

Commercial Vehicle Fuel Heater with Biodiesel

The further development of commercial vehicle heaters is aimed at improving their functions and operating convenience. At the same time, costs have to be minimised. With the development of the new "Hydronic M II", the Esslingen-based automotive supplier Eberspächer launched a new generation of pre-heaters and auxiliary heaters at the end of 2007. This article describes the requirements to be met by design and marketing in order to produce a heater at a price that is acceptable to the market. The new generation is available as a fuelpowered heater in three output versions with 1.6 to 9.6 kW, 1.2 to 12 kW and 1.6 to 8 kW, all with full biodiesel capability.

1 Introduction

During the planning of a product for existing or new markets, the key is really the basic strategic direction: If the competitive advantage "Quality" is put before the competitive advantage "Price", as illustrated in a matrix, Figure 1 [1], the three following strategies emerge:

- The "World-Champion Strategy", if you are convinced that you can achieve clear price and performance advantages
- The Value for Money Strategy on a price basis, with anticipated advantages of the factors price and cost
- The Value for Money Strategy on a performance basis, with an advantage of

the factors quality and performance. As with all Eberspächer heaters, the new Hydronic M II is to be manufactured in "Expensive" Germany. For this reason, strategies I. and II. hardly come into consideration. Therefore, if cheaper production is not possible, more performance for the same money must be offered i.e. a preference strategy must be developed.

This means that a newly to be developed heater must have clear advantages with regards to its customer-oriented performance features, without becoming more expensive than competitive products. Features that influence the application, such as size and connections of an established previous heater model, in particular with OEM customers, should not be changed. The following will introduce the series of Hydronic M water heaters as well as its most important steps of development, during which all ambitious targets were achieved.

2 The Hydronic M II Series

The fuel heater unit Hydronic M II (M stands for medium series), as shown in a cross-section in Figure 2, is available in three output ranges: The Hydronic M 10 with the output ranges 1.6 to 9.6 kW, the Hydronic M 12 with the output ranges 1.2 to 12 kW and the Hydronic M 8 Biodiesel with the output ranges 1.6 to 8 kW and 100 % biodiesel suitability. All versions have the following features:

- service life 6000 hours
- automatic altitude adjustment for operation up to 3000 m above sea level

- fully integrated control unit
- electronically commutated water pump motors and combustion air blowers (speed-regulated)
- _ power-regulated ceramic glow plugs
- almost position-independent operation
- redundant overheating monitor.

The technical data is listed in detail in the Table

3 SWOT Analysis and QFD

Prior to the compilation of the specification sheet for the new heater series, Eberspächer conducted comparisons and SWOT analyses (strengths, weaknesses, opportunities, threats analyses) on its own heaters as well as on commercially available competitive products.

In doing so, customer requirements also were taken into consideration. This knowledge gained from contacts and customer surveys were often very vague and not specific. By means of QFD (Quality Functional Deployment), the statements were refined and defined as follows:

- doubling of the service life (until now 3000 hours)
- increase in the maximum heating capacity from 10 kW to 12 kW
- position-independent functionality and operation
- one version with 100 % biodiesel suitability.

However, the SWOT analyses also clearly identified the main risk: a higher price. Despite considerably improved performance, it is not possible to achieve a sales

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product strategy price above the established price level for the manufacturers of commercial vehicles. In addition, this would be contradictory to the own market strategy.

4 Basic Concept

Particularly, doubling of the service life, but also the increased heating capacity and the biodiesel suitability, require individual components that are more sophisticated and more expensive: For this reason, 6,000 operating hours combined with a reasonable size can only be achieved with electronically commutated motors for the combustion air fan and the water pump. For the doubling of the expected starts of the heating units (ignitions), a ceramic glow plug as an ignition element is indispensable. The increase in the heating capacity requires a new combustion chamber concept, and, after all, the biodiesel suitability can only be achieved by higherquality evaporation material.

As the production should not incur more costs than for the previous model, a concept had to be found that compensates for the additional costs of the more sophisticated components. Amongst others, the concept team – in close cooperation with selected suppliers – has compiled the following measures:

- reduction in the number of components - for example, the fan housing, the motor housing as well as the control unit housing have been combined in a multifunctional component
- fully integrated "slide-in" control unit
- optimisation of the machining and production stages
- reduction of the production time by 20 %
- common parts concept sensors and glow plugs were taken over from the smaller water heaters, which are manufactured in large quantities
- easier assembly for example, clip connections instead of screw connections for plastic parts.

5 Combustion Chamber Concept

The combustion chamber of the new Hydronic M II series is based on the proven precision casting technology that is used for all new heaters with evaporation



burner since 1993. Based on this production technology, the functionality and interface independency of the combustion chamber were developed further.

In order to continue consistently with the common parts concept, the plug nozzle principle was retained: this way, the glow plug and plug strainer could be taken over from other heater types. However, for the first time, the combustion chamber has a second axisymmetric plug nozzle that contributes considerably to the even distribution of the fuel. Above all, it ensures a wide range of functionalities at the increased nominal output of 20 % and the operation with biodiesel. Among other things, the second glow plug could reduce the starting time (from the switch-on signal to full heating capacity) by half to a total of 2 min. In addition, the sturdiness of the heater will increase substantially (with only one glow plug, a safe start-up of the 10 kW version is possible).

Another feature of the new precision cast combustion chamber is the integrated flow/swirl device for the combustion air. The device has two advantages: on the one hand, the interface independency of the burner is ensured. On the other hand, the temperature household of the combustion chamber, especially in the area of the fuel inflow, is designed in such a way that the

Table: Technical data of the Hydronic M II

Power	steps	1	2	3	4	t	2	3	4		2	3	4	5	6
Heating capacity	kW	1.5	3,5	5.0	8.0	1,5	3.5	8.0	9,5	1,2	1,5	3.5	5,0	.9.5	12,0
Fan speed	rpm	1,600	2.640	3.680	4.400	1.600	2.640	4.800	6.080	1.400	1.600	2.640	3.660	3.080	7.74
Voltage	12/24				12/24				12/24						
Power Ope consumption	Start* W	- 35	39 2	46	55	35	39 t	60 20	86	34	35	39 1	46	86	132
Fuel consumption	l/h	0,18	0,4	0,85	0,9	0,18	0,4	0,9	1,2	0,15	0.18	0,4	0.65	1,2	1,5
Weight kg		6,2				6.2				6,2					
Measures L x B x H (mm)		330 x 138 x 219				330 × 138 × 219				330 x 138 x 219					
Ambient temperature operation/storage °C		-40 bis +80 / 85				-40 bis +80 / 85				-40 bis +80 / 85					
Operation with bi	yes (100 %)				5%"				5%**						



Figure 3: Fan capacity via air pressure

critical temperatures of the fuel used are avoided over the entire output range. This way, the build-up of deposits in the function-critical area is reliably prevented.

All these measures contribute to ensure an extended functionality (burner operation up to lambda 1.1 possible) with this further development of the combustion chamber concept and, at the same time, twice the service life, without reaching the permissible emission limits in the automotive sector. All the measures described lead to the following features of the combustion chamber in the new Hydronic M II:

- output increase +20
- service life +100 %
- output expansion + 33 %:
- number of output ranges + 50 %
- PME capability 100 %
- position-independent operation: Rotation around the longitudinal axis: 0 to 90°, rotation around the transverse axis 0 to 85°
- burner independent of interfaces.

Before the actual validation, the service life testing of the new burner concept took place in two stages. Before the project start of the new series of heating systems Hydronic M II, the basic concept had already been successfully tested in an initial prototype over a total of 10,000 operating hours. In doing so, valuable knowledge was gained, which was confirmed again in an A sample endurance test with eight devices over a period of more than 6000 hours.

6 Automatic Altitude Adjustment

The wide range of functionalities of the combustion chamber safely compensates for the tolerances in the delivery of the combustion air (tolerances in the fan gap of the side channel fan used) and the dosing of the appropriate fuel quantities. However, without any additional measures, a continuously "clean" operation of the previous heater units could only be ensured for altitudes of 1500 m above sea level.

For the first time, this heater unit can be operated at an altitude of up to 3000 m above sea level. This is made possible by a standard, special altitude detection, which needs no air pressure sensor:

During the operation, the control unit of the heater measures the power consumption of the speed controlled fan motor. Since the air density is reduced with increasing altitude, the power consumption of the fan motor decreases, **Figure 3**. If a limit value stored in the control unit falls below the normal level, the supplied fuel quantity will be adjusted accordingly via the metering pump. This way, proper combustion even at a higher altitude than 1500 m above sea level is ensured, with only an insignificant output reduction.

7 Validation

Due to the above-mentioned "More" in performance features and scopes of serv-

ices, a "More" in tests, inspections and validations was required. During the last few years, the specific requirements of the OEM in this regard have continuously become stricter. In addition, nature and extent of the inspections and verifications are not uniform and often differ specifically according to the customer. For this reason, all respective requirements are evaluated and the respectively most difficult tests selected in order to meet the requirements of all OEM's.

These are 136 tests, which were carried out not only at the suppliers but also at Eberspächer during the various different prototype statuses. Apart from the heater as a complete unit, the components such as control unit, motor, burner and water pump were particularly affected. At Eberspächer, the prototype and production statuses are divided as follows

- A samples: Components with initial development statuses for feasibility, design and installation testing. Here, the feasibility of the individual features will be checked. Based on sectional models, the feasibility status is visually represented in order to achieve a target/actual comparison
- B samples: Fully functioning samples, if possible from auxiliary tools. Pin assignments and outside dimensions correspond to the series status. These were used during field-testing (also at selected customers)
- C samples: Samples made from series material and manufactured with serial tools under preliminary series conditions
- Pilot production: As C samples, whereby series-operating equipment is qualified and linked
- Series: Components manufactured under series production conditions.

At the same time, the construction and process FMEAs will be adapted to the respective development statuses. In doing so, the new Hydronic M II device series ties in smoothly with the modern conception of the proven and smaller series of heating systems Hydronic and Airtronic from Eberspächer that has been produced a millionfold.

Reference

 Quelle: Godefroid, Investitionsgüter-Marketing, S. 151