Improvement efficiency of the design heating

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Abstract. This article strives towards and summarizes issues of new standard for calculation of heat loss. There are shown results by old and new standard for calculation heat loss and heat demand. Next part provides explanations for reasons and advantages of accumulation not only for heat pumps and described new requirements for size and way of accumulation for improvement of effectiveness in running of air/water heat pump. Last part of this article shows basic concept and criteria for analyses of heating systems.

Key words: heat loss, heat demand, heat pump, heat accumulation, multicriterion analysis

1 Differences in the calculation of heat loss

For calculation of heat loss was used standard CSN 06 0210 calculation of heat loss for central heating. This one was replaced by Czech version of European standard EN 12831 heating systems in buildings – Method for calculation of the design heat load.

1.1 Comparing calculation of both methods

The comparison of both methods was made at chosen house, which is situated in town Bruntál. Total build up area of this house is 239m^2 and external designed temperature is -18 °C. This house will be also used for research work in the future.

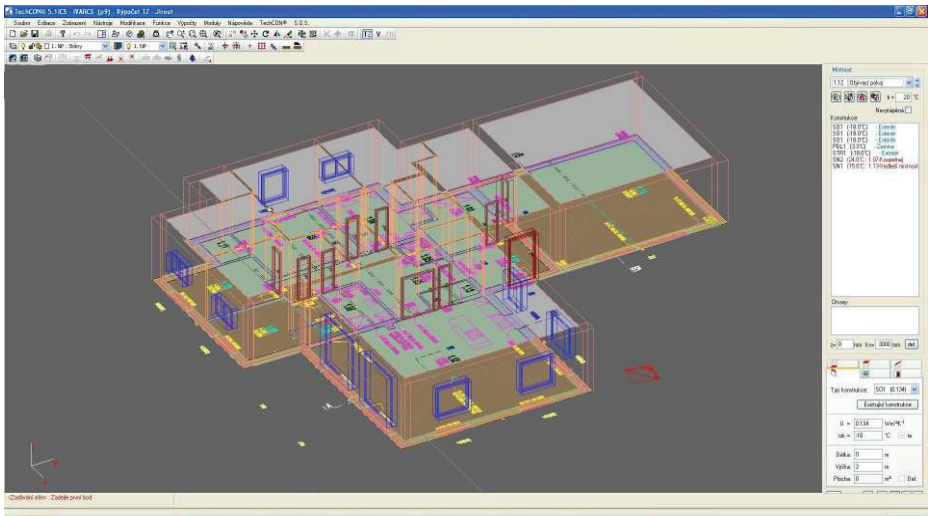

Fig. 1. 3D image of the chosen house showed in software Techcon IVAR CS.

1.2 Summary result of standards

Result of old Czech standard norm for chosen house is 5733 kW. The major news in European standard EN 12 831 is definition of heat bridge. Heat bridge can be described as place of crossing two different constructions e.g. isolation and brick wall. There are two types of results. First result includes heat bridges 7159 kW and second result 6185 kW without them.

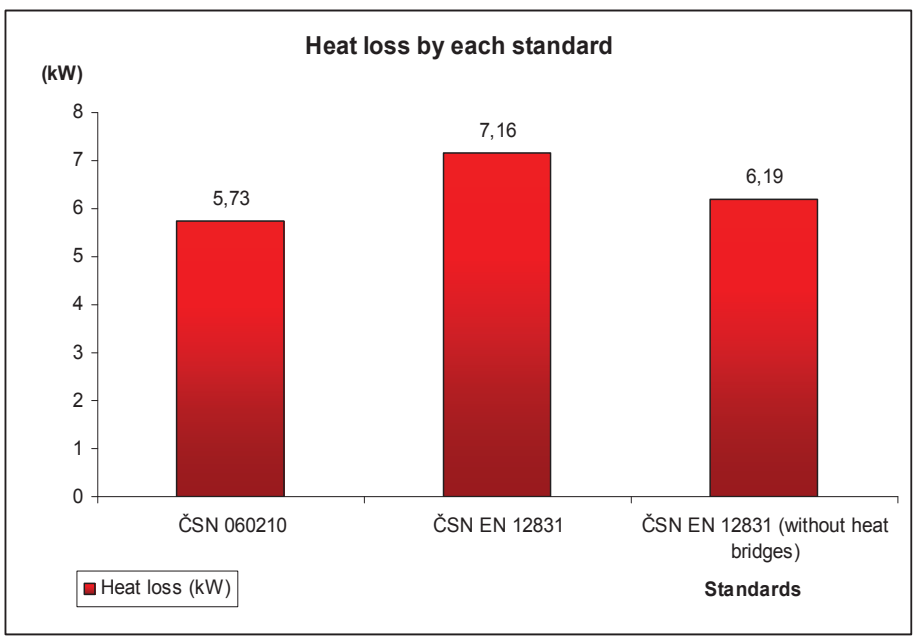

Fig. 2. Calculation heat loss results of chosen house.

1.3 Comparison of thermal demand

We have to design heating very precisely as is shown on Table 1, because differences in result of heat loss and also thermal demands are very large, nearly 20%.

Table 1. Differences of thermal demands of the chosen house by standards listed above.

Standards (for calculation heat loss)		ČSN 060210	ČSN EN 12831	ČSN EN 12831 (without heat bridge)
Thermal demands	(GJ/year)	39,53	49,36	42,64
	(MWh/year)	11,0	13,7	11,8

2 Heat pumps, accumulation of the heat and improvement of efficiency

In correct layouts, the heat pumps possess fairly stable parameters throughout the entire heating season. There is an exception represented by the air/air heat pumps and especially the air/water type pump. Their output is very variable depending on the ambient air temperature and its humidity.

2.1 Improvement of heat pump efficiency by means of accumulation

Accumulation with heat pumps provides for continuous operation, i.e. reduction of the frequent switching. However, as far as the air/water is concerned, its greatest disadvantage (decreasing output depending on the ambient temperature) can be utilized upon implementation of suitable accumulation features. The Fig. 3 shows the performance diagram of the air/water heat pump and substantial decrease in output after the 0°C mark. The purpose of this idea deals with suitable design of heat accumulation system to operate the heat pump within such area, where the same amount of electric power produces more heat energy to be accumulated for further use during frosty days.

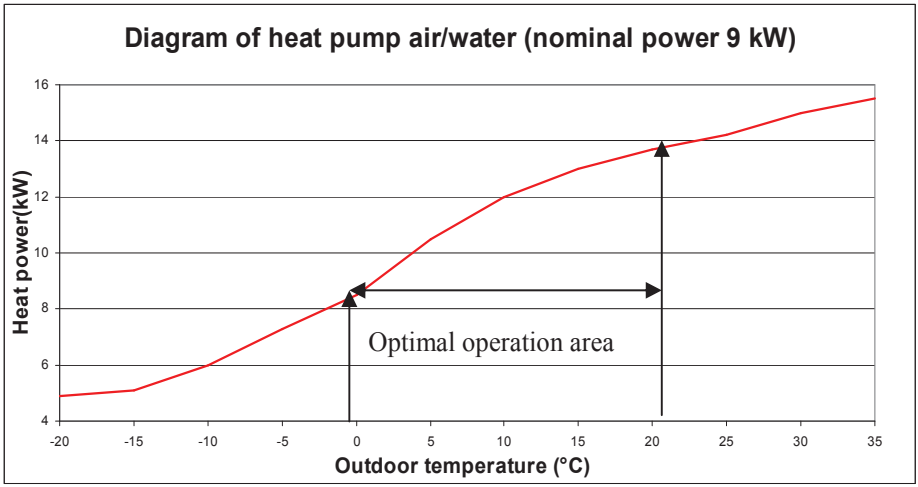

Fig. 3. Output diagram of the air/water heat pump with the nominal output of 9kW at A2/W35.

Accumulation of heat allows improvement efficiency and also quickest return of investment cost into heat pumps in comparison with others methods of heating. Next step of this research will determine sufficient capacity of accumulation tank and possibility of the prediction of outside temperature for optimal operation of air/water heat pumps.

2.2 Problems with design of tank capacity

But this size of magazine designed by (1) is only for short time accumulation e.g. two hours.

$$V_{AT} = Q_T \cdot k \quad (l) \tag{1}$$

Where:
V_{AT} is capacity of the accumulation tank (l),
k is recommended minimum amount of water for accumulation 1kW of heat energy (50 l/kW),
Q_T is heat loss of the buildings (kW).

If we want accumulate energy for cover demand of half of whole day, we will need more bigger tank e.g. 1000 or 1500 l, but this one are not possible to using in family houses due to problems with small dimensions of boiler rooms. This is reason to looking for another medium for accumulation than is water. This medium has to have higher thermal capacity and allows us using of tank with smaller dimension.
When we have this new accumulation method for storage of heat, we will be able to producing energy for further hours where we expect lower outdoor temperature and higher thermal demands by building. This also allows us moving with operation area of heat pumps to the more positive temperature (Fig. 3).

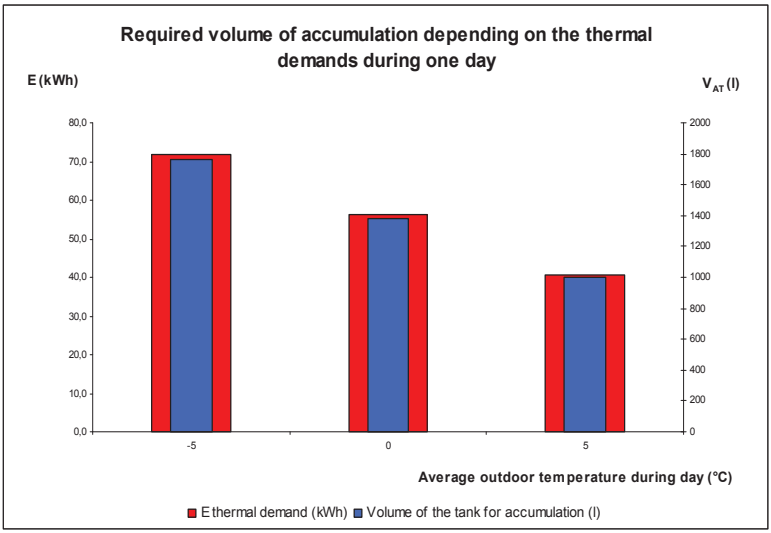

Fig. 4. Required water tank capacity for accumulation.

How much capacity of tank for accumulation enough energy is needed shows Fig. 4. Where is thermal demand (red column) in relation to outdoor temperature and that correspond to volume of tank (blue column).

3. Comparison of heating variants by MCA method

Regarding to above article we design the most used variants of heating in this time on the market for the operation on chosen house. All designed variants have the same starting conditions and the mainly one is the heat loss of buildings. For design I use the result of standard CSN EN 12831 including the heat bridges. Designed and chosen variants are shows in Table 2.

Table 2. Variants of heating for comparison by MCA methods.

No.	Type of heating system	Primary energy source	Hot domestic water (HDW)
1	Heat pump air/water	Low potential	from primary source
2	Heat pump ground/water	Low potential	from primary source
3	Automatic heating boiler + solar collector	Biomass + sun	from primary source + electric energy
4	Heating by natural gas	Natural gas	from primary source
5	Electric convectors	Electric energy	from primary source
6	Electric radiant heating	Electric energy	from primary source

This variants listed above will be compare by defined criteria (Table 3.).

Table 3. Variants of heating for comparison by MCA methods

No.	Criteria	Sign	Unit	Preference
1	Investment cost	N_i	Thousands CZK	min
2	Energetic balance	N_e	CZK/kWh	min
3	Operation cost	N_p	Thousands CZK	min
4	Lifetime of equipment	$N_ž$	Year	max
5	Impact on the environment	Envi	-	min

3.1 Data collection for the set criteria

For maximum objectivity will be collected data from several sources for each criterion. From this data will be find only one value (Modus), where will be cut off extreme value to get maximum objective data for all criteria listed in Table 3.

Conclusion

Result by different standard for calculation of heat loss gives us different numbers. Therefore it is necessary precise design and calculation heat demand by as much as possible relevant data.
To enhance the competitive strength of heat pumps in comparison with other heating sources, it is necessary to seek method towards improvement of their effectiveness. Such opportunity is granted by the methods of accumulation, which can reduce the variable availability of low-potential energy contained in the air.
Other parameters to be considered include the method of output of the air/water heat pump to enable its optimal operation as depicted in the Fig. 4 to produce sufficient energy for further hours. The ideal layout will require correct selection of the accumulation tank. However, all these steps need to be taken with reference to the financial exigency in order to ensure that the effect required, i.e. reduction of the return on investment and this is a main advantage.

Acknowledgments

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