often lower than 0°C. Therefore, outdoor measurements should best be carried out early in the morning or under cloudy skies. If for technical reasons this cannot be done, the mean radiant

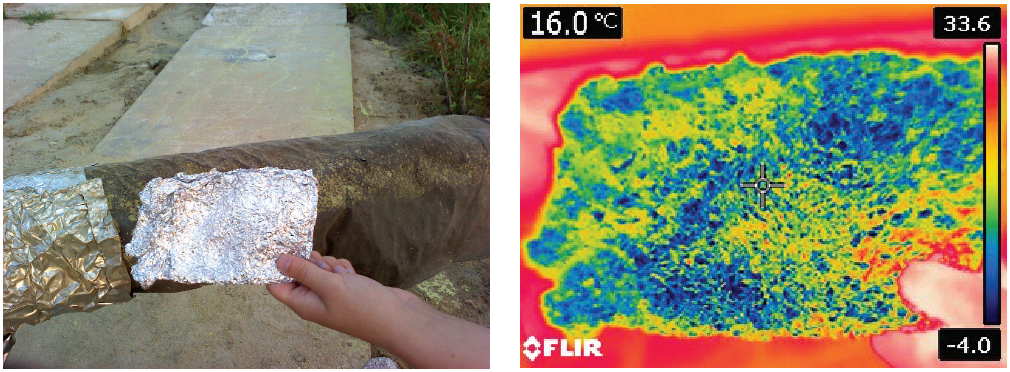

Fig. 4. RTC value determination using an equivalent of the Lambert radiator (a piece of crumpled and then smoothed out aluminium foil)

temperature of the sky (the sky temperature) has to be taken into consideration. Its value in the entire spectrum of thermal radiation, for the vertical plane in Poland, can be calculated using the empirical formulae presented below [30]:

- for a cloudless sky:

$$t_r = -19.04 + 1.33 \cdot t_e \tag{7}$$

- for a completely overcast sky:

$$t_r = -0.92 + 1.14 \cdot t_e \tag{8}$$

where:

t_e – air temperature, °C,
t_r – mean radiant temperature of the sky, °C.

Fig. 5 presents a thermogram obtained during an inspection of district heating pipelines, which illustrates an apparent occurrence of a negative temperature value on the tested objects due to the sky temperature reflection. This is the effect of the impact of a cloudless cold sky. It can be „seen" by a thermographic camera, which automatically expands the measuring range (the temperature scale) and changes the arrangement of colours in the thermogram.

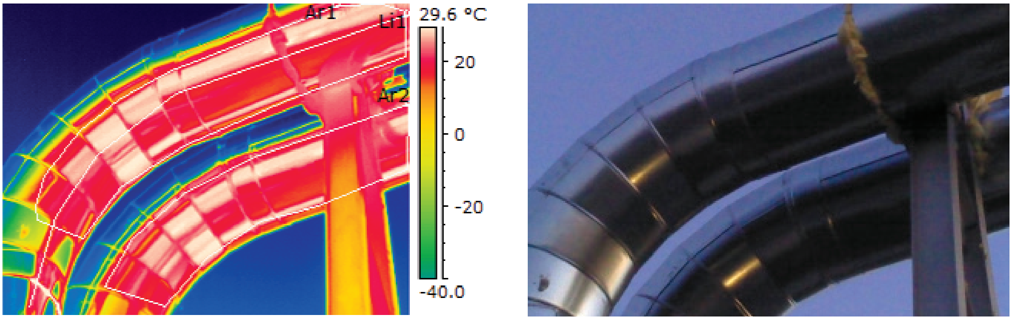

Fig. 5. Thermal images of a district heating pipeline

Conditions in the industries where the thermographic research are conducted, cause that accuracy of obtained thermograms are less dependent on exact determination of environmental parameters, i.e.: ambient temperature, the air humidity and flow velocity, and also distance and angle at which measurements are performed (in comparison to previously mentioned parameters, i.e. emissivity and reflected temperature). However, some of these parameters have major influence for determination of estimated heat losses, because their value is depend, among others, on:

- accuracy of ambient temperature determination,
- correct determination of the heat transfer coefficient, the value of which is substantially dependent on the air flow velocity.

The presented principles were applied while performing thermographic tests of an OP-140 power boiler. The aim of the testing was to identify the boiler thermal bridges and find the temperature of their surface and of the boiler other regular surfaces (walls). Successful completion of these tasks made it possible to assess the boiler heat losses, including those generated by thermal bridges [7]. Example thermograms, together with photographs of the inspected zones, are shown in Fig. 6 (for one of the boiler side walls) and Fig. 7 and Fig. 8 (for the boiler selected thermal bridges). The tests were performed using a FLIR E60 infrared thermal imaging camera for the boiler near-nominal continuous rating between 08:00–15:00 hours. At the same time, the parameters of the surroundings (here, the boiler room air) were measured, e.g. temperature, which varied depending on the boiler height from about +12°C (+0.00 m level) to about 40°C (+35.00 m level), and relative humidity, which totalled about 40%.

It should be added that Figs. 6–8 include areas limited by dashed lines, for which the mean value of the surface temperature was estimated using the software of the applied thermographic camera (the knowledge of the temperature is indispensable for determination of heat losses).

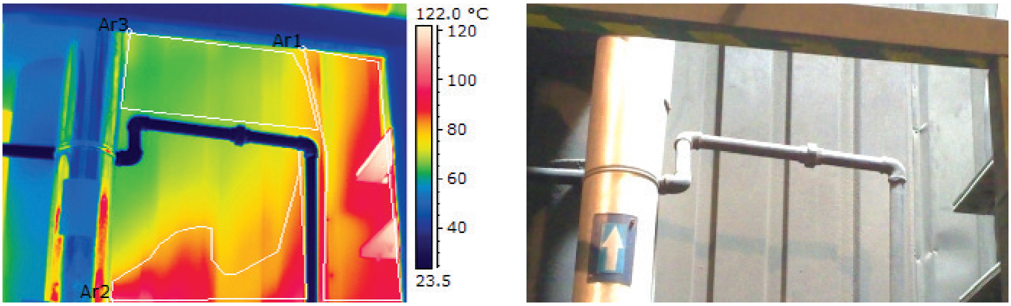

Fig. 6. Thermogram and photograph of the OP-140 boiler regular surface (wall)

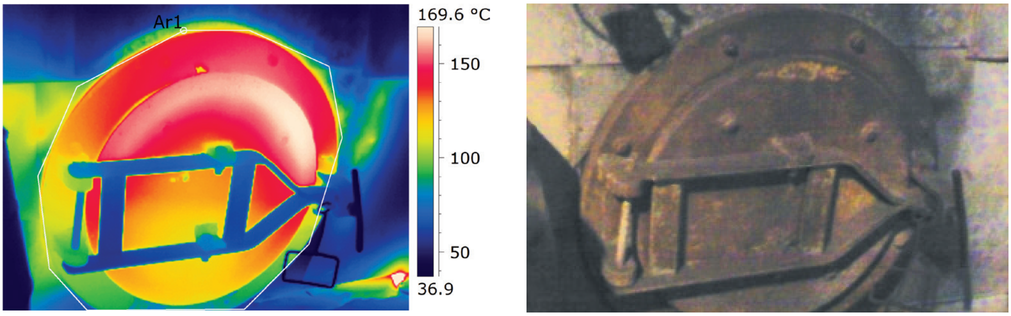

Fig. 7. Thermogram and photograph of the OP-140 boiler structural thermal bridge (inspection hatch)

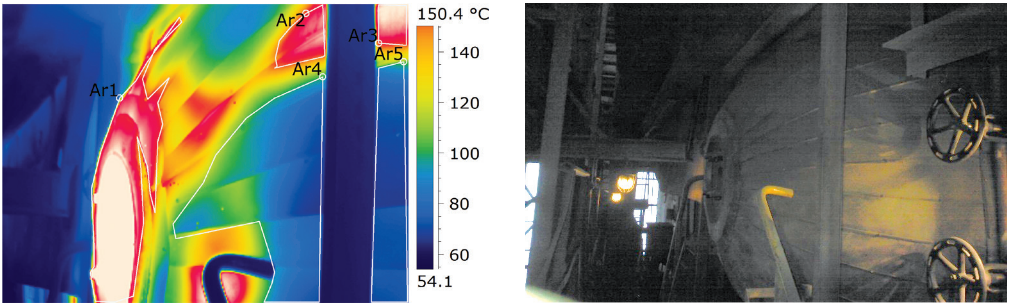

Fig. 8. Thermogram and photograph of the OP-140 boiler structural and assembly-related thermal bridge (inspection hatch of the boiler drum and displacement/irregularity thickness of insulation)

3. Concluding remarks

Thermographic testing is a good tool for thermal diagnostics of power engineering facilities. The advantages comprise the relative ease of performance, as well as the method non-invasiveness and the short time needed to obtain the measurement results and visualize them in an accessible way. This kind of testing is especially useful in areas such as:

- assessment of the technical state of thermal insulation, including detection of various defects thereof which may arise with time (e.g. thinning of insulation or its displacement, crumbling or dampness),
- identification of thermal bridges in the power engineering machinery, equipment and installations.

Using infrared thermal imaging cameras to measure the surface temperature of inspected power engineering facilities, for example for the purposes of estimation of heat losses, requires keeping adequate accuracy. In other words, the technique should produce reliable results. In order to eliminate possible errors, the necessary parameters should be determined correctly and then set in the thermographic camera. This especially concerns the values of the inspected surface emissivity and reflected temperature compensation (RTC). It is also important to select appropriate conditions for the measurement performance. For example, if the measurements are made in the power plant boiler or engine rooms (turbines hall), the sources of radiation that might interfere with obtained results should be removed or, at least, their impact should be mitigated. For measurements of outdoor facilities, the favourable conditions are e.g. the night-time or early morning hours, a cloudy sky and no rain.

The results of the thermographic testing performed for the OP-140 boiler indicate that numerous places characterized by increased heat losses may arise in the thermal power engineering facilities. These places are invisible to the naked eye, but thermal imaging makes it possible to detect them. This may especially concern the power engineering machinery, equipment and installations with a long lifetime because, with the passing of time, the thermal insulation degradation and destruction accumulate and become more severe. However, heat losses in power engineering facilities may also be generated by their thermal bridges. For now, the identification of thermal bridges is still incomplete and thus their effect cannot be taken into account to a satisfactory extent. Therefore, works carried out in this direction, with the use of infrared thermal imaging cameras, are fully justified. They will make it possible not only to prepare appropriate thermo-modernization actions but also develop better design solutions eliminating thermal bridges or mitigating the negative impact thereof. The actions will thus improve the energy efficiency of thermal power facilities and, indirectly, help to protect the natural environment.

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