



Institute for Building Systems Engineering
Research and Application GmbH
Prof. Oschatz - Dr. Hartmann - Dr. Werdin - Prof. Felsmann

Development of a method of an energy efficiency evaluation of heat pumps for EnEV und DIN V 18599

Summary

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Editor: Dr.-Ing. H. Werdin

Project manager: Prof. Dr.-Ing. B. Oschatz

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1 Intention

The intention of the improvement of the calculation method of heat pumps in DIN V 18599 is the development of an acceptable suggestion of a standardized calculation of energy efficiency of heat pumps. For that, a review of existing and intended normative approaches has to be carried out (ISO TC 205 „Heat pump systems for heating and cooling“, EN 15316-4-2, EN 14825, EN 14511, EN 255-3, DIN V18599, VDI 4650). Furthermore, results of the research project „Gesamtsystemanalyse von HLK-Anlagen“ and of up-to-date field test measurements are to be considered for an evaluation of energetic relevant parameters (source and sink temperatures, configuration of heating system, control system, etc.).

With these investigations, a suggestion for a normative evaluation is to be worked out, where different

- Heat sources (outside air, water, brine, exhaust air, waste heat),
- Heat sinks (heating system, domestic hot water),
- Driving forces (electrically driven, sorption),
- Control regime (monovalent, bivalent) and
- Opt. Combination with solar heat

have to be regarded. Standard values are needed for this approach, where an interaction with demands of the EEWärmeG has to be verified. A comparison with the German standard DIN V 4701-10 should be carried out.

The logic and applicability of the suggestion is demonstrated with the help of an Excel tool. The developed method is prepared as text for the usage within DIN V 18599.

2 Procedure

In a first step, current states of different approaches of standardization concerning heat pumps were compared. Thereby, all known standards were taken into consideration, which have to deal with energetic evaluation or have an influence on evaluation of heat pumps (Table 2-1). To that belong: the working draft of ISO 13612-2, European standard EN 15316-4-2, EN 14825 as well as German standards DIN V 18599-5, DIN V 18599-8, DIN V 4701-10 und VDI 4650.

Table 2-1: Comparison of standards for calculation of seasonal performance factors of heat pumps

	ISO/WD 13612-2	EN 15316-4-2	DIN V 18599-5	VDI 4650	DIN 4701-10	prEN 14825
Electrically driven HP (VCC)	X	X	X	X	X	X
Gas driven HP	X	X	X	(X)	-	-
Absorption HP (VAC)	X	X	-	-	-	-
Mode space heating	X	X	X	X	X	X
Mode space cooling	X	-	-	-	-	X
Mode domestic hot water	X	X	X	X	X	-
Method with discrete time steps	X (h,m)	X (h,m)	(m)	(j)	(j)	-
Method with temperature bins	X	X	X	-	-	(X)
Consideration of turn-off times	-	X	-	-	-	-
Consideration of external storages	-	X	X	-	-	-
Spread correction						
- exergetic efficiency	X	X	-	-	-	-
- tabularly	-	-	X	X	X	-
- by measurement	-	-	-	-	-	X
Operational mode with on-time calcul.	X	X	X	-	-	-

Each of the above mentioned standards contain a method of determination of a seasonal performance factor. A prerequisite of all methods is that the measured values have been determined according to European standard EN 14511-2 or EN 255-3.

New methods of an evaluation of heat pumps were developed (e.g. calculation of heating limit temperature, bivalence point, corrected theoretical building heat load and an approximation of the characteristics in partial load).

An assessment of the suggestions took place at regular intervals in committees of BDH, standardization organization DIN and with participation of a consultant of BBSR. Discussions with experts and manufacturers of different kinds of heat pumps led to a further development and improvement of suggested calculation methods.

3 Summary of results

The market offers controlled heat pumps which are more effective in partial load than single-staged heat pumps. A new method was developed for multi-staged or continuously controlled heat pumps.

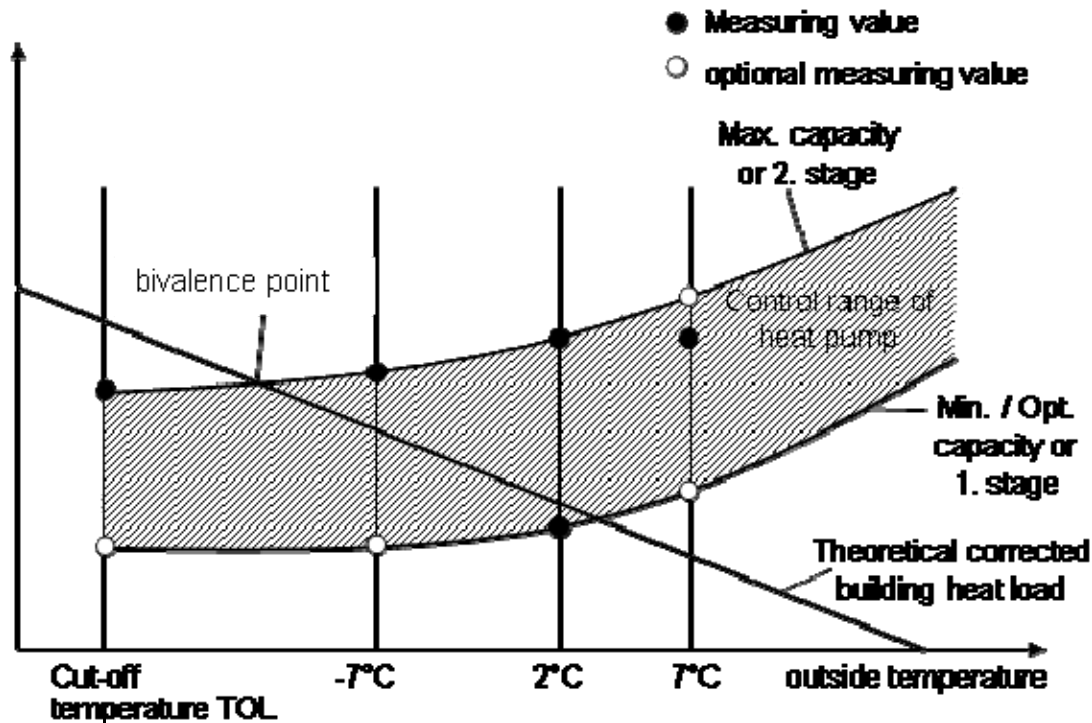


Figure 1: Heat power of multi-staged and continuously controlled heat pumps in dependency on outside air temperature at a defined flow temperature

A frequent turning-off of single-staged heat pumps occurs at higher outside temperature, because heat output of heat pump increases while heat load of building gets down. Because of increasing difference between heat capacity and heat load, runtime decreases and leads to auxiliary energy consumption during turn-off. On the other hand, a control of return temperature causes a higher flow temperature. This is the reason for a lower COP-value compared to a pure flow temperature control. This trend is calculable with the developed method.

New calculation methods were developed for the parameters heating limit temperature, bivalence point und corrected theoretical building heat load. The scope of that is to avoid an estimation of these parameters in DIN V 18599, which have an enormous influence on energy efficiency.

According to EN 15316-4-2, the calculation of the combined operation domestic hot water and space heating was included in DIN V 18599.

As heat pumps may be subject to intermittent operation and, additionally, cut-off times of energy supply company limit runtime, the new method regards these cut-off times and non-occupation times. The limitation of runtime leads to a higher average heat output of heat pump.

In order to ensure programmability of the developed method an Excel tool was issued that contains the algorithm, inputs and outputs.

The developed calculation method coincides with European and international standardizations of energy evaluation of heat pumps concerning program flow and considered effects.