TECHNICAL PAPERS SUPPORTING SAP 2012

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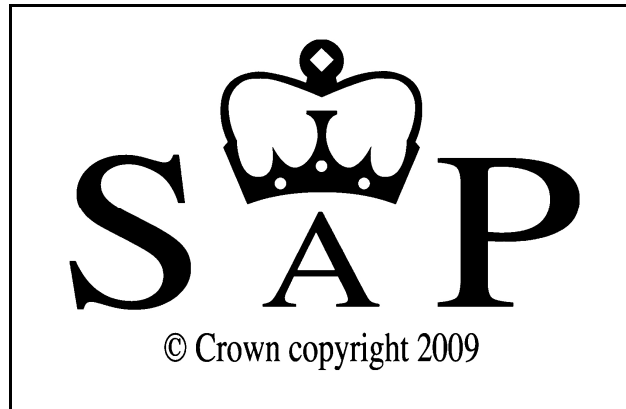
Changes to the calculation of pipework losses in SAP 2012

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Summary

This paper describes a new method to determine primary pipework losses in SAP.

The primary pipework loss lookup table in SAP was reviewed with the intention of offering more possible options, such as partially insulated pipework. However, since the number of possibilities we wished to cover was large, a simple calculation method was devised to replace the table, allowing the SAP software to calculate the figure directly, rather than looking it up.

Contents

1   Introduction

SAP 2009 Table 3 contains data giving the heat loss from primary pipework for a limited number of possible configurations. This table was reviewed with the aim of increasing the number of situations that can be modelled. For example, it is not uncommon for primary pipework to be partially insulated, since some parts are more easily accessible than others – at present it is not possible to deal with this in SAP.

During the course of the review, it became apparent that there were rather a large number of possible variables: with/without insulation, extent of insulation, thickness of insulation, with/without cylinder thermostat, with/without separately timed water. A table containing all reasonable combinations of these would be large and rather difficult to use, so the option of using formulae to calculate the loss rate was investigated.

2   Derivation of new method

1.1   A detailed calculation method

In the absence of field data, a detailed physically based calculation to estimate the heat loss from primary pipework, based on ISO 12241:2008, was used. For calculation details, such as equations, this Standard should be referred to directly, but a brief description of the method used and assumptions made is given here.

Step 1 – Calculate the surface resistance of the pipework using the average of the values for horizontal and vertical pipework.

Step 2 – Calculate the thermal resistance of the insulation (if present) and add this to the surface resistance. The reciprocal of their sum gives the specific heat loss in W/K per metre length of pipework.

Step 3 – Multiply by the length of pipework and an assumed temperature difference of 40K to obtain the heat loss rate in Watts when the boiler is heating the water. Multiply this by the number of hours per day the water is heated and divide by 1000 to obtain the daily heat loss in kWh.

Step 4 – Calculate the quantity of heat stranded in the pipework when water heating stops. Assume this happens twice per day and add this to the loss obtained in Step 3 to give the total daily heat loss.

This calculation method gave similar figures to those in the existing SAP table when inputs typical of UK dwellings were used. Other situations of interest, not currently in the SAP primary loss table, could also readily be modelled.

This method provided a very flexible tool, but is far too complicated to include in SAP directly. Its use might therefore have been limited to providing numbers to add to the existing lookup table. However, it was also found useful for deriving and validating a much simple model that was designed to give approximately the same answers, albeit in more limited situations.

1.2   A simplified calculation method

Assuming standard 22mm pipework is used in all cases, for insulated pipework the heat loss in Watts per metre of length is assumed to be 9.12 W/m. This is the figure given in the Domestic Building Services Compliance Guide[1]. For uninsulated pipework, the heat loss was calculated using the detailed method described earlier based on ISO 12241:2008, giving a figure of 24.5 W/m.

We wish to be able to model cases where only part of the pipework is insulated. If this proportion is known, a weighted average of the two figures (insulated and uninsulated) can be taken to get an appropriate loss for the whole primary pipework system. It is proposed for the proportion to be limited to the fixed values from the following table, which are thought to represent common situations:

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[1] www.planningportal.gov.uk/uploads/br/domestic_building_compliance_guide_2010.pdf

Table 1 : Proportion of primary pipework insulated

Description	%
Uninsulated primary pipework	0%
First 1m from cylinder insulated	10%
All accessible pipework insulated	30%
Fully insulated primary pipework	100%

The heat loss from the whole primary circuit is calculated using:

Primary pipework loss per m (W/m) = 9.1*p+24.5*(1-p)

where p is the proportion that is insulated.

This is multiplied by the total length of the pipework in metres. A fixed value of 14m is to be used in SAP. This figure is simply our best estimate – there appears to be no field data on the subject. We considered allowing a measured figure to be entered. This seems like a good idea in order to encourage good design, However, there is a danger it could actually encourage suboptimal design, by the use of very short runs of primary pipework at the expense of long runs of secondary pipework (since the latter is not a SAP input). In the longer term it may be feasible for both to be entered.

This provides an instantaneous heat loss rate in watts when the water is actually being heated, which must be multiplied by the hours of water heating per day to calculate the loss in kWh per day. The number of hours of heating depends on the level of control and timing capability of the system. It may also be different in the summer, when space heating is not used, depending on the controls present. The following figures are proposed:

Table 2 : Hours per day of circulation of primary hot water

Control type	Winter	Summer
No tank stat	11	3
Tank stat present, water not separately timed	5	3
Tank stat present, water separately timed	3	3

The summer figure is to be used in the months of June, July, August and September. In all other months the winter figure is used.

The amount of stranded heat in the pipework after the water heater has switched off has still to be accounted for. This is all assumed to be lost as the pipework cools down to ambient temperature (whether pipework is insulated or not). Assuming this happens twice a day, this is a fixed amount per metre of pipework, equal to 0.0236 kWh/day per metre of pipework. Adding this to the loss during running hours to gives the total daily primary loss in kWh/day. This is multiplied by the number of days in the month to give the monthly total needed in the SAP calculation.

Thermal stores previously had a reduced annual loss figure since they were assessed as being heated for less hours per day than cylinders. That is no longer appropriate now that there is an allowance for timing. Community heating systems will continue to have a notional allowance as previously.

3   Description of method proposed

Inputs: Proportion of primary pipework that is insulated, cylinder thermostat, separate timing of water heating

Calculation steps:

1. Calculate the loss rate per metre of primary pipework when the water is being heated

Primary pipework loss per m (W/m) = 9.1*p+24.5*(1-p)

where p is the proportion of the pipework that is insulated (from Table 1)

2. Multiply the result by the length of pipework (fixed at 14m for SAP).

3. For each month, multiply by hours per day of heating (from Table 2) and divide by 1000 to convert to kWh/day.

4. Calculate standing loss from pipework cooling after water heating is turned off

Primary pipework standing loss (kWh/day) = 0.0263* l

where l is the length of primary pipework (fixed at 14m for SAP)

5. Add together the standing loss and the heating loss to get the total primary loss, and then multiply by the number of days in the month.

Output: The primary pipework loss for each month in kWh

Examples

The following examples compare primary loss values from the existing SAP look-up table with the value obtained using the simple proposed method and the detailed method. They are all annual totals in kWh/yr, for ease of comparison. (The simple/detailed modelled values happen to be identical in these examples.)

System type	SAP09	Proposed	Detailed
Heat generator with uninsulated primary pipework and no cylinder thermostat	1220	1177	1177
Heat generator with insulated primary pipework and no cylinder thermostat	610	522	522
Heat generator with uninsulated primary pipework and with cylinder thermostat	610	510	510
Heat generator with insulated primary pipework and with cylinder thermostat	360	274	274

4   Conclusion

A simple-to-use calculation method has been proposed which gives answers matching a detailed method based on ISO 12241:2008, where 22mm pipework is used. The use of such a procedure would avoid the need for a much larger table to cover all the primary pipework configurations we want SAP to be able to deal with and gives the potential to cover more possibilities in future, such as the ability to vary the pipework length.