Electric wires and ribbon heating elements for under floor heating

Comparison analysis of energy consumption

1. Introduction

Heat propagation from the heating element looks as: the input power heats the heating element itself, the electric insulation itself and after that the heating element heats the ambient. In every case the mass of the floor is essentially more than the mass of the heating element (both ribbon and wire). Set up time depends on the mass of the floor and practically not depends on the mass of heating element. It means that the energy saving takes place only during the time that heating element arrives to the certain temperature. From this point of view the amorphous metallic alloy ribbon posses very low mass because it thickness (20 – 25 μm). It results very quick heating to needing temperature and less energy in comparison with wire heating element. Beside this the specific electric resistance of wire in many cases essentially less than amorphous ribbon one resulting more mass to supply the same electric resistance. The same electric resistance provides the same electric power for both heating elements.

2. How much energy needs to heat the heating element itself?

Let us do the calculation for electric power 1 kW for AHT ribbon and wire cable. The following geometrical parameters will supply the same power at 220 V voltage:

Amorphous ribbon:

- thickness is 25 μm
- width is 25 mm
- length is 21.6 m
- specific electric resistance is $1.4*10^{-6}$ Ohm*m

Wire:

- diameter is 1 mm
- length is 70m
- specific electric resistance is $0.54*10^{-6}$ Ohm*m

The specific density for both elements is 8000 kg/m^3, specific heat capacity is approximately the same and equal to 600 J/kg^{0}C. Because the elements are thin in both cases the temperature gradient is negligible and simple formulas can be used to calculate the heating power:

$Q = m*C*(Tf – Ti)$,

Were Q is heat quantity, m is the mass of element, C is the specific heat capacity, Tf is the set up temperature, Ti is the initial temperature of the element. The heating time to the set time temperature can be found from the formula:

$t= Q/P$,

were P is input power .

The modern under floor heating uses the thermostat for temperature control. It means set up and set off time. For an average insulated house the set up time during 24 hours is 12 hours. During this set up time we have certain number of switch on – switch off cycles. Usually the temperature difference (maximum temperature minus minimum temperature) is 2^0C. Everybody can calculate that to increase the heating element temperature of the wire element for 2^0C needs electric power of 0.00016 kWh. The mass of the ribbon element in this case is 4 times less. It means that electric power to heat the ribbon element itself will be 0.00004 kWh.
For 150 cycles you need 0.024 kWh of electric power to heat wire element itself. Amorphous ribbon element will take only 0.006 kWh. If you have 10^6 cycles, for example, 160 kWh heat losses for wire heating element and 40 kWh for ribbon one.
It must be underlined that wire element has more insulation material than ribbons one. It means that real expenditures to heat the wire element increase yet in comparison with ribbon element.

3. Conclusion

The ribbon heating element is more efficient than the wire, because the electric power expenditures to heat the wire element itself is 2-4 times more than to heat the ribbon element, thus saving energy.

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