Dan-iso A/S

Dan-isoFIT

Test of insulation properties

Herluf Montes Schütte, Senior Application Engineer
08-09-2025

Content

1 Overview

This document presents the results from a series of tests performed to determine the energy losses that occur in a dirt arrester under the following conditions:

- Fitted with no insulation
- Fitted with a Dan-isoFIT insulation solution

For the tests, a DN-200 dirt arrester was filled with water and the water was heated to a temperature of ~85°C using a 2KW electric heater. Once the system had achieved a steady-state temperature condition, the temperature was maintained constant for a period of 100 hours using a PID temperature controller.

The total energy required to maintain the temperature of the water constant at 85°C was measured using a power usage monitor.

The same procedure was performed with no insulation and with the test object covered by a Dan-isoFit shell.

The Dan-isoFIT solution provided a 91.7% reduction in energy consumption compared to the mineral wool solution.

2 Introduction

Piping insulation tends to be prioritized by most energy intensive industries that rely on the transportation of fluids at temperatures that are lower or higher than that of the surrounding environment. However, insulation of non-standard geometries, such as flanged connections for pumps, valves, dirt arresters and similar installations is often overlooked.

2.1 Determining the Heat Losses in Valves and Flanged Connections

In their 2024 white paper "The Overlooked Industry Decarbonization Champion: Technical Insulation" [3] the European Industrial Insulation Foundation (EiiF) highlights the potential for substantial energy savings through better insulation of industrial installations, with a particular emphasis on insulating non-standard geometries such as valves and dirt arresters.

One of the main hurdles when discussing the potential energy savings that can be achieved by insulating this type of installation is the lack of empirical data regarding the benefits of insulating piping connectors.

The ISO standard EN/ISO 12241 in its 2008 version [1] presents a method which converts various types of flanges connections to an equivalent installation length. For example, a DN 200 flanged connection transporting a fluid at 100°C, and located inside a building at 20°C is stated to have energy losses equivalent to between 5 and 11 meters of uninsulated DN 200 pipe (see Figure 1) while the same connection fitted with insulation would be equivalent to 0.8 to 1.3m of uninsulated pipe.

This tabular data is an improvement from the previous version of the standard [3], published in 1998, which did not account at all for the losses from valves or non-standard pipe geometries.

The tables in the 2008 version of the standard highlight the importance of insulation around non-standard piping geometries, but the estimates provided by them remain a very rough approximation, with values that can span a difference of more than 200% between the minimum and maximum estimated losses for the uninsulated cases and more than 60% for the insulated cases.

Table A.1 — Equivalent length for installation-related "thermal bridges"

Flanges for pressure stages PN 25 to PN 100 [b]			Equivalent length for given temperatures [a] Δl m		
			100 °C	250 °C	450 °C
Uninsulated for pipes	in buildings at 20 °C	DN 50 [c]	3 to 5	5 to 11	9 to 15
		DN 100	4 to 7	7 to 16	13 to 16
		DN 150	4 to 9	7 to 17	17 to 30
		DN 200	5 to 11	10 to 26	20 to 37
		DN 300	6 to 16	12 to 37	25 to 57
		DN 400	9 to 16	15 to 36	33 to 56
		DN 500	10 to 16	17 to 36	37 to 57
	in the open air at 0 °C	DN 50	7 to 11	9 to 16	12 to 19
		DN 100	9 to 14	13 to 23	18 to 28
		DN 150	11 to 18	14 to 29	22 to 37
		DN 200	13 to 24	18 to 38	27 to 46
		DN 300	16 to 32	21 to 54	32 to 69
		DN 400	22 to 31	28 to 53	44 to 68
		DN 500	25 to 32	31 to 52	48 to 69
Insulated	in buildings at 20 °C and in the open air at 0 °C	DN 50 [c]	0,7 to 1,0	0,7 to 1,0	1,0 to 1,1
		DN 100	0,7 to 1,0	0,8 to 1,2	1,1 to 1,4
		DN 150	0,8 to 1,1	0,8 to 1,3	1,3 to 1,6
		DN 200	0,8 to 1,3	0,9 to 1,4	1,3 to 1,7
		DN 300	0,8 to 1,4	1,0 to 1,6	1,4 to 1,9
		DN 400	1,0 to 1,4	1,1 to 1,6	1,6 to 1,9
		DN 500	1,1 to 1,3	1,1 to 1,6	1,6 to 1,8

Figure 1: Table excerpt from the 2008 edition of EN-ISO 12241.

The latest version of the same standard was published in 2022 [2]. This version includes a considerably more complex set of calculation rules for various valves and flange connections. An excerpt from the relevant table is shown in the figure below.

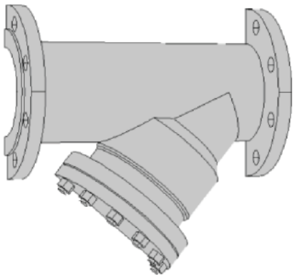
8	**Dirt arrester, flanged**		DN 15–DN 200; PN = (6…16) $f_A = -\frac{0,37}{1\ 000}\cdot\theta_i + 0,938$ $A_A = 18,4\cdot D_{p,e}^2 + 0,969\cdot D_{p,e} + 0,034\ 6$ $K_A = f_A\cdot h_{se}\cdot A_A + K_{fl}$

Figure 2: Excerpt from table A.3 in the 2022 version of EN-ISO 12241, showing correction factors for a dirt arrester.

Figure 2 shows the correction factors required to calculate heat losses in a dirt arrester. These correction factors are based on finite element method simulations performed at temperatures ranging from 50°C to 500°C. This is clearly a much more precise method than the rough estimates provided by the previous version of the standard.

The evolution of the standard in this respect, from no data to detailed calculation rules for over a dozen geometries based on hundreds of FEM simulations, indicates an increased focus on valves and other flanged connections as an area of interest where large energy losses are expected to occur. However, even this latest version of the standard only provides very simplified methods for calculating energy losses for these same geometries under insulated conditions.

A survey using Google Scholar indicates the subject has not received particular attention in the scientific literature either.

This lack of reliable data or guidelines makes it desirable to perform a series of tests to ascertain the influence of various types of insulation on heat losses on at least some geometries.

2.2 Insulation Solutions

Several solutions exist on the market that are intended to provide insulation for these geometries. Most of these are based on a “soft” insulation material (such as mineral wool) that is contained in tarpaulin bag that can be wrapped around the installation and held in place via elastic fasteners. While these solutions do reduce the energy losses that occur at the part in question, they are less than ideal as they allow for the creation of thermal bridges and areas where the insulation gets compressed (which severely reduces its effectiveness).

Dan-iso has developed a product line designed to fulfill the need for effective insulation of valves and other flanged connections.

Dan-isoFIT products are designed to easily fit around flanged connections. Due to their rigid construction, Dan-isoFit products ensure that proper insulation is maintained all around the insulated part. Additionally, Dan-isoFIT products are designed to allow for easy inspection and servicing of the insulated part, as they can be uninstalled and re-installed by using a simple screwdriver.

This document presents the results of tests performed on a DN 200 dirt arrester containing water heated at ~85°C to determine the energy losses that occur under the following conditions:

- without insulation
- using a Dan-isoFIT product.

3 Objectives

The main objectives of the tests were the following:

- To quantify the energy savings and thermal retention benefits of a Dan-isoFIT insulation solution.
- To ascertain the energy losses incurred by the dirt arrester when no insulation is used.

Due to the limitations of the test equipment, the tests are intended first and foremost as comparative tests. Thus, while the heat losses measured during the tests are expected to be representative and reasonably accurate, the values obtained are mostly intended to serve as a reference relative to each other.

4 Test Setup and Methodology

In this section, the test object and instrumentation used to determine the temperature and energy losses during tests are described.

4.1 Test Object

The test object was an AVK dirt arrester model 910-0200-21-311020004. This dirt arrester conforms with DN 200 dimensions and has a PN10 pressure rating. The dirt arrester is made of cast iron and is coated with an epoxy coating.

The figure below shows the main dimensions of the arrester.

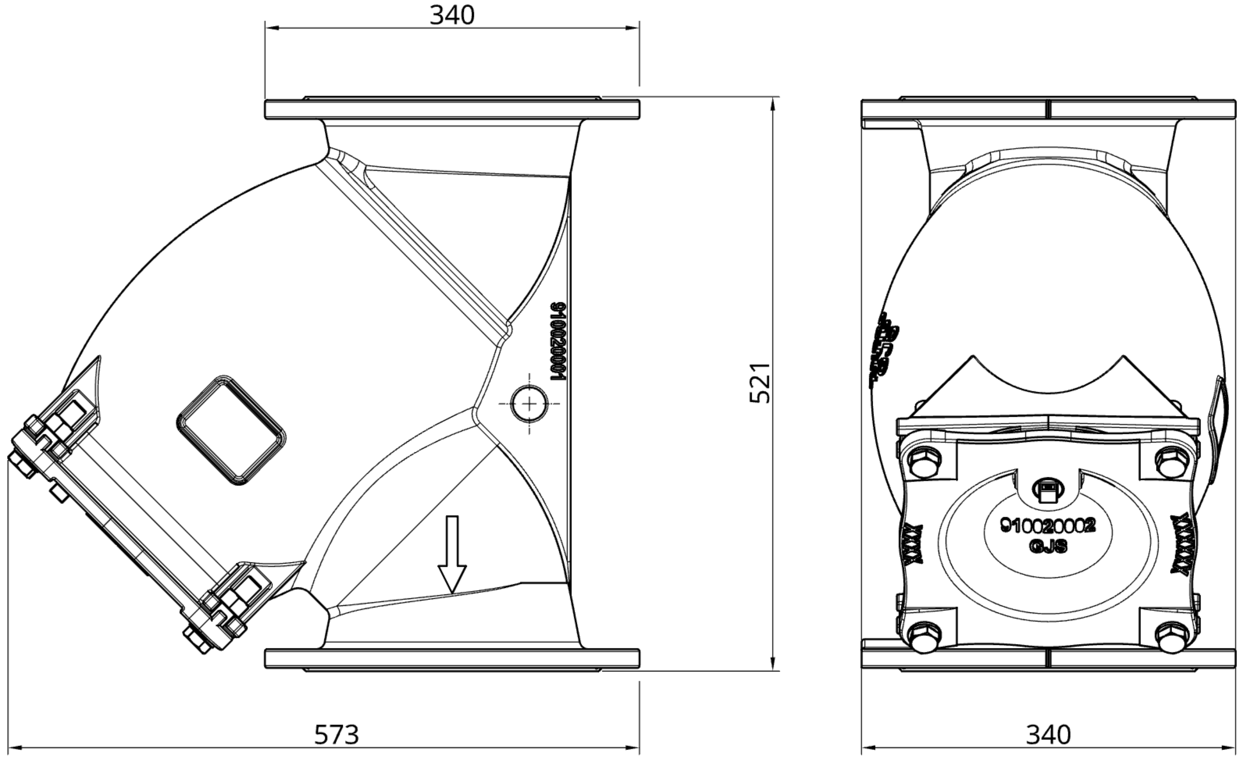


Figure 3: General dimensions of the AVK dirt arrester that was used as test object.

The dirt arrester has an internal volume of approximately 31.5 liters.
This particular test object was chosen, as it presents a typical geometry that is commonly found in district heating pump stations and industrial settings where hot or cold fluids are transported via pipes. Yet it is a component that is often overlooked when insulating installations despite the readily availability of insulation solutions based on mineral wool.

Figure 4 shows a DN 200 dirt arrester installed at a district heating pump station. The image shows the same arrester without insulation, insulated with a mineral wool solution and with a Dan-isoFIT insulation solution.

Figure 4: Dirt arrester installed in a district heating pump station.

4.2 Test Assembly

In addition to the AVK DN-200 dirt arrester, the test assembly consisted of two plates (end-flanges) designed to close each of the arrester flanges and keep the water inside during the tests.

The bottom flange was closed using a 10mm thick steel plate with a diameter of 340mm, the standard diameter for a DN200 PN10 flange. The plate was held in place using M20 bolts or appropriate length for the connection (70mm) and their respective nuts and washers. This plate was fitted with a ½" threaded perforation that allowed for the installation of a heat element as described in the following sections.

The top flange of the arrester was closed with a 20mm thick HDPE plate with a diameter of 340mm. This plate had a Ø11mm perforation located at a distance of approximately 100mm from its center. The purpose of this perforation was to serve as an inlet for the various thermoelements required for data acquisition. Additionally, this perforation allowed for the water and steam to escape and prevent pressure build-up in the event of boiling. As in the case of the bottom plate, the HDPE plate was fastened using M20x70mm bolt assemblies.

The heads of 8 of the M20 bolts used for retaining the plates were drilled and tapped with an M10 thread.

To ensure replicable conditions for all tests, and to limit the heat transfer from areas that are not covered by the tested insulation solutions, the top and bottom flanges were insulated with 130mm polyurethane cylinders. Each of these cylinders was held in place by means of 4 threaded rod assemblies. The threaded rod assemblies consisted of two M10 threaded rods separated by a HDPE piece. The HDPE served as an insulator and minimized heat transmission.

The threaded rods, combined with the HDPE piece, constitute an insulated support. These insulated supports were screwed into the head of 4 of the M20 bolts that were used to fasten each of the flange plates.

Just like the HDPE plate, the upper insulation cylinder had a Ø11mm perforation to permit the instrument wires to pass through it.

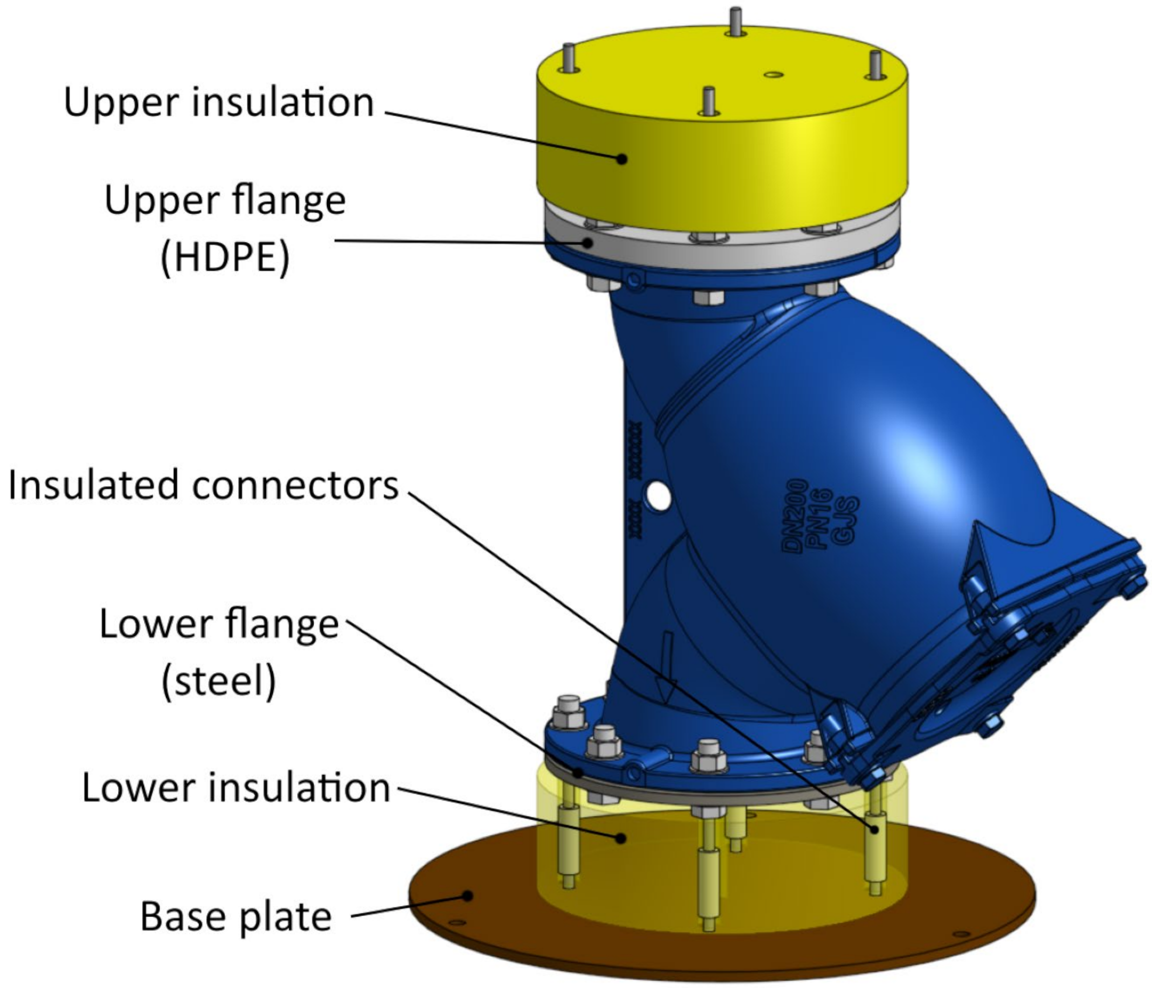


Figure 5: Test assembly showing its main components. The lower insulation block is shown semi-transparent.

The complete assembly rested on the lower insulated connectors which were fastened to a circular 10mm thick steel base plate with a diameter of 600mm.

This setup was used for both test configurations.

It is worth noting that the connectors serve as thermal bridges where heat can escape to the surrounding environment. However, given the limited exposed surfaces (non-insulated) and the low heat transfer coefficient of HDPE, the energy losses through them are considered to be negligible compared to the total losses from the main structure. Additionally, the main purpose of the tests is to provide comparative results between the various insulation methods.

Given that the rods are present in all test configurations, their presence will result in the same offset in the total energy losses for all configurations.

4.3 Instrumentation

The following instruments were used to track temperature conditions at and around the test object as well as the energy consumption during the tests.

- Danoplus THE-373 Thermometer / Data Logger with 4 channels fitter with type K thermoelements
- Ketotek KTEM02 electricity usage monitor (2 units)
- Bosch GTC 400C thermal camera

The thermometer was calibrated and its linearity verified by using boiling water and water just at the freezing point. The procedure is described in Appendix B.

The power meters (electricity use monitors) were of “consumer grade”, i.e. no calibration certificate was supplied with them, and the manufacturer provides no information regarding the accuracy of the device.

The monitors were tests in tandem (connected after each other) and the values they provided for energy consumption when connected to a resistance were compared to the values measured by multimeter. A detailed description of the tests is provided under Appendix 10.3.

These tests indicate that the devices show a good repeatability and an acceptable precision in the displayed values.

Since the purpose of the present tests series is to perform a comparative assessment of the two insulation systems, the absolute accuracy of the power meter is deemed to be less important than a high level of precision and repeatability.

4.4 Heating Equipment

Two electric heating elements were utilized to heat the water. Both heating elements were cylinders with a diameter of 16mm that were fitted with a 1 inch (32mm) standard pipe thread at their base. The length of the heating elements was dependent on their power rating.

Heating element 1 was rated at 2kW. Its actual power consumption at full capacity was measured using the power-use monitors to be ~1.890kW. The element had a length of 300mm and was fixed to the lower part of the arrester arm by means of its thread. This was the element that was used during all tests to maintain a steady state temperature in the system.

Heating element 2 was rated at 3kW, but its actual consumption was measured to be ~3.650kW. The element had a length of 400mm and was attached to the bottom plate (lower flange) by means of its thread. This heat element was installed as a backup and to make the initial heating of the test object faster until a steady temperature was obtained throughout the dirt arrester. The heating element was not used during the tests once steady state temperature was reached.

Figure 6 shows the location of heat elements 1 and 2 inside the test object. The dirt arrester is shown as translucent in this figure.

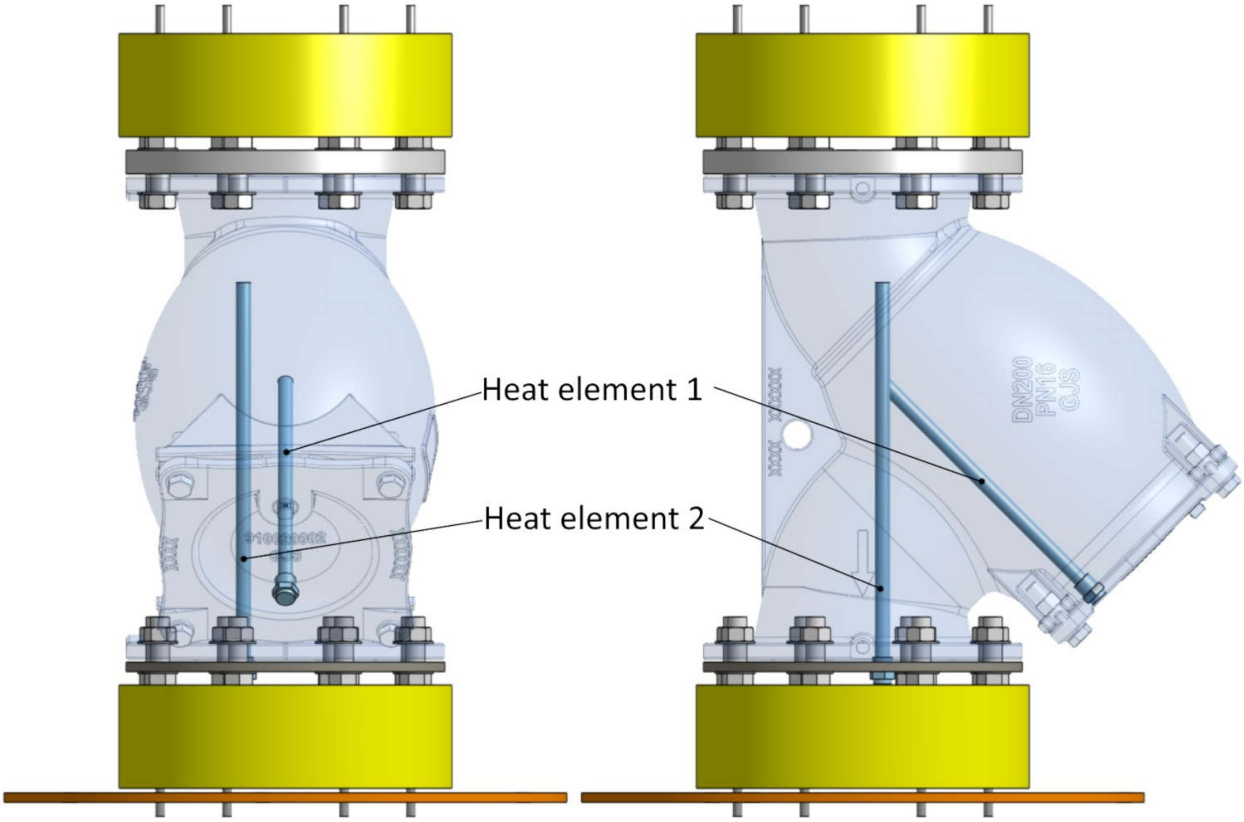


Figure 6: Location of heat elements 1 and 3. The elements are shown in light blue.

Each of the heaters was controlled by a REX-C100 Proportional Integral Derivative (PID) temperature digital controller. The REX-C100 is a ubiquitous low-cost temperature controller that is compatible with K-type thermocouples. The controller was connected to a solid-state relay (SSR) that supplied variable voltage to the heat elements.

Figure 7: Photo of the PID controller used for the test showing actual (upper) and target (lower) temperature values.

The PID controller allows to set a target temperature while showing the current temperature measured by the K thermocouple connected to it. The values shown by the controller were not calibrated as the temperatures were measured and logged by an independent set of sensors. The appropriate input temperature for the controller was determined by a preliminary test as described in Appendix 11.1.

4.5 Location of Thermoelements

5 thermoelements were used in total during each of the tests. They were given numbers T1 to T5 as presented below:

- **T1:** Was used to measure and log the water temperature in the upper section of the dirt arrester. The thermoelement was positioned 120mm from the upper flange.
- **T2:** Was used to measure and log the water temperature close to the bottom of the dirt arrester. The thermoelement was positioned 420mm from the upper flange.
- **T3:** Was used to measure and log the temperature of the dirt arrester surface close to the middle of the body.
- **T4:** Was used to measure and log the temperature surrounding the test object.
- **T5:** This thermoelement was connected to the PID controller and was used to provide feedback to the heating circuit. The thermoelement was positioned 400mm from the upper flange.

The thermoelements used for measuring water temperature (T1, T2 and T5) were fixed to an instrument rod that was submerged into the water. The purpose of this rod was to ensure that temperature measurements were performed at the exact same positions during each test.

The photo below shows the instrument rod attached to the HDPE flange with a meter-stick for reference. The location of the thermoelements is indicated.

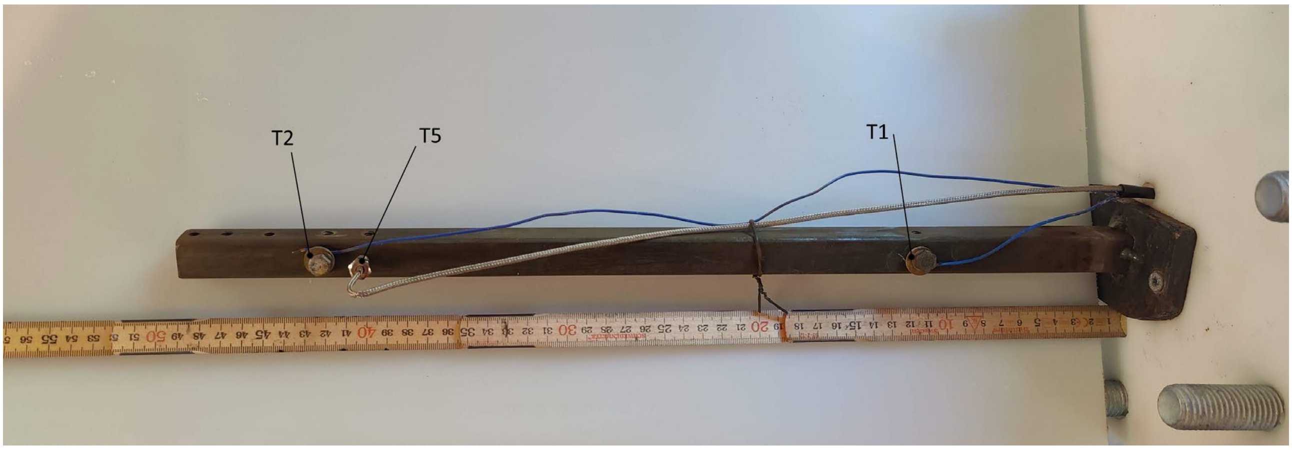


Figure 8: Instrumentation rod, attached to the top flange and showing the location of termoelements T1, T2 and T5.

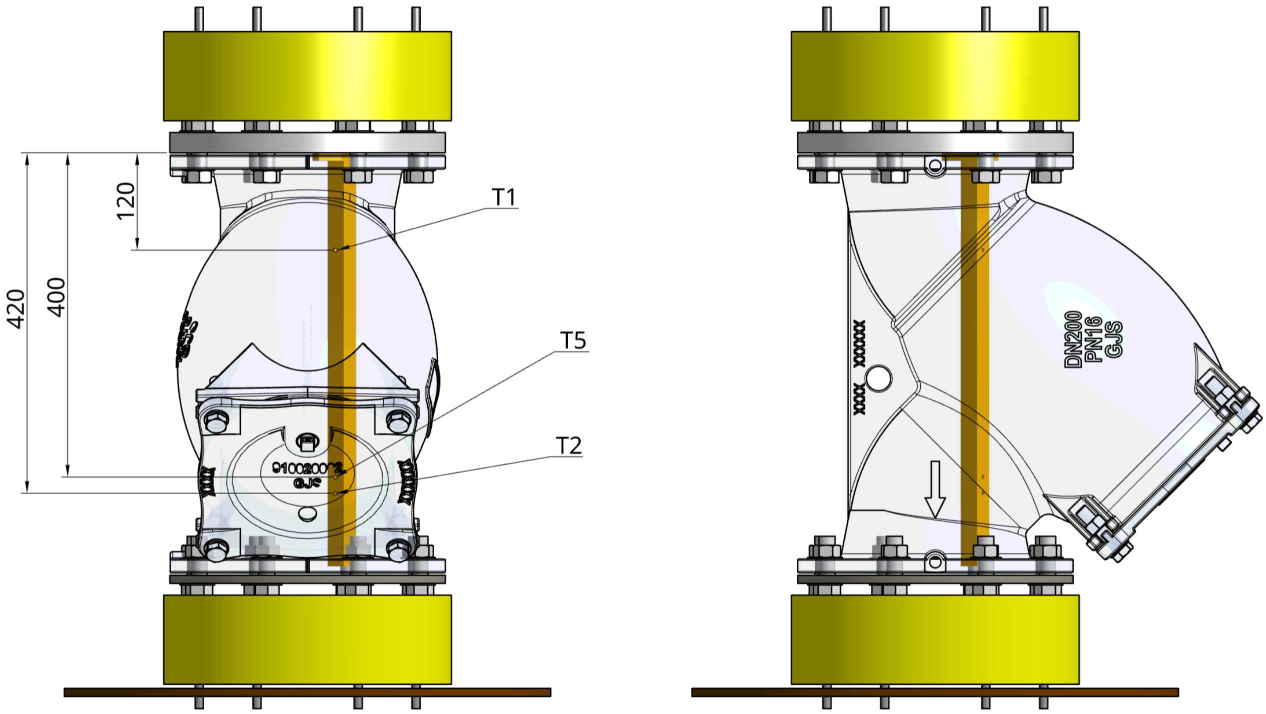


Figure 9: Test assembly showing the location of the instrument rod (light orange) within the arrester (dirt arrester is shown transparent)

4.6 Data Collection

The temperature was measured and logged at 1-minute intervals by thermoelements T1 to T4. Due to the internal memory limitations of the thermometer (5000 measuring points), the data was downloaded after ~48 hours into a computer. This led to a 4-to-5-minute gap in the measurements during each of the main tests. Due to the high thermal stability of the system, this gap is considered to be negligible and not to affect comparative results.

Power consumption was observed throughout each of the tests, but it was only logged at the end of each of the tests.

4.7 Installation Environment

The test assembly was placed in Dan-iso's "smithy". This area is located within an insulated building that is heated with a heat pump. The area is kept at a constant temperature of ~23°C and efforts were made to maintain this temperature for the duration of the tests. However, due to external factors such as the weather, the opening of windows and the limitations of the thermostat controlling the heat pump, small temperature variations were expected to occur during the tests.

The ambient temperature was measured and recorded at 1-minute intervals during each of the tests at the point indicated in the figure below (thermoelement T4).

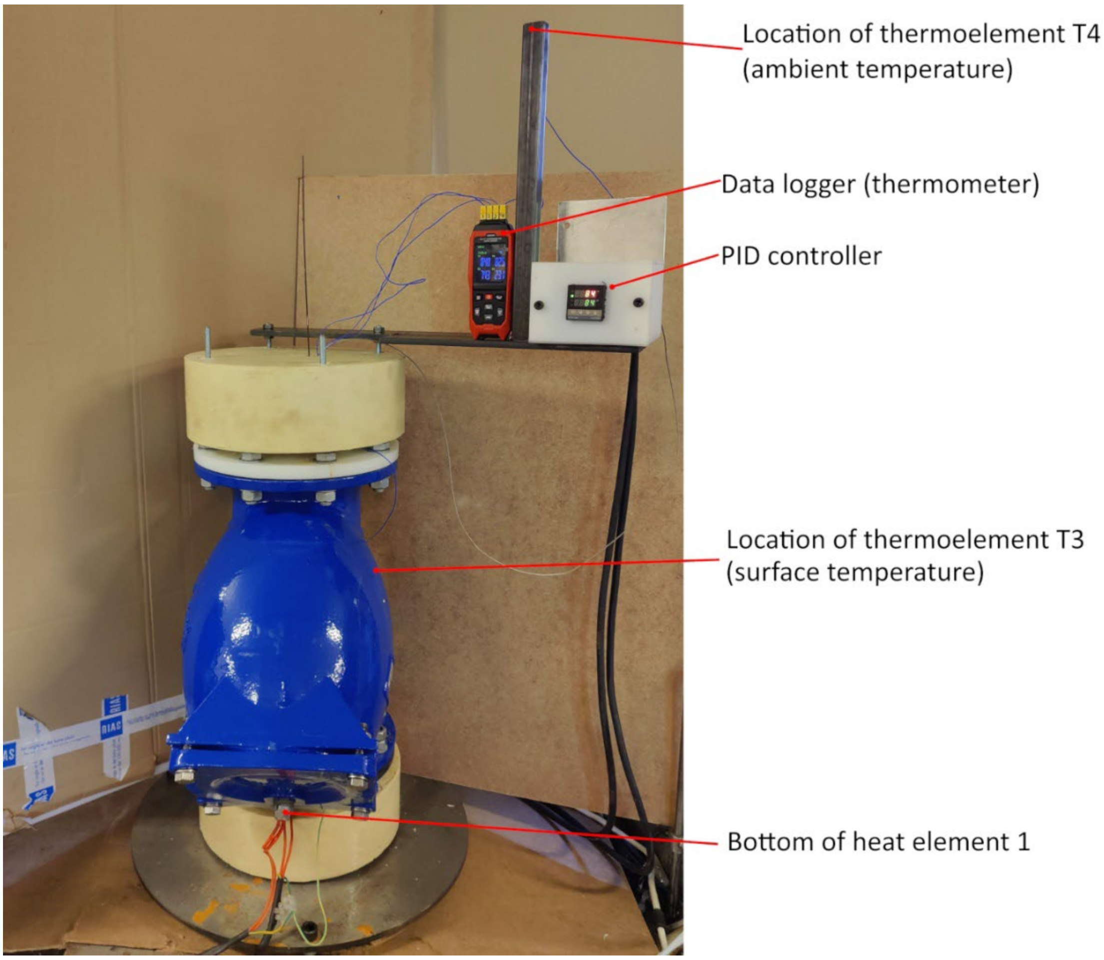


Figure 10: Test object and instrumentation showing the location of thermoelements T3 and T4.

4.8 Preliminary Tests

As preparation for the main series of tests, 4 preliminary tests were performed to check the reliability of data acquisition, ascertain the temperature distribution of the water with various heat inputs, and the times required to achieve steady state temperature conditions.

The procedure and results of these preliminary tests are presented under Appendix 10.1.

5 Test 1: Non-insulated Arrester

The first test was performed with a non-insulated arrester.

The test assembly was placed inside a heated and insulated building at Dan-iso. This room was kept at a temperature of approximately 23° during the test. It must be noted that due to the operation of the heating system, and the opening and closing of windows, some minor sudden changes in the room temperature were expected.

Figure 11: Test assembly during test 1.

Based on the results from the preliminary tests, the PID controller was set to a temperature of 84°C. This value was found to result in a value of approximately 85°C when averaging the readings from thermoelements T1 and T2. The assembly was allowed to heat up to the desired temperature and then allowed to stabilize for 6 hours. After this initial period the data recording was initiated, and the test was allowed to run for 100 hours. The following data was recorded:

- Accumulated power consumption during the 100 hours

- Temperature at the 4 locations described under section

5.1 Results: Test 1

The chart below shows the average of the temperatures registered by the T1 and T2 thermoelements as well as the difference between this average temperature and the temperature of the surroundings.

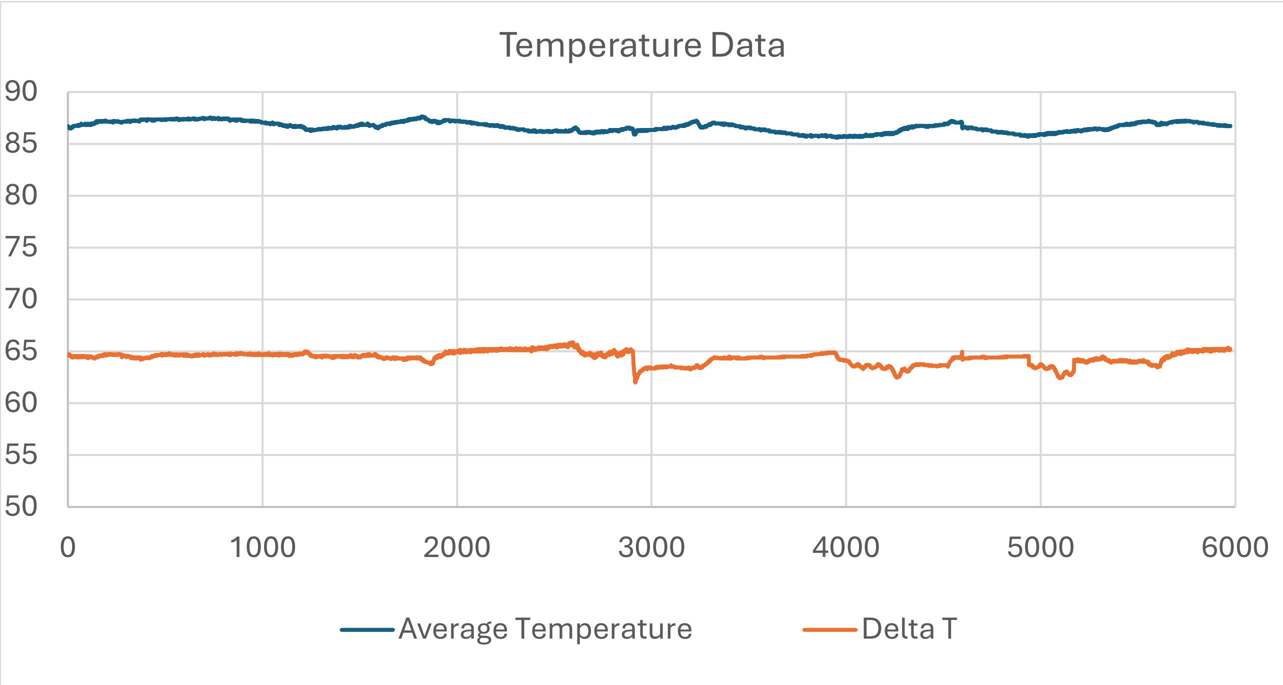


Figure 12: Temperature data from Test 1. Y axis: Temperature in °C. X axis: time in minutes.

The chart in Figure 12 indicates that the water temperature inside the test object was maintained at a relatively constant temperature between 85.5°C and 87.5°C. The two abrupt drops seen in the water temperature correspond to the two disconnections of the thermometer that were necessary to download the data. These interruptions are also the reason why the temperature data has slightly less than 6000 data points which corresponds to the 100 hours the test lasted.

At the end of the test the total energy consumption logged by the two electricity usage monitors was 56.01kWh and 56.06kWh, averaging 56.04kWh. This translates into an average heat loss of 560.4W.
The table below summarizes the results.

Installation	Energy input after 100h [kWh]	Average heat loss in installation [W]
No insulation	56.04	560.4

Table 1: Total and average energy consumption for test 1.

A thermography of the installation was taken after approximately 99 hours. The resulting images are shown below.

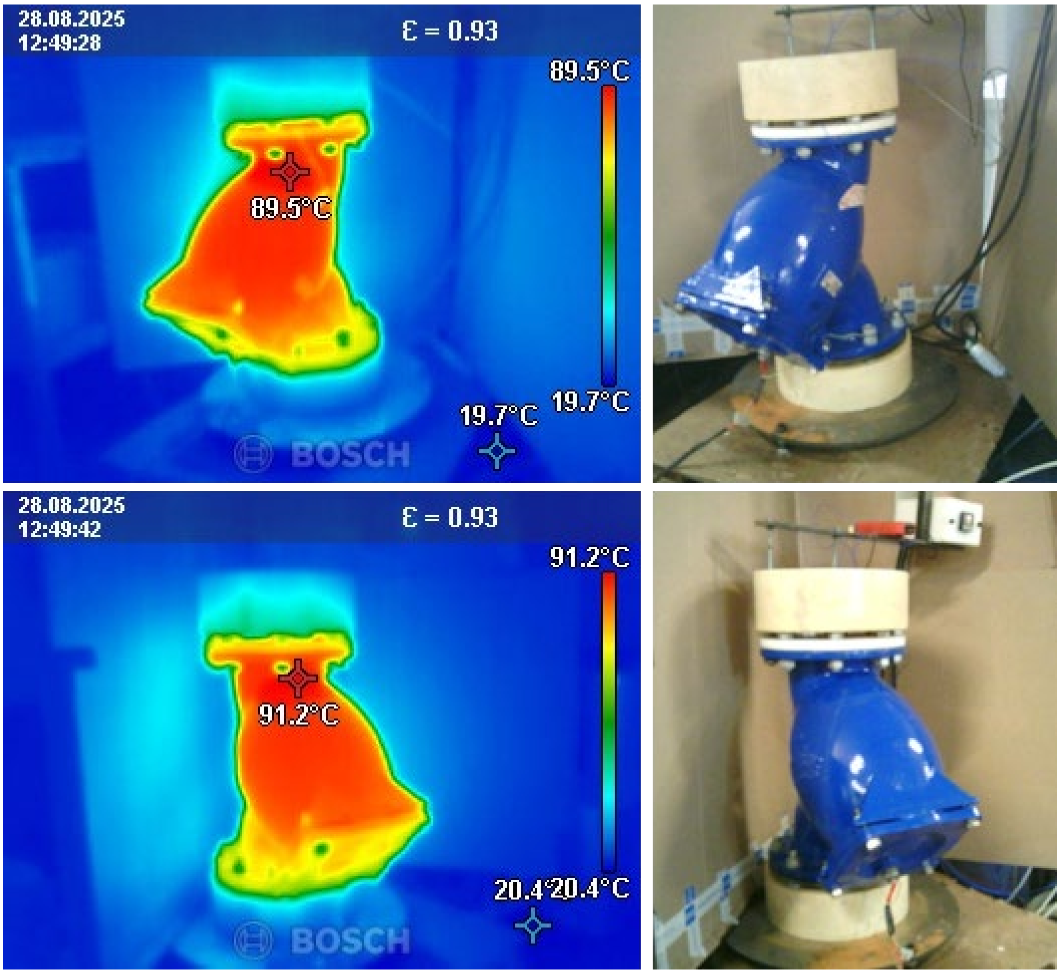


Figure 13: Thermography of the test installation, along with the corresponding visible light image of it.

The thermal images of the test installation showed surfaces temperatures exceeding 90°C on the upper surfaces of the dirt arrester. The images also showed a clear temperature gradient between the bottom an the top of the installation. The thermography measurements were in good agreement with the temperatures measured by the thermocouples.

6 Test 2: Arrester with Dan-isoFIT Insulation

The second test was performed with the dirt arrester covered by a Dan-isoFIT insulation solution.

As with the previous tests, the test assembly was placed inside a heated and insulated building at Dan-iso. This room was kept at a temperature of approximately 23° during the test. It must be noted that due to the operation of the heating system, and the opening and closing of windows, some minor sudden changes in the room temperature were expected.

Figure 14: Test assembly during test 3.

Based on the results from the preliminary tests, the PID controller was set to a temperature of 85°C. This value was found to result in a value of approximately 85°C when averaging the readings from thermoelements T1 and T2. The assembly was allowed to heat up to the desired temperature and then allowed to stabilize for 6 hours. After this initial period the data recording was initiated, and the test was allowed to run for 100 hours. The following data was recorded:

- Accumulated power consumption during the 100 hours.

- Temperature at the 4 locations described under section

6.1 Results: Test 2

The chart below shows the average of the temperatures registered by the T1 and T2 thermoelements as well as the difference between this average temperature and the temperature of the surroundings.

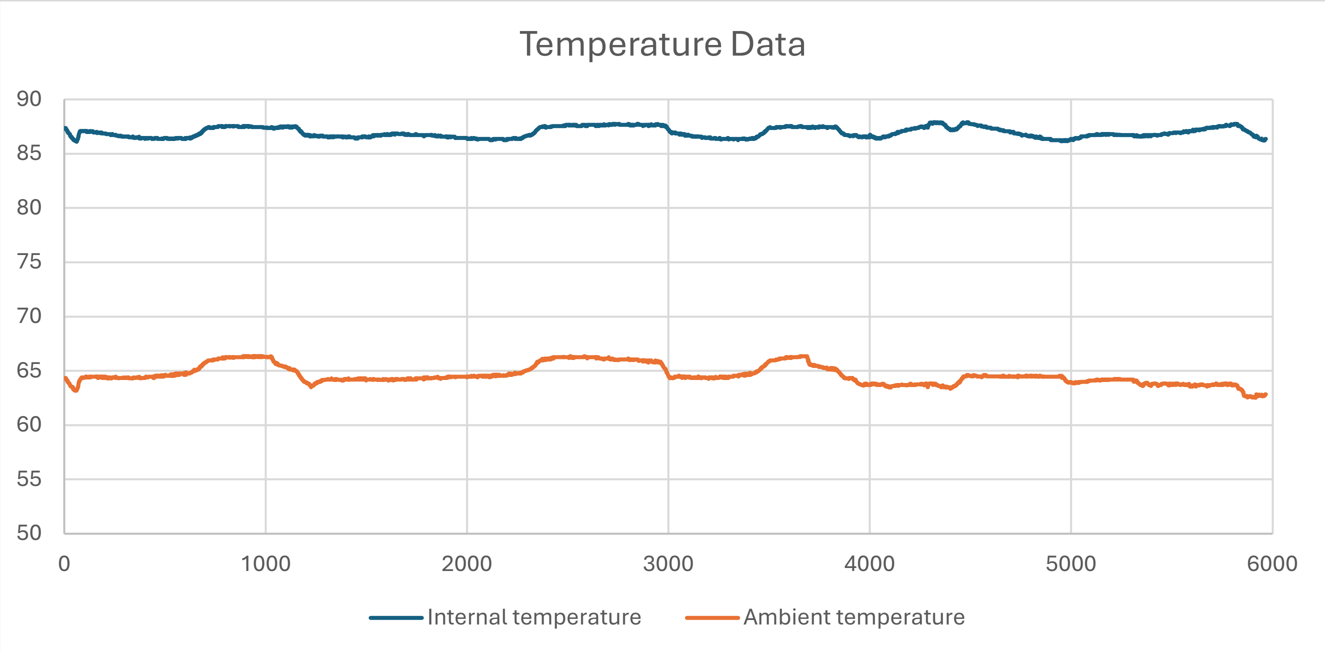


Figure 15: Temperature data from Test 3. Y axis: Temperature in °C. X axis: time in minutes.

The data shown in Figure 14 indicates that the water temperature inside the test object was maintained at a relatively constant temperature, but it was higher than it was during the previous tests, between 86.0°C and 87.9°C. The necessity to download the data from the thermometer is the reason why the temperature data has slightly less than 6000 data points which corresponds to the 100 hours the test lasted.

At the end of the test the total energy consumption logged by the two electricity usage monitors was 4.526kWh and 4.600kWh, averaging 4.563kWh. This translates into an average heat loss of 45.63W.
The table below summarizes the results.

Installation	Energy input after 100h [kWh]	Average heat loss in installation [W]
No insulation	4.563	45.63

Table 2: Total and average energy consumption for test 2.

A thermography of the installation was taken after approximately 99 hours. The resulting images are shown below.

Figure 16: Thermography of the test installation, along with the corresponding visible light image of it.

The thermal images of the test installation show no clear thermal bridges at the intefaces between the two insulation components. Additionally, the surface temperature of the insulation had a very similar temperature to that of the surroundings.

The highest temperatures were measured at the top of the installation were the Dan-isoFIT solution interfaced with the upper insulation disk, i.e. at an area that would not be present in a real installation with connecting pipes. This indicates that, while the Dan-isoFIT solutions offers outstanding insulation, correct interfacing with the surrounding insulation components is a key factor in achieving the most efficient system insulation.

7 Discussion of Results

The tests indicate a substantial reduction in energy consumption that can be achieved by insulating this type of installation with a Dan-isoFIT solution. The total consumption and average heat losses during the experiments are summarized in the table below.

Installation	Energy input after 100h [kWh]	Average heat loss in installation [W]
No insulation	56.04	560.4
Insulated with Dan-isoFIT	4.563	45.63

Table 3: energy losses in dirt arrested after 100h, comparison between non-insulated and insulated cases.

As the results above indicate, installing a Dan-isoFIT solution can reduce energy losses by 91.7% compared to a non-insulated arrester. The savings are illustrated graphically in the chart below.

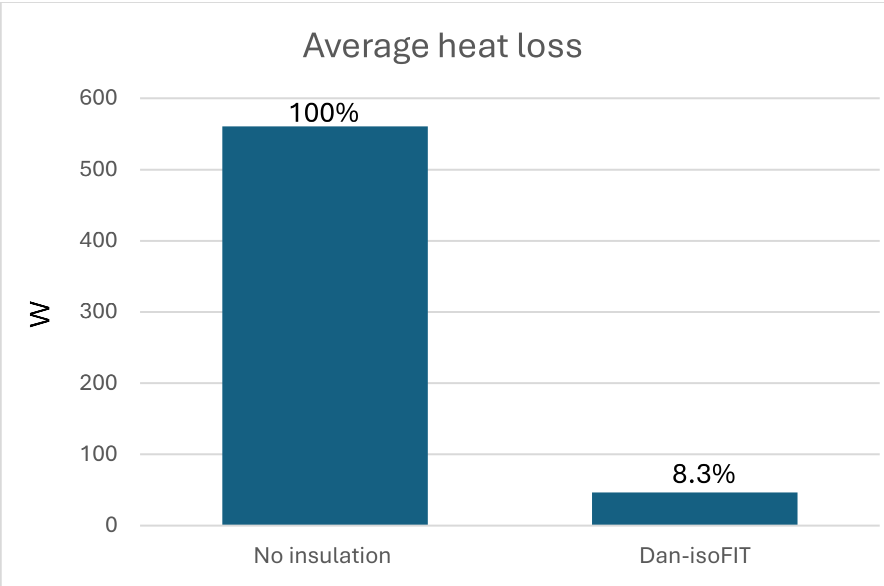


Figure 17: Average heat loss, no insulation vs. Dan-isoFIT.

The substantial savings that can be achieved correlate well with the thermographic analysis of the test object under both the insulated and un-insulated conditions which indicated very little losses in the insulated installation.

7.1 Comparison with Heat Loss Estimates by EN ISO 12241

As discussed in the introduction, EN ISO standard 12241 establishes a set of calculation rules for estimating energy losses in insulated and uninsulated industrial installations. The 2008 version of the standard estimates the losses that occurred at flanged connections by converting each flange to an equivalent length of standard piping. For a DN 200 flange connection operating at

100°C and located inside a 20°C room, the standard specifies an equivalent length between 5 and 11m.

The heat losses of DN 200 pipe sections of 5 and 11m can be estimated using the calculation rules specified by the same standard. The Dan-iso Online Calculation Tool is an implementation of these rules. The image below shows a set of inputs and results based on the test conditions.

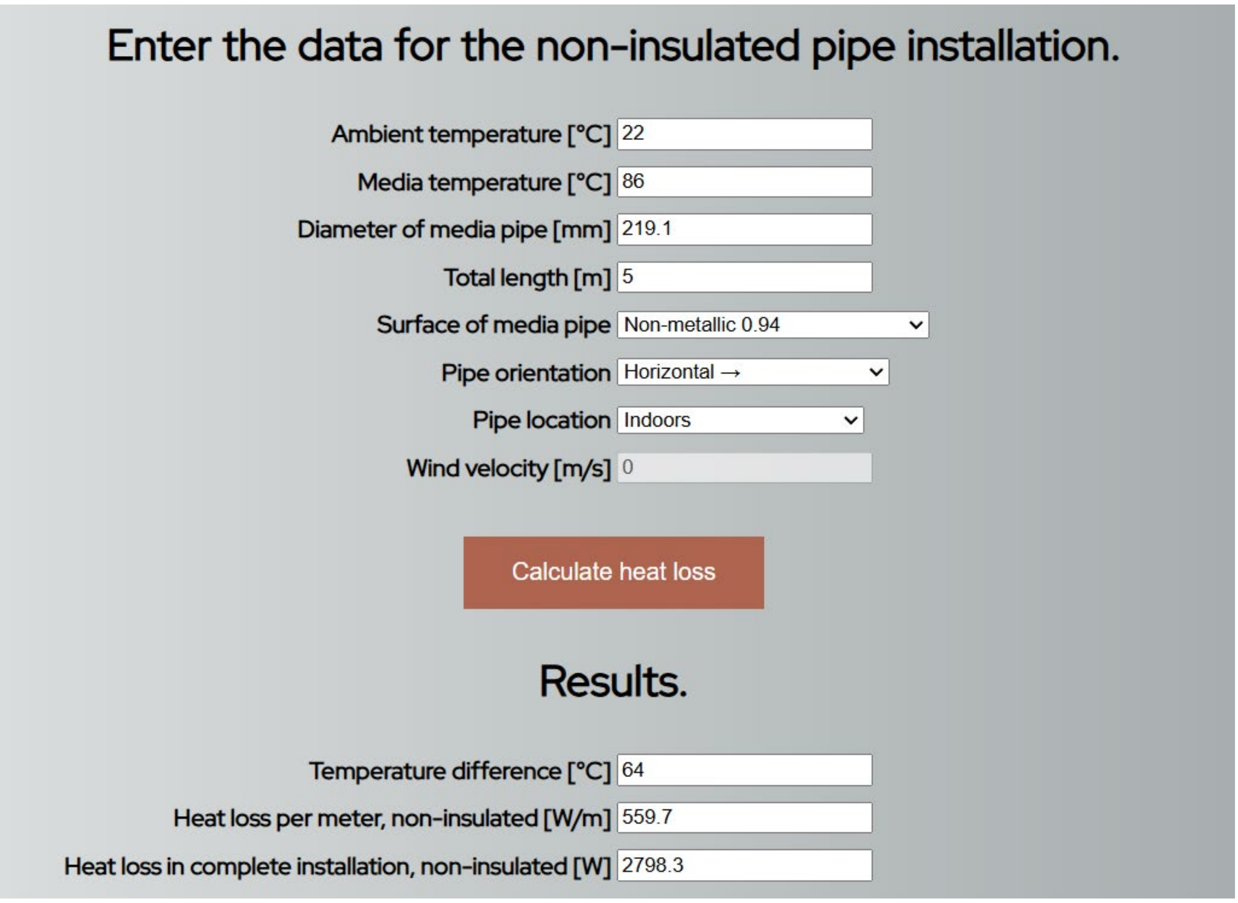


Figure 18: Input and results from the Dan-iso Online Calculation Tool using 5m as equivalent length.

The Dan-iso Online Calculation Tool returns heat losses of 2798W to 5156W for 5m and 11mm respectively (the range of estimates in the standard for a DN 200 un-insulated flange connection). This is approximately 5 to 11 times the actual average heat losses measured during test 1.

The results indicate that the losses measured in the installation are much closer to an equivalent length of 1m than to 5m or 11m as the standard suggests. This discrepancy may be partially since the standard assumes a pressure rate between PN 25 and PN 100, while the test installation is only PN 10 rated. Flanges with higher pressure ratings have a larger diameter and thus a larger surface where heat can be dissipated. Still, the discrepancy between the experimental results and the standard estimates is between 500% and 1100%, which is a very substantial over-estimation of the losses.

The standard also specifies an equivalent pipe length for estimating the losses incurred by insulated flange connections. For the present case, the equivalent pipe length specified by the standard would be 0.8 to 1.3m.

By using this length as input for the Dan-iso Online Calculation Tool, the estimated heat losses in the insulated case range from 392W to 728W. These values range from 859% to 1595% of the heat losses that were measured during the test for the insulated case.

The ratio of heat losses between the insulated and un-insulated cases as estimated by the standard ranges from 75% to 94%, which is in good agreement with the reduction in energy consumption observed during the tests (91.7%).

It can be concluded that the standard-specified values cannot be used as good estimates for PN 10 connections. However, the ratio of heat losses between the insulated and un-insulated cases does correspond to what has been experimentally measured using a Dan-isoFIT solution for the insulated case.

Despite the large discrepancy, the results of the test indicate that there are substantial energy savings to be gained from properly insulating non-standard piping geometries even if these are not as large as estimated by the standard in its 2008 edition.

8 Reduction of Greenhouse Gasses Emission

Energy efficiency is a key factor in reducing greenhouse gas emissions and mitigating climate change. One of the ways to achieve this is by improving the insulation of pipes that carry hot or cold fluids in industrial and domestic settings. Insulation reduces heat losses or gains, which in turn lowers the energy demand and the associated CO_2 emissions.

The exact reduction in greenhouse gas emissions that may be achieved through insulation of a system is heavily dependent on the energy sources utilized for heating or cooling a fluid.

The table on page 26 shows the expected reductions based on the assumption that a steady temperature is maintained in the system using electric power as a heat source to maintain the temperature of the test object under conditions equivalent to that of the test setup. The numbers are based on the national average CO_2 emissions per kWh produced in Denmark and Germany respectively.

Reference installation	Energy savings in installation [W]	Energy savings per year [kWh]	Emissions reduction, Denmark [CO_2-eq.] Ref [5]	Emissions reduction, Germany [CO_2-eq.] Ref [6]
Un-insulated arrester	514.0	4502.77	621.38 kg	1621.0 kg

Table 4: Examples of greenhouse emission reductions that may be achieved by using a Dan-isoFIT insulation solution.

9 Conclusions

The purpose of the tests was to determine the potential energy savings that may be achieved from insulating flanged connections and other non-standard pipe geometries. Additionally, EN ISO 12241:2008 provides estimates for heat losses in this type of installation. The tests were intended to serve as reference points to evaluate the accuracy of these estimates.

The tests indicated that insulating a non-standard pipe geometry, in this case a dirt arrester, can result in a drastic reduction of energy losses. In the present case, a reduction of 91.7% in energy losses was measured during the tests.

The equivalent length presented by EN ISO 12241:2008 results in a substantial over-estimation of energy losses for PN 10 flanges. However, the ratio of energy losses between the un-insulated and insulated cases does correspond to what has been measured during the tests presented in this document.

Based on these results the benefits of Dan-isoFIT insulation solution may be summarized as follows:

- Energy Efficiency: Utilizing Dan-isoFIT solutions significantly enhances energy efficiency in industrial settings.

- Cost Reduction: The material's low thermal conductivity and durability lead to reduced energy consumption. The ease of installation and removal of the Dan-isoFIT insulation solutions allows for easier maintenance which may contribute to a reduction in operating costs.

- Environmental Impact: By minimizing energy losses, polyurethane insulation solutions contribute to substantial CO_2 emission reductions.

10 References

1. *Thermal insulation for building equipment and industrial installations – Calculation rules (ISO 12241:2008)*
2. *Thermal insulation for building equipment and industrial installations – Calculation rules (ISO 12241:2022)*
3. *Thermal insulation for building equipment and industrial installations – Calculation rules (ISO 12241:1998)*
4. *EiiF White Paper 09/2024. The Overlooked Industry Decarbonization Champion: Technical Insulation. European Industrial Insulation Foundation*
5. *Danish Energy Agency - Key figures - Denmark – 2021 (https://ens.dk/en/our-services/statistics-data-key-figures-and-energy-maps/key-figures)*
   Retrieved 20-12-2023
6. *Ember - Yearly Electricity Data (2023); Ember - European Electricity Review (2022); Energy Institute - Statistical Review of World Energy (2023).*
7. *Dan-iso Online Calculation Tool. (https://dan-iso.dk/en/calculation-tool/)*