TECHNISCHER LÖSUNGSVORSCHLAGAktenzeichen:H2015-010

Title:"Freezingrisk detection

Unternehmenseinheit:DiehlMetering S.A.S.

The Description:

Detecting the risk of frost

Some water-containing appliances cannot withstand freezing. If this happens they burst. This is particularly true of water meters. The invention makes it possible to calculate the risk of freezing and possibly to send an alarm signal.

The solutions seen so far are based on simple detection of the ambient temperature, or the temperature of the water. However, they do not take into account the very large inertia due to the amount of heat that needs to be extracted from the water in order to change its state from liquid to ice.

Most commercial documentation or instructions for use mention this situation.

Depending on the measured temperature, ambient or water temperature, the invention makes it possible to calculate the risk of change of state of the water.

In this way, it is possible to calculate the risk of frost, send an alarm signal, and act before it is too late.

This invention will be integrated into a radio module to be mounted on a water meter. This will make it possible to monitor the risk of freezing.

1. Method for preventive detection and warning of the existence of an actual risk of freezing of an apparatus or device (1) through which a liquid, in particular water, flows, such as for example a water meter, this apparatus or device (1) being installed in a supply or circulation pipe section (2, 2') for the liquid and the unit or arrangement [apparatus/pipe section incorporating it] being installed in a thermally characterizable local installation environment (3)

process characterized

in that it consists, in an initial calibration phase, in preliminarily establishing, by means of measurement(s), experiment(s) and/or at least partial simulation(s), in the circumstances and conditions of use and implementation of the apparatus (1) in question, or by reproducing these circumstances and conditions, a reference curve (CR) making it possible to determine the state of the liquid for example water, present in the apparatus (1), for example a meter, as a function of the value of the temperature of the said liquid and its development over time, determining more particularly with precision the characteristic temperature plateau (PTC) corresponding to the phase of progressive solidification of the liquid in the apparatus (1), and

in that, in use, a current position on the reference curve (CR) indicating the state of the liquid present in the apparatus (1) is determined continuously or at regular intervals by simulation and by evaluating at least one updated measurement of the temperature of the local installation environment (3), and in that a signal is given that a limit position (PL) on the aforementioned characteristic temperature step (PTC) has been reached.

2. Method according to claim 1, characterised in that it consists, in order to estimate the current position of the state of the water on the reference curve (CR), in measuring the temperature of the water present in the meter (1) and the temperature of the local environment (3) in which the latter is installed, either continuously or at regular intervals, and in quantifying the heat energy dissipated or absorbed by the assembly [meter (1)/portion (2, 2') of pipe integrating it] with respect to the said environment, integrating with respect to time the balance of the heat exchanges between the aforementioned assembly (1, 2, 2') and the local environment in which it is installed, by simultaneously measuring the temperature of the water present in the meter (1), and deducing continuously a current position on the reference curve (CR) from the updated values resulting from the aforementioned integration and measurement operations.

3. Method according to claim 2, characterised in that it consists in carrying out the operation of integrating the heat exchanges only when the temperature of the water present in the meter (1) is close to 0°C.

4. A method according to claim 2 or 3, characterised in that the heat exchange integration operation is performed over a sliding time window,

said operation being stopped during a current time window as soon as the temperature of the water present in the meter (1) exceeds substantially 0° C and a new integration time window starting with reinitialisation and restart of the integration operation as soon as said temperature of the water present in the meter (1) is close to 0° C again.

5. Method according to any one of claims 2 to 4, characterised in that it consists, in order to quantify the heat energy exchanged between the assembly [meter (1)/portion (2, 2') of pipe integrating it] and the local environment of installation (3), in establishing a digital thermal model of the said assembly (1, 2, 2') which is fed by the value of the temperature of the environment of installation (3), measured continuously or at regular intervals.

6. Method according to claim 5, characterised in that the numerical thermal model is constituted by aggregation of individual numerical thermal models each corresponding to a specific constituent component of the assembly [meter (1)/portion (2, 2') of pipe incorporating it] and to the volume of water present in the meter (1) and possibly in the parts (2, 2') of the portion of pipe incorporating it.

7. Method according to any one of claims 1 to 4, characterised in that it consists in simulating the thermal behaviour of the assembly [meter (1) + portion (2, 2') of pipe integrating it] and of the volume of water contained in this assembly (1, 2, 2') by means of analogue electronic circuits, the operation of which is, if necessary, reproduced in software form.

8. Arrangement of a liquid meter, in particular a water meter, comprising a system for preventive detection and warning of a risk of freezing in use, suitable and intended for implementing the method according to any one of claims 1 to 7,said meter (1) comprising in particular a management and processing unit (4), advantageously integrated into a radio module (5) forming part of said meter (1), the latter being mounted in a portion (2, 2') of the supply or circulation pipe for the liquid forming the above-mentioned arrangement with the meter (1),

arrangement characterised in that the meter (1) also comprises, or is connected to, a sensor (6) for measuring the temperature of the water or liquid present in the meter (1), and a sensor (7) for measuring the temperature of the surrounding installation environment (3) receiving the said meter (1) and the said portion (2, 2') of pipe integrating it, together forming the arrangement (1, 2, 2'), and in that the management and processing unit (4) integrates a digital thermal model (8), for example in the form of a simulation of analogue electronic circuits, of the arrangement or assembly [meter (1) + portion (2, 2') of pipe integrating it] and storing a reference curve (CR) making it possible to determine the physical state of the liquid, for example water, present in the meter (1), by exploiting the value of the temperature of the said liquid and the value of the temperature of the environment (3), and their evolutions over time.

Drawings:

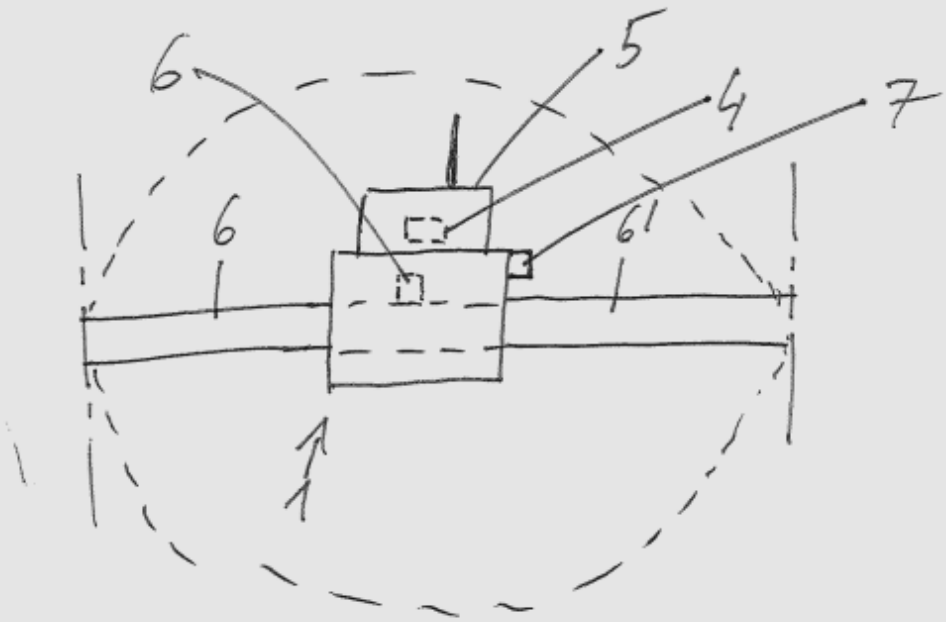


Fig 1

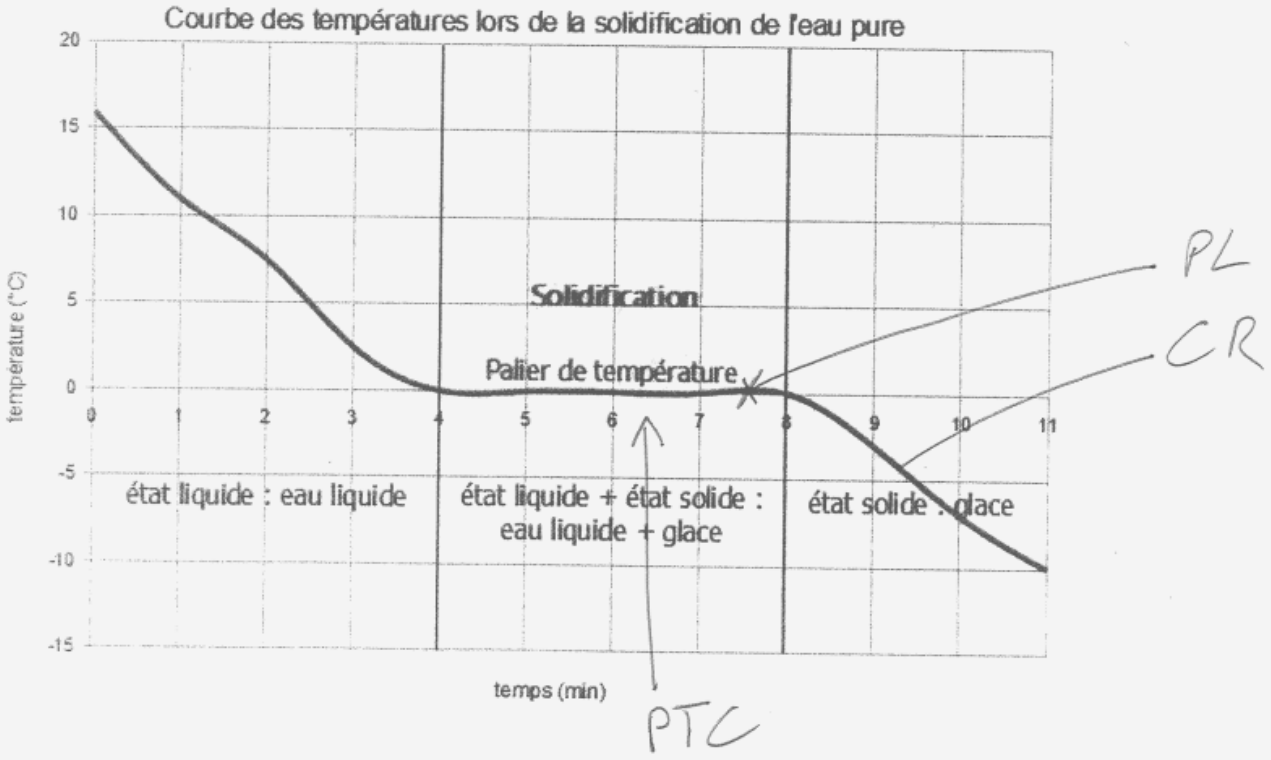
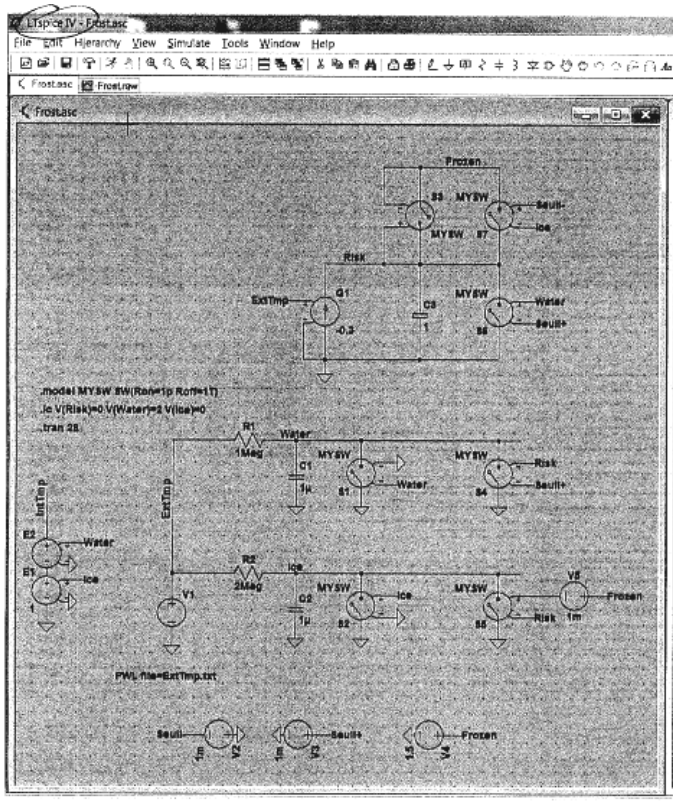

Courbe des températures lors de la solidification de l'eau pure
température (°C)
20
15
10
5
0
-5
-10
-15
0
1
2
3
4
5
6
7
8
9
10
11
Solidification
Palier de température
état liquide : eau liquide
état liquide + état solide :
eau liquide + glace
état solide : glace
temps (min)
PL
CR
PTC

Fig 2


LTspice IV - Frost.asc
File Edit Hierarchy View Simulate Tools Window Help
Frost.asc
Frost.raw
Frozen
S3 MYSW
Seuil-
Ice
MYSW S7
Risk
ExtTmp
G1
-0.3
C3
1
MYSW
Water
Seuil+
S6
.model MYSW SW(Ron=1p Roff=1T)
.ic V(Risk)=0 V(Water)=2 V(Ice)=0
.tran 28
R1
1Meg
Water
C1
1µ
MYSW
S1
MYSW
Risk
Seuil+
S4
IntTmp
E2
Water
E1
Ice
ExtTmp
R2
2Meg
Ice
V1
C2
1µ
MYSW
S2
MYSW
V5
Frozen
1m
Risk
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Seuil-
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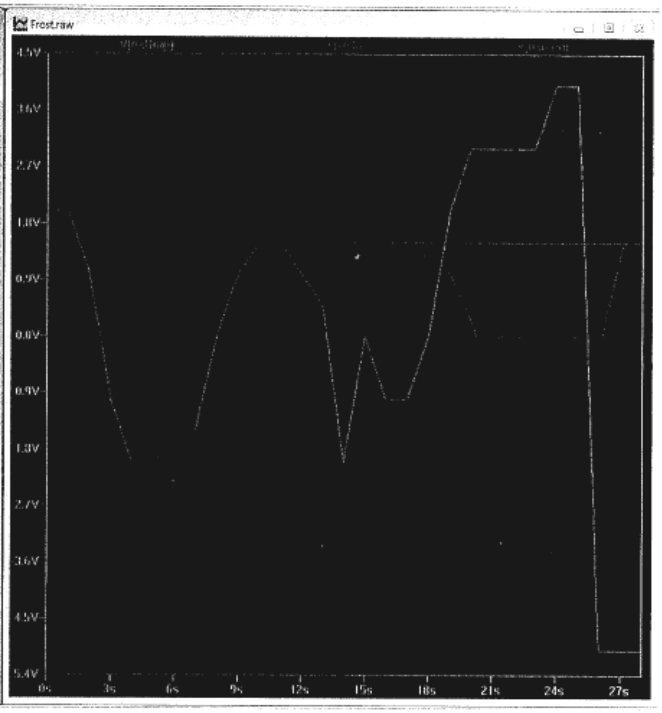
V2
Seuil+
1n
V3
Frozen
1.5
V4


Frost.raw
4.5V
3.6V
2.7V
1.8V
0.9V
0.0V
-0.9V
-1.8V
-2.7V
-3.6V
-4.5V
-5.4V
0s
3s
6s
9s
12s
15s
18s
21s
24s
27s

8

Fig 3

Fig 4