MONITORING THE CONDITION OF SELECTED DEVICE COMPONENTS USING THERMAL IMAGING

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Thermographic diagnostics serve as an important tool for monitoring thermal processes and identifying potential operational deficiencies in industrial equipment. This method enables non-contact measurement of temperature distribution on object surfaces, analysis of heat transfer, and the detection of thermal anomalies that may indicate functional malfunctions or excessive thermal stress on individual components. This article explores the experimental application of thermographic measurement for investigating thermal processes at specific locations within technical equipment. The measurements were conducted in a laboratory setting using a thermographic system comprising a Micro-Epsilon Thermo IMAGER TIM QVGA-HD infrared camera, TIM software for data processing and evaluation, and the necessary experimental accessories. The experimental investigation focused on evaluating the heating uniformity of the print bed on a Creality CR-X Pro 3D printer, as well as analyzing temperature profiles and distribution at selected points on a test rig designed for evaluating belt drives. The acquired thermographic data were processed and evaluated through graphical outputs, allowing for a detailed assessment of the observed thermal phenomena. Based on the results, a technical analysis of the thermal processes was performed, and the potential for using thermographic monitoring to assess the functionality and operational status of the equipment under study was evaluated.

KEYWORDS

monitoring, emissivity, heat, thermography, belt tension, rotational speed

1 INTRODUCTION

Contemporary industry is characterized by dynamic development, marked by the integration of modern technologies and innovative solutions into production processes. One of the key factors in the success of enterprises is quality, which is not merely a characteristic of the final products but also encompasses the technical condition of machinery, the functionality of equipment, the reliability of production processes, and the efficiency of their operation. Measurement methods play a vital role in ensuring quality and have seen significant advancement in recent years, driven by technological progress. In industrial practice, non-contact measurement methods are increasingly being adopted, as they allow for the collection of necessary data without direct contact with the object being measured [Kondrat 2025].

One promising method is thermographic measurement, which falls under the field of infrared thermography. This technology enables the detection of infrared radiation emitted from the surfaces of objects, which is then used to generate thermal images that display the distribution of surface temperatures. It is applied across various sectors, including industry, construction, the automotive industry, medicine, and security systems. In an industrial setting, it serves as a significant tool for enhancing the efficiency, safety, and quality of production and inspection processes.

Thermographic diagnostics hold a special place in the maintenance of machinery and technical equipment. Using a thermal imaging camera, it is possible to monitor the temperature of individual components during operation, analyze thermal loads, and identify unusual thermal patterns. One example is the monitoring of electric motors, where temperature conditions can be compared before startup, during operation, and after shutdown [Kuznetsov 2020]. In this way, it is possible to detect overheating, uneven temperature distribution, or other anomalies that may indicate a technical problem [Mascenik 2016a, Klarak 2024].

An important advantage of thermographic measurement is the ability to evaluate temperature distribution across larger surfaces and monitor temperature changes over time. The data obtained provides a basis for maintenance planning, the early identification of faults, and the implementation of preventive measures. Consequently, the proper application of this diagnostic method contributes to increased operational reliability of equipment, a reduced risk of unplanned downtime, and improved safety in the working environment.

2 PRINCIPLES OF THERMAL IMAGING AND ITS APPLICATIONS

Thermal imaging, also known as infrared thermography, is a non-contact method used to detect and visualize the temperature distribution on the surfaces of objects under examination. It works by capturing infrared radiation emitted by surfaces, which varies according to their temperature and emissive properties. Since this radiation is invisible to the human eye, specialized thermal imaging cameras are used for its detection. Using optical components and an infrared detector, these cameras convert the captured radiation into a visual image. The resulting thermogram provides a graphical representation of the temperature field, making it possible to identify temperature differences across various parts of the object being observed.

Compared to contact-based methods, thermography offers the advantage of measurement without direct contact with the surface under examination. It allows for simultaneous monitoring of larger areas and the assessment of thermal conditions, even in locations that are difficult to access or are in motion. This capability is particularly useful when inspecting electrical equipment, machinery parts, and components exposed to high temperatures. Thermographic data can be used to identify temperature maxima and minima, compare different surface areas, and track temperature changes in real time. The measured data are subsequently processed using software that enables detailed analysis of thermograms and the generation of graphical outputs [Kim 2012].

In the industrial sector, thermographic measurement is primarily used for the diagnostics and maintenance of machinery, as well as technological and technical equipment. Temperature variations on the surface of components can indicate emerging faults, excessive mechanical stress, increased friction, inadequate lubrication, or issues with heat dissipation [Cacko 2014]. By regularly monitoring thermal characteristics, it is possible to identify abnormal operating conditions early and schedule necessary service interventions. This approach supports preventive and predictive maintenance, helping to prevent more serious equipment damage.

Another advantage of thermography is the ability to perform inspections during normal operation, without the need to shut down equipment. The results obtained can be compared with

previous measurements and reference values, making it possible to monitor long-term temperature trends. Early detection of adverse conditions can reduce the number of unplanned downtimes, repair costs, and the risk of damage to technical system components. At the same time, it contributes to enhanced workplace safety and the reliability of production processes.

Measurement accuracy is influenced by several factors, including surface emissivity, reflected radiation, distance, the viewing angle, as well as the temperature and humidity of the surrounding environment. Therefore, it is necessary to correctly configure the camera parameters and ensure appropriate conditions during measurement [Kuchar 2023]. Thorough processing and interpretation of thermographic data are essential for obtaining reliable results. Consequently, thermographic diagnostics serve as an effective tool for evaluating thermal processes, optimizing maintenance, and enhancing the operational efficiency of technical equipment.

2.1 Application in Industrial Practice

In industrial practice, thermographic measurement is widely used, primarily for diagnosing the technical condition of machinery, equipment, and technological processes. A significant application area is the inspection of electrical equipment, where a thermal imaging camera can be used to identify excessive heating in electrical connections, terminals, cable runs, circuit breakers, switchboards, transformers, or electric motors. A localized temperature increase may indicate, for example, increased electrical resistance at a connection, a loose terminal, uneven loading, or component damage. An advantage of this method is that inspections can be performed without interrupting electrical operations, while the thermographic data provides visual information regarding the temperature distribution across the entire area under observation [Duhancik 2024].

In the field of mechanical equipment, thermography is primarily used to inspect bearings, shafts, couplings, gearboxes, and belt or chain drives. In mechanical systems, an elevated surface temperature can indicate increased friction, inadequate lubrication, component misalignment, or the progressive deterioration of a bearing. For instance, in a belt drive, temperature differentials between various parts of the system can be observed to identify areas subject to excessive thermal stress. Consequently, thermographic monitoring can be employed to assess the operational condition of a mechanism and to detect, at an early stage, any abnormalities that could otherwise lead to equipment failure or unplanned downtime.

Thermal imaging plays a significant role in monitoring production and technological processes where temperature is a critical parameter. It is used, for example, to assess temperature uniformity in heating furnaces, drying equipment, injection molding and pressing processes, welding, heat treatment of materials, and the manufacturing of plastic or metal components. A thermographic camera allows for the observation of temperature changes over time while simultaneously identifying areas with undesirable temperature variations. In production, for example, the uniformity of heating of the work surface, mold or production tool can be controlled in this way, which can have a direct impact on the quality of the resulting product [Henao-Sepulveda 2005].

Thermography is also used in the inspection of cooling and heating systems. Through thermal imaging, it is possible to analyze temperature distribution across pipes, heat exchangers, cooling circuits, radiators, or industrial equipment that utilizes heat. Temperature deviations may indicate inadequate heat transfer, issues with medium circulation, fouling of a heat exchanger, or insufficient thermal insulation. In energy-intensive operations, such diagnostics can help identify heat losses, subsequently enabling the optimization of the energy efficiency of industrial processes.

Another area of application is the quality control of products and technological joints. Thermography can be used to verify the uniformity of a product's heating or cooling, inspect areas subject to thermal stress, and identify localized thermal non-uniformities. In certain applications, it is also possible to monitor the dynamics of an object's cooling or heating and, based on the resulting temperature profile, assess its material or technological properties. An advantage of this approach is the ability to perform inspections without mechanical contact with the product, a feature particularly valuable when dealing with sensitive, moving, or high-temperature items [Peretiaka 2020].

In current industrial practice, thermographic diagnostics are closely linked to the principles of preventive and predictive maintenance. By regularly capturing thermographic images, it is possible to build a database of the thermal characteristics of individual pieces of equipment and monitor how these change over time. For instance, if the temperature of a bearing or an electric motor gradually rises despite comparable operating conditions, it may indicate the progressive degradation of the component. Identifying such a trend allows for maintenance to be scheduled before a serious failure occurs. Consequently, thermographic measurement can help extend equipment lifespan, improve the planning of service interventions, and enhance safety within the production environment [Vahovsky 2019].

Area	Monitored object	What thermal imaging can reveal
Electrical Engineering	Electric motor	overheating, uneven load, bearing problem
Mechanics	Bearing	Increased friction, insufficient lubrication, damage
Transmission systems	Belt drive	excessive friction, slippage, temperature non-uniformity
Production	3D printer	uneven heating of the printing surface
Energy Sector	Switchboard	overloaded or loose electrical connections
Cooling	Cooling circuit	insufficient heat dissipation, circulation failure
Plastics production	Injection mold	uneven cooling or heating
Maintenance	Machines in general	emerging temperature anomalies and degradations

Table 1. Examples of the use of thermal imaging in technical practice

2.2 Emissivity

Emissivity is one of the most significant surface characteristics in the context of infrared radiation and is also a crucial parameter for non-contact temperature measurement. It is defined as the ratio of the radiation intensity of a measured surface to the radiation intensity of an ideal black body at the same thermodynamic temperature, at the same wavelength, and under identical observation conditions. It is a dimensionless quantity with a value ranging from 0 to 1. An emissivity value of $\varepsilon = 1$ corresponds to an ideal black body, which, at a given temperature, absorbs and subsequently emits the maximum possible amount of energy. Conversely, a surface with an emissivity approaching 0 exhibits a very low capacity to emit thermal radiation, and its surface properties are characterized by high reflectivity [Pastukhov 2023].

Emissivity is not strictly a material constant; rather, it depends on various physical and geometric properties of the surface in question. Significant factors include the type of material, its chemical composition, surface structure and roughness, degree

of oxidation, surface finish, and any potential contamination or damage. Consequently, the same material may exhibit different emissivity values depending on the condition of its surface. Metallic materials serve as a typical example: a clean, smooth, and polished surface generally displays lower emissivity and higher reflectivity, whereas a roughened, oxidized, or otherwise treated metal surface can exhibit significantly higher emissivity. Therefore, in practical thermographic measurements, it is essential to account for the actual condition of the object's surface, rather than assuming that a tabulated emissivity value is universally applicable under all conditions [Jakubek 2021].

Emissivity also exhibits spectral, temperature, and directional dependence. Its value can vary depending on the wavelength of the infrared radiation, the surface temperature, and the angle at which the surface is observed. For this reason, in quantitative infrared thermography, it is essential to correctly set the emissivity value within the measurement system and, whenever possible, to determine it for the specific material, surface, and measurement conditions. An incorrectly determined emissivity value can lead to a significant systematic error in the measured temperature, as the thermal imaging camera calculates temperature based on the amount of infrared radiation captured by its detector. This issue is even more pronounced for surfaces with low emissivity, where a substantial portion of the detected radiation may consist of radiation reflected from the surrounding environment [Olejarova 2021].

Knowledge of emissivity is therefore of fundamental importance not only for infrared temperature measurement but also for the analysis of thermal processes and calculations related to radiative heat transfer. Thermal imaging and radiation-based measurement systems are typically calibrated using reference radiation sources whose properties approximate those of an ideal blackbody. However, ideal conditions are usually not met with real objects, and therefore, when evaluating the measurement, it is necessary to take into account the emissivity of the monitored surface along with other parameters such as ambient temperature, reflected radiation, distance between the camera and the object, or atmospheric conditions. Accurately determining emissivity and subsequently incorporating it into the measurement process is a fundamental requirement for achieving sufficient accuracy and reproducibility in thermographic measurement results. The emissivity of typical real-world surfaces is always less than 1 [Metrologiaholding 2026].

2.3 Examples of the emissivity of various surfaces

- Matte black surface – typically exhibits high emissivity, approximately ε = 0.90 – 0.98. Such a surface is well-suited for thermographic measurement, as the majority of the detected radiation originates directly from the surface being measured.
- Oxidized metal – oxidation of a metal surface can significantly increase its emissivity. Depending on the material and the degree of oxidation, the emissivity can range from approximately 0.70 to 0.95.
- Polished aluminum – typically has very low emissivity, approximately 0.03 – 0.10, combined with high reflectivity. During thermographic measurement, the result can be significantly influenced by the reflection of infrared radiation from the surrounding environment.
- Polished stainless steel – like aluminum, it can exhibit low emissivity, approximately 0.05 – 0.20, with the specific value depending on the surface finish and the condition of the material.
- Matte or painted metal surface – applying a suitable surface coating can significantly increase emissivity, often to approximately 0.85 – 0.95. Consequently, such surfaces are easier to evaluate using thermography.
- Plastics – many common plastics exhibit relatively high emissivity, often around 0.85 – 0.95, making them generally suitable for thermographic measurement.
- Glass – its thermographic properties are specific because, in addition to its own emission, it can significantly reflect infrared radiation from the surrounding environment, while simultaneously being opaque to certain wavelengths of infrared radiation.

3 EXPERIMENTAL MONITORING OF SYSTEM CONDITION USING A THERMAL CAMERA

The Thermo IMAGER TIM system consists of several main components that ensure accurate detection of thermal radiation and temperature measurement in an industrial environment. Its most important components include:

- Infrared camera – used for capturing the temperature distribution of objects and creating high-precision thermal images.
- USB/Ethernet interface – facilitates communication between the device and a computer, as well as the transmission of measured data.
- Process Interface (PIF) – enables the integration of the thermal imaging system with control and automation components of industrial equipment.
- TIM Connect software – provides tools for camera configuration, processing of measured data, and real-time evaluation of temperature information.

The Micro-Epsilon TIM QVGA-HD infrared camera (Fig. 1) is part of the Thermo IMAGER TIM product series, designed for non-contact temperature measurement and thermal field analysis in industrial applications. The device enables continuous temperature monitoring and provides data essential for controlling technological processes, assessing product quality, and conducting research activities. This thermal imaging camera features high-resolution thermal imaging and a wide measurable temperature range—spanning from −20 °C to 900 °C or from 200 °C to 1500 °C, depending on the device configuration. It utilizes USB and Ethernet interfaces for data transmission, allowing for connection to a computer and other devices. The TIM Connect software supports the real-time processing, analysis, and evaluation of the measured temperature data, facilitating a detailed interpretation of the measurement results [Mascenik 2024].



Figure 1. Thermal camera Micro-Epsilon TIM QVGA-HD

3.1 Monitoring the uniformity of heating of the 3D pad

The experimental part of the article addresses the application of thermographic measurement in industrial practice. The main objective of the experiment was to measure the surface temperatures of selected objects and subsequently identify potentially critical thermal areas that could affect equipment functionality, as well as the quality and safety of operations [Husar 2022].

One of the preparatory phases for the experimental measurements involved selecting a suitable location for the thermal imaging camera. When monitoring the heating of the 3D printer build plate, the thermal imaging system could be positioned close to the plate, with the camera tripod placed directly on the 3D printer table. For measurements of temperature changes at specific points on the belt drive, the camera tripod was positioned outside the supporting structure of the belt drive system; this was done to avoid the influence of vibrations, which could otherwise affect the measurement results.

To ensure stable thermal imaging measurements, three factors were addressed. First, thermal stabilization of the instrument was achieved by keeping the thermal imaging system in the same environment as the equipment being measured. Second, environmental and object conditions were stabilized by conducting experimental measurements within a controlled laboratory setting. Third, mechanical stability was ensured through the use of a high-stability tripod.

Since temperature changes were measured across various components made of different materials, it was necessary to correct the measurement results by applying the appropriate emissivity values. The thermal imaging camera used allows for the recording of thermal video containing data for every point in the image, with the option to adjust the emissivity value even after the measurement has been completed. For the 3D printer build plate, an emissivity value of ε = 0.75 was set. When monitoring the belt drive, an emissivity value of ε = 0.85 was set for the pulley, while a value of ε = 0.93 was set for the belt itself. Figure 2 shows a thermal image obtained during an experimental measurement of the heating uniformity of the print bed on a Creality CR-X Pro 3D printer. The measurement was conducted using a Thermo IMAGER TIM thermal imaging system, with the temperature distribution evaluated across selected areas of the print surface while the heating temperature was set to 65 °C. A temperature of 68.3 °C was recorded in the central part of the print bed, representing the highest surface temperature within the observed area.

Visual evaluation of the thermal image shows that the temperature field of the printing surface is mostly uniform, with no significant local temperature anomalies identified in the form of excessively heated or significantly colder areas. Along the edges of the print bed, a slight temperature drop of approximately 3 to 8 °C was observed compared to the central region. This difference points to a spatial non-uniformity in the temperature field, which may be related to the heat distribution within the print bed and the conditions under which heat is transferred to the surrounding environment.

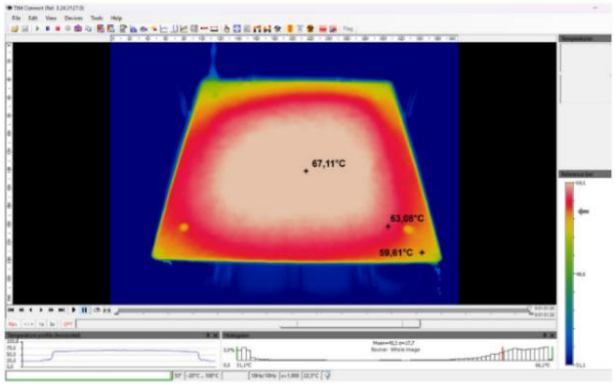


Figure 2. Thermal image of a heated 3D printing bed

Based on thermographic analysis, it can be concluded that the print bed exhibits a largely uniform surface temperature distribution, although a decrease in temperature is observed in the peripheral areas. Visual assessment revealed no significant temperature deviations that would clearly indicate localized overheating or insufficient heating. The measurement results thus provide a basis for evaluating the thermal conditions of the print surface in the context of its use for 3D printing. However, assessing the suitability of the thermal regime for specific printing materials—such as PLA and PETG—requires taking into account the recommended operating temperatures for the material in question, as well as other printing parameters.

3.2 Monitoring temperatures on the belt drive

Temperature measurements were also conducted on a belt drive, which is part of a test rig designed for scientific research and educational purposes. This system allows for monitoring of the operational characteristics of mechanical transmission components under load, applied via electric motors. The output of the belt drive is loaded not by a mechanical brake, but by an electric motor controlled by a frequency converter; this setup also enables the adjustment of the output torque (i.e., the output load) [Mascenik 2017]. During the experimental measurements, a thermal imaging device was positioned and oriented toward the belt drive to record temperature changes across its various components during operation. The thermographic data obtained in this manner provides information on the temperature distribution at specific locations on the system and can serve as a basis for further analysis. The objective of this study is to evaluate how the heating of the belt drive components varies in relation to rotational speed, belt tension, and system load. The transmission ratio of the belt drive is 1, meaning the rotational speeds of the driving and driven pulleys are identical [Mascenik 2016b].

Temperature measurements of the belt drive were conducted under four different operating configurations, which varied in terms of belt tension, load magnitude, and rotational output speed. Temperatures were recorded using a thermal imaging camera at specific locations on the drive—namely, on the surfaces of the driving and driven pulleys, as well as on the upper and lower sections of the belt. The measured data allow for an assessment of how operating conditions influence the heating of individual drive components. Elevated temperatures may be attributed to mechanical losses, friction between the belt and the pulleys, belt deformation during bending, and the load placed on the electric motor bearings. However, temperature data alone cannot definitively identify the cause of the heating without further measurements.

Measurement at 257 N tension, 0 % load and 950 rpm

Given that the first experimental measurement (Figure 3) was conducted at the lowest load parameters, the expectation that the temperature readings would be at their lowest was confirmed.



Figure 3. Thermographic image of the output pulley (belt tension 257 N, output load 0 %, rotational speed 950 rpm)

A temperature of 25.16 °C was recorded on the upper section of the belt, 24.66 °C in the area of the central part of the pulley, and 25.44 °C on the lower section of the belt. The highest of these temperatures was observed on the lower section of the belt, with a difference of only 0.78 °C compared to the temperature on the upper section. These low temperatures correspond to operation at low rotational speeds and without an output load. Under such conditions, lower mechanical losses and reduced heating of the transmission components can be expected. The temperature differences between the monitored locations were small, indicating relatively uniform thermal conditions during the measurement.

Measurement at 257 N tension, 0 % load and 3000 rpm

When the rotational speed was increased from 950 rpm to 3,000 rpm, the temperatures at various locations rose significantly. A temperature of 31.93 °C was measured on the upper section of the belt, while the temperature in the pulley contact area increased slightly to 26.74 °C, and the temperature on the lower section of the belt reached 33.78 °C. The thermographic image (Figure 4) also indicates a maximum temperature of 35.42 °C. Compared to the first measurement, there is a more pronounced heating of the belt, particularly along its lower section. This phenomenon may be attributed to an increased frequency of belt bending, a higher number of contact events with the pulleys, and an increase in mechanical losses at higher rotational speeds.

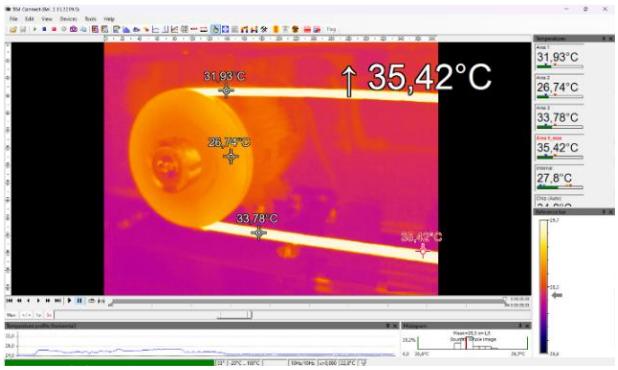


Figure 4. Thermographic image of the output pulley (belt tension 257 N, output load 0 %, rotational speed 3000 rpm)

The higher temperature on the lower section may also be influenced by local contact conditions and heat transfer characteristics. Since the output load of the drive remained at 0 % and the belt tension remained unchanged, the increase in rotational speed represents the primary difference compared to the initial setup. Consequently, the results demonstrate the influence of rotational speed on the thermal state of the drive.

Measurement at 350 N tension, 14 % load and 950 rpm

In the third configuration, the belt tension was increased to 350 N, and the output load reached 14 % (Figure 5). The rotational speed was 950 rpm. The measured temperatures were 27.25 °C on the upper section of the belt, 26.29 °C in the pulley area, and 26.78 °C on the lower section of the belt. Compared to the first measurement, the temperatures were slightly higher, particularly on the upper section of the belt. However, despite the higher tension and the applied load, the temperature increase was not as pronounced as that observed in the second measurement, which was conducted at a rotational speed of 3000 rpm. While higher belt tension can improve the transmission of circumferential force and reduce slippage, it simultaneously increases the radial load on the shafts and bearings. Based on the measured values, it is not possible to definitively determine which of these factors had the greatest impact. The results indicate that, with this configuration, no significant localized overheating occurred at the monitored locations.

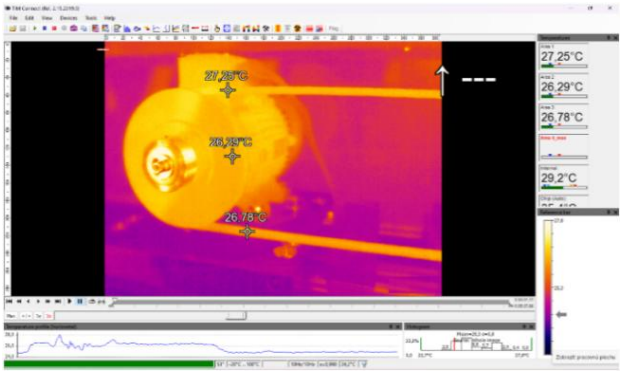


Figure 5. Thermographic image of the output pulley (belt tension 350 N, output load 14 %, rotational speed 950 rpm)

Measurement at 350 N tension, 14 % load and 3000 rpm

The final configuration yielded the highest temperatures of all four measurements. The temperature of the upper section of the belt reached 34.44 °C, a temperature of 31.41 °C was recorded in the pulley area, and the lower section of the belt reached 35.79 °C (Figure 6). The maximum temperature indicated in the thermal image was 40.16 °C. The highest temperature was recorded on the lower section of the belt, while the upper section also reached a relatively high temperature. This distribution may be attributed to a combination of high rotational speed, increased tension, and power transmission under an output load of 14 %. Under these conditions, losses caused by belt bending, friction in contact areas, and increased bearing loads may increase. Compared to the third measurement, which used the same tension and load but a lower rotational speed, a significant increase in temperature is evident. These results indicate that the combination of higher rotational speed and load leads to more intense heating of the drive system.

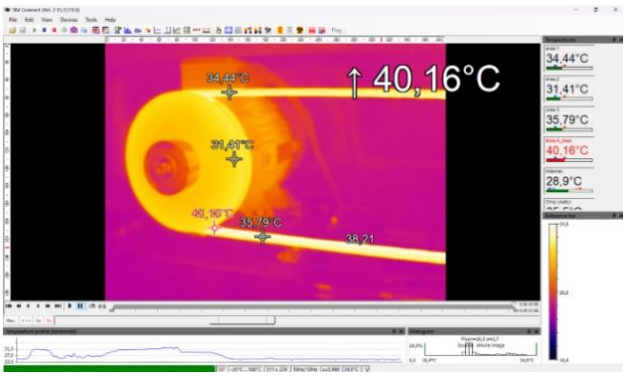


Figure 6. Thermal image of the output pulley (belt tension 350 N, output load 14 %, rotational speed 3000 rpm)

The influence of tension, rotational speed, and load on the expected temperature rise:

- *Increasing rotational speed* – May increase losses caused by friction, belt bending, and air resistance.
- *Increasing belt tension* – Increases the radial load on shafts and bearings; may alter contact and frictional losses.
- *Increasing output load* – Increases the transmitted power and may lead to greater heating of the motor, belt, and bearings.
- *Duration of operation* – Temperatures may gradually rise until an approximate thermal equilibrium is reached.

4 CONCLUSIONS

Based on the results of thermal imaging measurements, it can be concluded that if the belt tension value did not change during the measurement, then the greatest influence on the change in belt heating is the change in rotation speed, since the belt tension also increases simultaneously due to centrifugal force [Krawiec 2022]. If the belt tension is also adjusted mechanically (for example, by altering the center distance), it cannot be definitively stated that the temperature changes are primarily caused by an increase in the rotational speed of the pulleys. Belt tension and the transmitted load can also contribute to an increase in temperature. At a rotational speed of 950 rpm, the measured temperatures were approximately 25 °C.

When the speed was increased to 3,000 rpm with tension remaining constant and the load at zero the temperature of the lower section of the belt rose from 25.44 °C to 33.78 °C, representing an increase of 8.34 °C. With a tension of 350 N and a load of 14%, the same increase in rotational speed caused the temperature of the lower section to rise from 26.78 °C to 35.79 °C, an increase of 9.01 °C. In all four measurements, the temperature in the vicinity of the pulley was lower than the temperature of at least one of the monitored belt sections. This phenomenon may be related to the spatial distribution of mechanical losses, the nature of the contact surfaces, and heat dissipation conditions.

The maximum measured temperature reached 40.16 °C with a combination of 350 N tension, a 14 % load, and a rotational speed of 3,000 rpm.

When interpreting the results, it is essential to consider that the individual measurement conditions differed across several parameters. The data obtained primarily indicate a correlation between increasing rotational speed and rising temperature; however, the individual effects of tension and load cannot be definitively isolated. A more precise evaluation would require additional experiments in which only one parameter is varied at a time, while all other conditions remain constant. Furthermore, it is advisable to ensure consistent duration for the system to reach thermal equilibrium.

The results confirm the value of thermographic diagnostics for assessing the thermal stress on a belt drive and for identifying potentially adverse operating conditions.

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