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Deliverable D2.3: 1st set of prototypes

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Executive Summary

In the Deliverable D2.3: “1st set of prototypes” - the main objective is to present the first set of prototypes of the components for the battery thermal management system to be developed in WP2. The components are subdivided into three groups:

1. Front-end module consisting of
 - Low temperature (LT) radiator
 - Evaporator/Condenser
 - Fan system
2. The cold storage device (CSD) including PCM, refrigerant pump and control strategy.
3. Battery housing consisting of
 - 18 Battery modules (30 cells each)
 - Cooling plates between the modules
 - PCM heat buffer underneath the modules

Group 1) and 2) form the thermal system.

Attainment of the objectives and explanation of deviations

Due to the global pandemic, the task objectives related to the deliverable have been achieved only partially. Indeed, during the imposed lock-down and limited and regulated lab work, some components essential to the prototyping were not available such as the cold storage module and the battery housing. Also, practical work in the companies and research, institutes had been almost stopped.

Additionally, after the end of the lock-down, it has been not possible to immediately ramp-up to 100 %. Due to the economic slump caused by the pandemic many companies (such as Valeo) have short-time work. Valeo is the manufacturer of the thermal system.

Therefore, it was decided that the reporting will be about the components that were available at the due date of D2.3 (M18), namely group 1), the front-end module. In a later stage, an updated version of the report will be submitted in M21 in which all components of the prototype will be detailed.



1 Introduction

1.1 SELFIE and its objectives

SELFIE - **SELF**-sustained and Smart Battery Thermal Management Solution for Battery Electric Vehicles is a project funded under Horizon 2020 program by the European Union (Grant agreement no: 824290).

SELFIE intends to develop and demonstrate a novel self-sustained compact battery system, consisting of:

- **A smart modular battery pack**, which has excellent internal thermal conductivity properties, a refrigerant cooling system and thermal storage system (heat buffer) capable to absorb excess heat due to fast charging, and which is thoroughly insulated from the outside;
- **An advanced battery thermal management system** capable to keep the battery temperature effectively within the optimal window and to prevent overheating (and battery degradation) due to fast charging.

Successful implementation of the project will significantly increase user acceptance of EVs by enabling fast-charging and offering significant cost reductions and elimination of range anxiety compared to other propulsion technologies.

1.2 Rationale

Subject of this report is the presentation of the first set of prototypes of components for WP2. The corresponding tasks and items are listed in the following:

- ST 2.3.1 Selection and adaptation of manufacturing technologies.
- ST 2.3.2 Prototyping of components.

2 Front end module

In this section, the prototype of the front-end module is presented. More detailed information on the front-end module component can be found in [1,2].

The front-end module consists of:

- Low temperature (LT) radiator
- Evaporator/Condenser
- Fan system

Via the front-end module, the heat generated by the battery, the engine and power electronics during driving, and HVAC is transferred to the environment. Details of the design of the SELFIE front end module are described in [1], Chapt. 5.4. The principal design and the progress towards the current cooling module are summarized again as follows:

A scheme of the current module, which can provide 16 kW of cooling power, is shown in **Figure 1**.

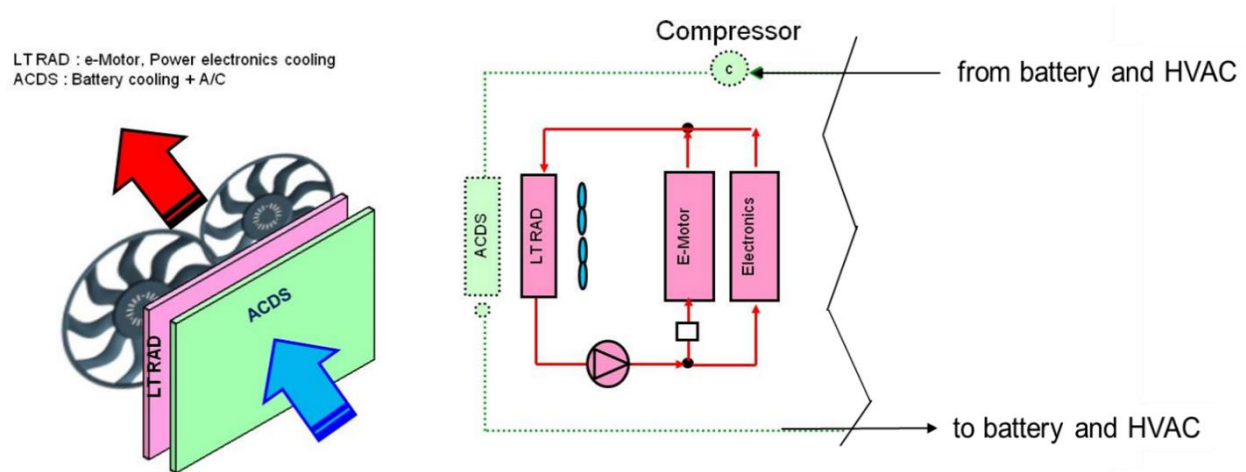


Figure 1: Scheme of the current front-end module (left) and the attached cooling loops (right). The fan system consist of two fans powered by a 300 W motor each.

A fan system generates an air stream which passes first the ACDS and second the LT RAD. The ACDS cools the refrigerant which serves for the battery cooling as well as the HVAC. The LT RAD removes the heat of the coolant which is used to cool the E-motor and the power electronics. This motor loop is essentially operated only during driving, while it is not active during charging.

As one aim of the SELFIE project is to allow fast charging plus cabin cooling at the same time, it has been necessary to increase the cooling power of the ACDS with the refrigerant loop to 20 kW. The solution developed by Valeo is to utilize the motor loop during fast charging too, by installing a WCDS into that loop. This WCDS pre-cools the refrigerant coming from battery and HVAC, and the resulting heat is transferred to the environment by the LT RAD which is served by the fan anyway. The pre-cooled refrigerant is cooled down and liquefied finally in the ACDS as usual. The scheme of the new cooling loop design is shown in **Figure 2**.

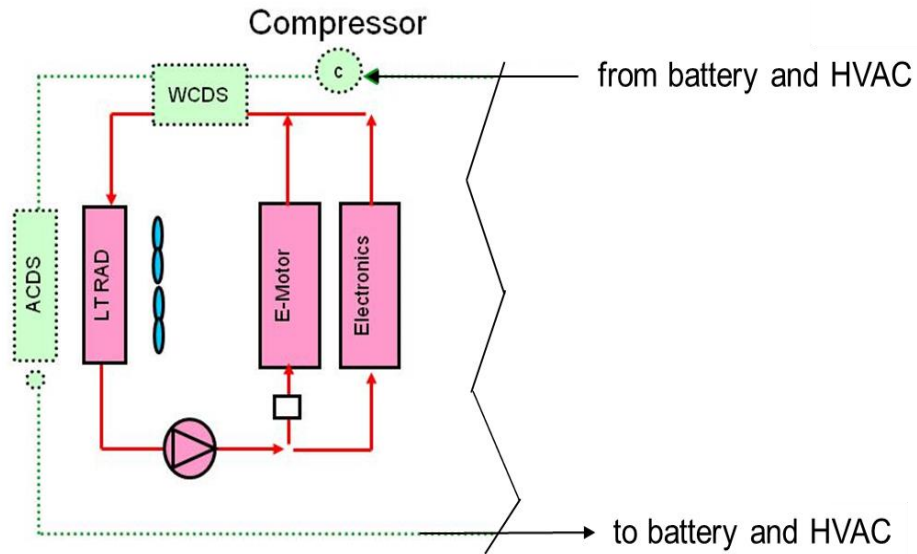


Figure 2: Scheme of the new cooling loop design.

The sequence of the fan, ACDS and LT RAD in the front-end module is the same as in **Figure 1**. However, the design has been optimized due to the airflow, so that 20 kW cooling power is obtained by a single fan (600 W motor) and a condenser (or LT RAD) area of only 25 dm². In the current design (**Figure 1**) the condenser area was 33 dm² (with only 16 kW cooling power). The 1st set of components of the new front-end are shown in **Figure 3**.

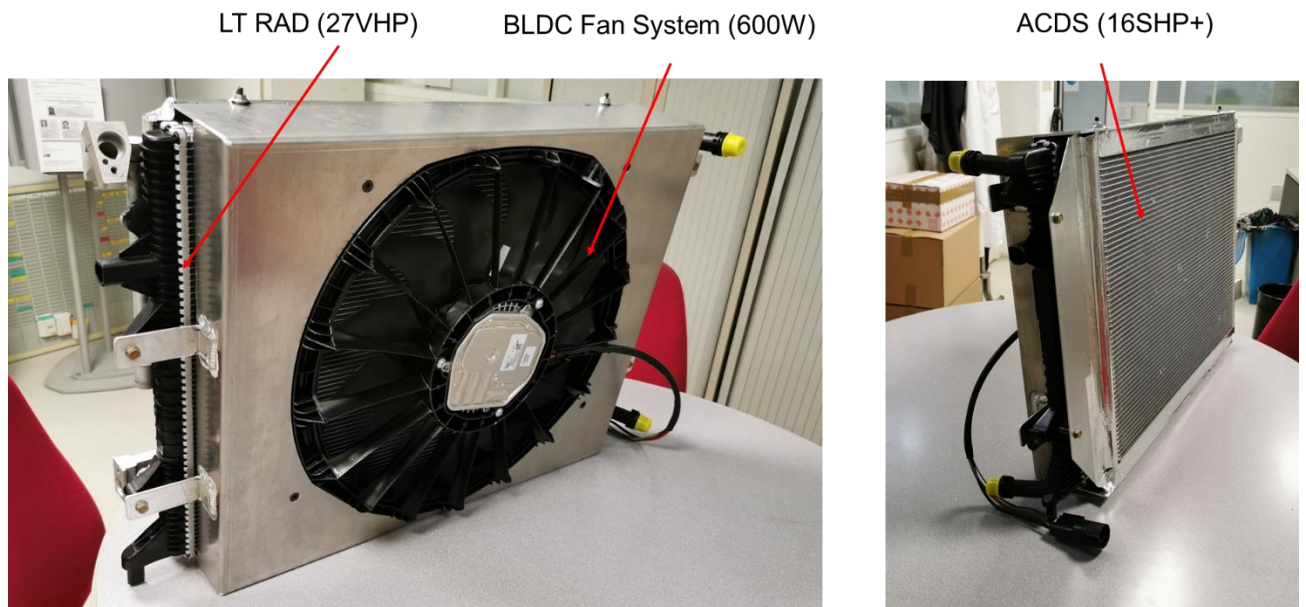


Figure 3: 1st set of components of the new front end.



3 Conclusion

The 1st group of the components including the front-end module has been manufactured and thermal performance tests are about to be conducted. After successful testing, these units will be shipped to IMECAR, who will install them in the FIAT DOBLO foreseen for this project.

Nonetheless, as stated at the beginning, the prototyping of the other components (CSD and housing) will be described in an updated version of the D2.3 which will be delivered in Sept. 2020.



References

Abbreviations and Definitions

Term	Definition
ACDS	Air Condenser
BLDC	Brush-less direct current (motor)
CAD	Computer Aided Design
CSD	Cold storage device
EV	Electric Vehicle
HVAC	Heating, Venting, Air-Conditioning system
PCM	Phase Change Material
LT RAD	Low Temperature Radiator
WCDS	Water cooled condenser
27VHP	Valeo Radiator Technology (27 mm thick)
16SHP+	Valeo Condenser Technology (16 mm thick)

Literature

[1] SELFIE WP2: Deliverable D2.1: Intermediate report on design of components (01/2020).

[2] SELFIE WP2: Deliverable D2.2: Final report on design of components (06/2020).



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