

Explosive atmospheres —

Part 30-2: Electrical resistance trace heating — Application guide for design, installation and maintenance

ICS 29.260.20

National foreword

This British Standard is the UK implementation of EN 60079-30-2:2007. It is identical to IEC 60079-30-2:2007. It supersedes BS EN 62086-2:2005 which is withdrawn and, together with DD IEC/TS 62395-2:2008, it supersedes BS 6351-2:1983 and BS 6351-3:1983 which are withdrawn.

The general and testing requirements previously contained in BS EN 62086-1:2005 and BS 6351-1:1983 are now contained in BS EN 60079-30-1:2007 and BS EN 62395-1:2006.

The UK participation in its preparation was entrusted by Technical Committee GEL/31, Equipment for explosive atmospheres, to Subcommittee GEL/31/14, Types of protection “e” and “n”.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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**Explosive atmospheres -
Part 30-2: Electrical resistance trace heating -
Application guide for design, installation and maintenance
(IEC 60079-30-2:2007)**

Atmosphères explosives -
Partie 30-2: Traçage
par résistance électrique -
Guide d'application pour la conception,
l'installation et la maintenance
(CEI 60079-30-2:2007)

Explosionsfähige Atmosphäre -
Teil 30-2: Elektrische
Widerstands-Begleitheizungen -
Anwendungsleitfaden für Entwurf,
Installation und Instandhaltung
(IEC 60079-30-2:2007)

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CENELEC

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Foreword

The text of document 31/662/FDIS, future edition 1 of IEC 60079-30-2, prepared by IEC TC 31, Equipment for explosive atmospheres, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60079-30-2 on 2007-03-01.

This European Standard supersedes EN 62086-2:2005.

The general revisions and updating to produce EN 60079-30-2:2007 are a result of national comments received.

The main technical differences apart from the general revision and updating of EN 62086-2:2005 are as follows:

- corrections;
- extensive revision and additions for design and installation recommendations.

This standard is to be used in conjunction with EN 60079-30-1:2007, *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2007-12-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2010-03-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60079-30-2:2007 was approved by CENELEC as a European Standard without any modification.

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EXPLOSIVE ATMOSPHERES –

Part 30-2: Electrical resistance trace heating – Application guide for design, installation and maintenance

1 Scope

This part of IEC 60079 provides guidance for the application of electrical resistance trace heating systems in areas where explosive gas atmospheres may be present, with the exception of those classified as zone 0.

It provides recommendations for the design, installation, maintenance and repair of trace heating equipment and associated control and monitoring equipment. It does not cover devices that operate by induction heating, skin effect heating or direct pipeline heating, nor those intended for stress relieving.

This part supplements the requirements specified in IEC 60079-30-1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-0:2004, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-1:2003, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures “d”*

IEC 60079-7:2001, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety ‘e’*

IEC 60079-10:2002, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-14:1996, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-17:1996, *Electrical apparatus for explosive gas atmospheres – Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines)*

IEC 60079-30-1:2006, *Explosive atmospheres – Part 1: Electrical resistance trace heating – General and testing requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0, IEC 60079-1 and IEC 60079-7 apply.

NOTE Additional terms and definitions applicable to explosive atmospheres can be found in IEC 60050 (426)¹.

4 Application considerations

4.1 General

This standard supplements the requirements of IEC 60079-14 and IEC 60079-17.

Where trace heating systems are to be installed in explosive gas atmospheres, full details of the hazardous area classification(s) (IEC 60079-10) shall be specified. The specification shall state the zone (1 or 2), gas group (IIA, IIB or IIC) and temperature classification in accordance with IEC 60079-0. Where special considerations apply or where site conditions may be especially onerous, these conditions shall be detailed in the trace heating specification.

Where trace heating systems are to be installed on mobile equipment or interchangeable skid units, the specification for these trace heating systems should accommodate the worst conditions in which the trace heating system may be used.

Where any parts of the trace heating system are likely to be exposed, those parts should be suitable for the environment.

4.2 Corrosive areas

All components of electric trace heating systems should be examined to verify that they are compatible with any corrosive materials that may be encountered during the lifetime of the system. Trace heating systems operating in corrosive environments have a higher potential for failure than in non-corrosive environments. Deterioration of the thermal insulation system is made worse by corrosion of the weather barrier and the possibility of pipeline and vessel leaks soaking the thermal insulation. Particular attention should be given to the materials of piping systems, as well as the electric trace heating systems, as related to the effective earth-leakage/ground-fault return path. The use of non-metallic or lined or coated piping systems may further complicate the earth-leakage/ground-fault return path and special consideration should be given to these piping systems. Earth-leakage/ground-fault return paths established at the time of installation may become degraded due to corrosion during the operation of the plant.

¹ IEC 60050-426, International Electrotechnical Vocabulary (IEV) – Part 426: Electrical apparatus for explosive atmospheres

4.3 Process temperature accuracy

4.3.1 Type I

A Type I process is one for which the temperature should be maintained above a minimum point. Ambient sensing control may be acceptable. Large blocks of power may be controlled by means of a single control device and an electrical distribution panel board. Heat input may be provided unnecessarily at times and wide temperature excursions should be tolerable. Energy efficiency may be improved through the use of dead-leg control techniques (see 6.13).

4.3.2 Type II

A Type II process is one for which the temperature should be maintained within a moderate band. Control by pipeline sensing mechanical thermostats is typical.

4.3.3 Type III

A Type III process is one for which the temperature should be controlled within a narrow band. Electronic pipe-sensing controllers using thermocouple or resistance-temperature detector (RTD) units facilitate field (work site) calibration and provide maximum flexibility in the selection of temperature alarm and monitoring functions. Heat input capability may be provided to preheat an empty pipe or raise the fluid temperature, or both, within a specified range and time interval. Type III systems require strict adherence to flow patterns and thermal insulation systems.

4.4 Installation considerations

If failure of any part of the trace heating system can result in a safety or process problem, then the trace heating system may be considered to be a critical component of the total process. The temperature control and circuit monitoring requirements of an application may be defined according to the temperature control types described in 4.3, together with the circuit monitoring criticality as described in Table 1.

Table 1 – Process types

Is trace heating a critical component of the process?	Desired accuracy of process temperature control		
	Above a minimum point Type I	Within a moderate band Type II	Within a narrow band Type III
Yes = Critical (C-)	C – I	C – II	C – III
No = Non-critical (NC-)	NC – I	NC – II	NC – III

When trace heating is critical to the process, circuit monitoring for correct operation, malfunction alarms, and back-up (redundant) trace heaters should be considered. Spare or back-up controllers can be specified to be automatically activated in the event of a fault being indicated by the monitoring/alarm system. This is sometimes known as "redundancy". Back-up trace heaters may allow maintenance or repairs to be performed without a process shutdown and may be used to enhance reliability.

5 Thermal insulation

5.1 General

The selection, installation and maintenance of thermal insulation should be considered a key component in the performance of an electrical trace heating system. The thermal insulation system is normally designed to prevent the majority of heat loss with the trace heating system compensating for the remainder. Therefore, problems with thermal insulation will have a direct impact on the overall system performance.

The primary function of thermal insulation is to reduce the rate of heat transfer from a surface that is operating at a temperature other than ambient. This reduction of energy loss may

- reduce operating expenses;
- improve system performance;
- increase system output capability.

Prior to any heat loss analysis for an electrically traced pipeline, vessel or other mechanical equipment, a review of the selection of the insulation system is recommended. The principal areas for consideration are as follows:

- selection of an insulation material;
- selection of a weather barrier (cladding);
- selection of the economic insulation thickness;
- selection of the proper insulation size.

5.2 Selection of insulating material

The following are important aspects to be considered when selecting an insulation material. These factors should be considered and the selection optimised according to the operator's criteria:

- temperature rating;
- thermal conductivity, λ , of the insulation;
- mechanical properties;
- chemical compatibility and corrosion resistance;
- moisture resistance;
- health risks during installation;
- fire resistance;
- toxicological properties when exposed to fire;
- costs.

Insulation materials commonly available include:

- expanded silica;
- mineral fibre;
- cellular glass;
- urethane;
- fibreglass;
- calcium silicate;
- polyisocyanurate;
- perlite silicate.

For soft insulants (mineral fibre, fibreglass, etc.), actual pipe size insulation may be used in many cases by banding the insulation tightly. Care should be taken to prevent the trace heater from being buried within the insulation, which may cause damage to the trace heater or may restrict proper heat transfer. As an alternative, the next largest pipe size insulation that can easily enclose pipe and electric trace heater is also acceptable. Rigid insulation (calcium silicate, expanded silica, cellular glass, etc.), may be pipe-size insulation if board sections are cut to fit the longitudinal joint. This type of installation technique is commonly referred to as an extended leg installation. Alternatively, the next largest insulation size may be selected to accommodate the trace heater. In all cases, the insulation size and thickness should be clearly specified.

5.3 Selection of weather barrier (cladding)

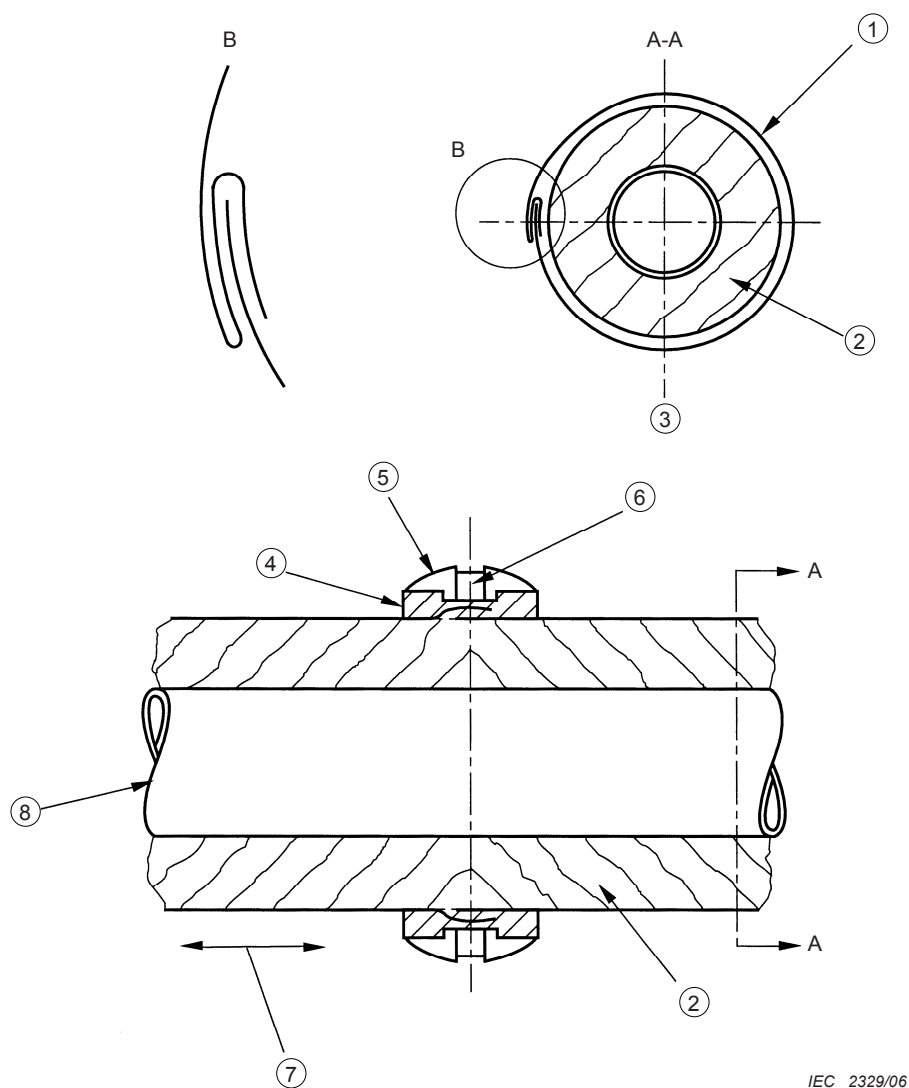
Proper operation of an electrically trace heated system depends upon the insulation being dry. Electric tracing normally has insufficient heat output to dry wet thermal insulation. Some insulation materials, even though removed from the piping and force dried, never regain their initial characteristics after once being wet.

Straight piping may be weather-protected with metal jacketing, polymeric, or a mastic system. When metal jacketing is used, it should be smooth with formed, modified “S” longitudinal joints. The circumferential end joints should be sealed with closure bands and supplied with sealant on the outer edge or where they overlap (see Figure 1).

Jacketing that is overlapped or otherwise closed without sealant is not effective as a barrier to moisture. A single, unsealed joint can allow a considerable amount of water to leak into the insulation during a rainstorm.

The type of weather barrier used should, as a minimum, be based on a consideration of the following:

- effectiveness in excluding moisture;
- corrosive nature of chemicals in the area;
- fire protection requirements;
- durability to mechanical abuse;
- cost.



Key

- | | |
|-------------------------------|-------------------|
| 1 metal jacket | 5 closure band |
| 2 insulation | 6 insulated strap |
| 3 metal jacket insulated pipe | 7 movement |
| 4 mastic sealer | 8 pipe |

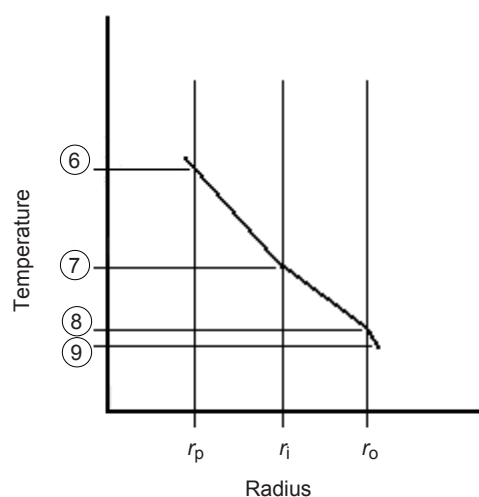
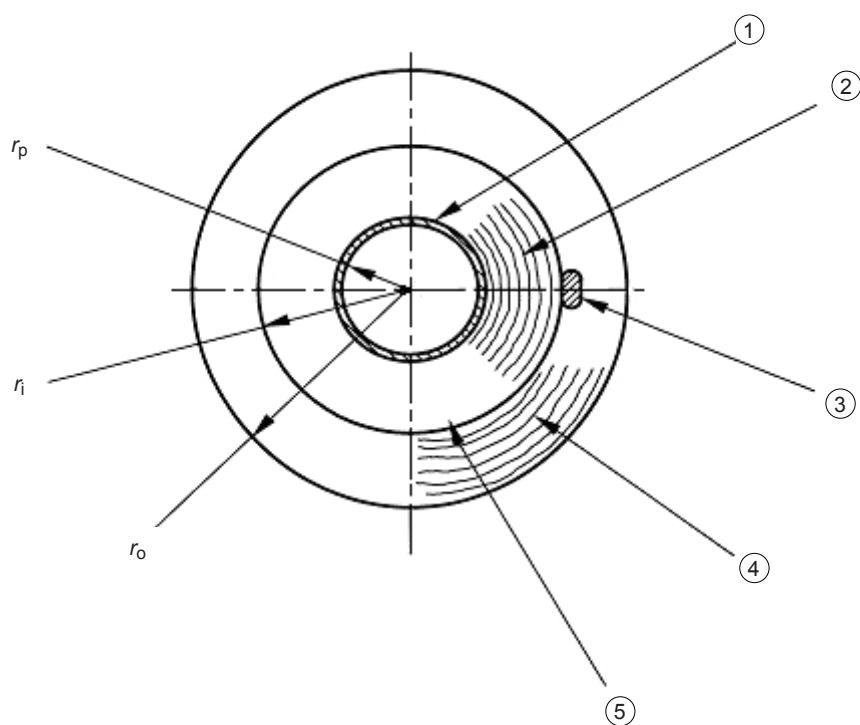
Figure 1 – Thermal insulation – Weather-barrier installation

5.4 Selection of economical thickness

At a minimum, an economic consideration of the insulation will weigh the initial costs of the materials and installation against the energy saved over the life of the insulation. It should be noted that the actual insulation thicknesses do not always correspond exactly to the nominal insulation thickness. When choosing the insulation size, considerations should be made as to whether or not the actual pipe-size insulation is suitable for accommodating both pipe and trace heater.

5.5 Double insulation

The double insulation technique may be employed when the pipe temperature exceeds the maximum allowable temperature of the trace heater. Prevention of the freezing of condensate in high-temperature steam lines when these lines are not in use is a typical application. It consists of locating the trace heater between two layers of insulation surrounding the pipe. The essence of the double-insulation technique is to determine the correct combination of inner and outer insulation type and thickness that will result in an acceptable interface temperature for the trace heater. This relationship is illustrated in Figure 2. Note that maximum ambient temperature conditions should be considered in this determination.



IEC 2330/06

Key

- | | |
|--------------------------|--|
| 1 pipe | 6 maximum temperature pipe |
| 2 inner insulation layer | 7 interface temperature |
| 3 heat tracer | 8 outer insulation surface temperature |
| 4 outer insulation layer | 9 ambient temperature |
| 5 metal foil (aluminium) | |

Figure 2 – Typical temperature profile

6 System design

6.1 Introduction

Each trace heating application imposes unique demands on the designer to achieve the desired temperature and maintain it within the specified conditions. Trace heating systems necessarily interface with other specified items of equipment such as thermal insulation and the electrical supply available to power the system. The final system will be an integration of all these component parts so the values of these interface items have to be known and controlled in order to design systems that will perform as required.

The design of any trace heating system shall conform to all IEC requirements for the use of electrical equipment and with the requirements of this standard. Consideration shall be given as to the maintenance of the systems and process equipment, to energy efficiency, and to testing the installed systems for operational satisfaction and safety.

When designing trace heating systems for use in explosive gas atmospheres, additional constraints are imposed due to the requirements and classification of the area under consideration.

Persons involved in the design and planning of electric trace heating systems should be suitably trained in all techniques required.

6.2 Purpose of, and major requirement for, trace heating

Trace heaters should be selected and installed so as to provide sufficient power for:

- a) compensation of heat loss when maintaining a specified temperature of a workpiece at the specified minimum ambient temperature; see calculation method in 6.3; or
- b) raising the temperature of a workpiece, and its contents when specified, within a specified time period; see calculation method in 6.4; or
- c) a combination of a) and b).

The system heat requirements should then be multiplied by a safety factor as determined on the basis of 6.5.

The trace heater selection shall consider the determination of the maximum possible system temperature under worst case conditions as specified in IEC 60079-30-1. The temperature may be reduced, for example, through adjustments to the system parameters, by the use of multiple tracers to reduce the power produced per unit length, or by the selection of the temperature control system. The excess of installed power over the power as required, and the way in which trace heaters are applied, installed and operated shall not be the cause, not even after evaluation of worst-case conditions, of any unacceptable risk in explosive gas atmospheres.

6.3 Heat loss calculations

The heat loss of a workpiece can be calculated in simplified form as:

$$q = k \Delta T \quad (1)$$

where

- q is the heat loss per unit length of pipe, in watts per metre (W/m);
- ΔT is the difference in temperature between the desired maintenance temperature (T_p) and the minimum design ambient temperature (T_a), in degrees Celsius (°C);
- k is the thermal conductivity of the system that for the sake of simplification can be considered to be a constant (W/m K).

Factor k is a function of the thickness, size, and type of the thermal insulation layer(s), the mean temperature of the thermal insulation, and the convective film coefficients of the workpiece contents and the outside environment. The degree of accuracy of the calculation therefore depends on the degree of definition of the system parameters.

Given these parameters, the heat loss for pipes and tubes may be determined by using more detailed calculations. The equation given in (1) takes the following form when the conduction parameters are taken into account:

$$q = \frac{2\pi K (T_p - T_a)}{\ln\left(\frac{D_2}{D_1}\right)} \quad (2)$$

where

- q is the heat loss per unit length of pipe, in watts per metre (W/m);
- T_p is the desired maintenance temperature, in degrees Celsius (°C);
- T_a is the minimum design ambient temperature, in degrees Celsius (°C);
- D_1 is the inside diameter of the inner insulation layer, in metres (m);
- D_2 is the outside diameter of the outer insulation layer, in metres (m);
- K is the thermal conductivity of the inner layer of insulation evaluated at its mean temperature (W/m K).

Further accuracy in the heat loss equation can be obtained by differentiating the characteristics of the different system layers and by incorporating the convective parameters, as given in the following equation:

$$q = \frac{(T_p - T_a)}{\frac{1}{\pi D_1 h_i} + \frac{\ln\left(\frac{D_2}{D_1}\right)}{2\pi K_1} + \frac{\ln\left(\frac{D_3}{D_2}\right)}{2\pi K_2} + \frac{1}{\pi D_3 h_{co}} + \frac{1}{\pi D_3 h_o}} \quad (3)$$

where

- D_2 is the outside diameter of the inner insulation layer, in metres (m), (inside diameter of the outer insulation layer when present);
- D_3 is the outside diameter of the outer insulation layer when present, in metres (m);
- K_1 is the thermal conductivity of the inner layer of insulation evaluated at its mean temperature (W/m K);
- K_2 is the thermal conductivity of the outer layer of insulation, when present, evaluated at its mean temperature (W/m K);
- h_i is the inside air contact coefficient from the pipe to the inner insulation surface when present (W/m² K);

h_{co} is the inside air contact coefficient from the outer insulation surface to the weather barrier when present ($W/m^2 K$);

h_o is the outside air film coefficient from the weather barrier to ambient ($W/m^2 K$) (typical values for this term range from 5 $W/m K$ to 50 $W/m K$ for low-temperature applications below 50 °C).

Vessel heat losses often require a more complex analysis to determine total heat loss. The trace heating supplier should be consulted.

For ease of product selection, trace heating suppliers will often furnish simple charts and graphs of heat losses for variously maintained temperatures and insulations, which usually include a safety factor.

6.4 Heat-up considerations

In certain plant operations, it may be necessary to specify that the trace heating system is capable of raising the temperature of a static product within a certain time period. The heat delivery requirement of a trace heated system on piping may be evaluated by use of the following equation:

$$t = H \ln \left\{ \frac{q_c - U(T_i - T_a)}{q_c - U(T_f - T_a)} \right\} + \frac{P_1 V_{c1} h_f}{q_c - U(T_{sc} - T_a)} \quad (4)$$

where

U is the heat loss per unit length of pipe per degree of temperature difference.

$$U = \frac{1}{\frac{1}{\pi D_1 h_i} + \frac{\ln \left(\frac{D_2}{D_1} \right)}{2\pi K_1} + \frac{\ln \left(\frac{D_3}{D_2} \right)}{2\pi K_2} + \frac{1}{\pi D_3 h_{co}} + \frac{1}{\pi D_3 h_o}} \quad (5)$$

H is the thermal time constant, which is the total energy stored in the mass of pipe, fluid, and insulation per degree of temperature divided by the heat loss per unit length per degree temperature differential.

$$H = \frac{P_1 C_{p1} V_{c1} + P_2 C_{p2} V_{c2} + 0,5 P_3 C_{p3} V_{c3}}{U} \quad (6)$$

P_1 is the density of the product in the pipe (kg/m^3);

C_{p1} is the specific heat of the product ($J/kg K$);

V_{c1} is the internal volume of the pipe (m^3/m);

P_2 is the density of the pipe (kg/m^3);

C_{p2} is the specific heat of the pipe ($J/kg K$);

V_{c2} is the pipe wall volume (m^3/m);

P_3 is the density of insulation (kg/m^3);

C_{p3} is the specific heat of the insulation ($J/kg K$);

V_{c3} is the insulation wall volume (m^3/m);

T_i is the initial temperature of the pipe, in degrees Celsius (°C);

T_f is the final temperature of the fluid and the pipe, in degrees Celsius (°C);