NAFEMS UK Regional Conference 2018 - Abstract Submission

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Please identify the event for which your submitting?	NAFEMS UK Conference 2018
Will you be the presenting author?	Yes
Presentation Title	Thermal Management System Design, Simulation and Optimisation of Air Conditioning Systems for Plug in Hybrid Electric Vehicles
Relevant Themes / Keywords	Air Conditioning, System Design and Integration, System of Systems, Automotive, Plug in Hybrid Electric Vehicle, 1D CFD, System CFD, System Simulation, CFD Thermal, FloMASTER

Abstract (plain text)	The ability to quickly and accurately model air conditioning (AC) systems is of increasing interest to the automotive industry due to the growing trend towards Electric Vehicles (EV's), Plug in Hybrid Electric Vehicles (PHEV's) and vehicle autonomy. While AC systems have been used for over 85 year to cool vehicle cabins extra requirements are being placed on the Heating Ventilation and Air Conditioning (HVAC) systems [1]. This is due primarily to battery technology along with motors, inverters and computing resources requiring advanced thermal management solutions. In addition to the thermal management requirements, packaging, the increased system control and complexity, AC systems typically add 3 kW of power draw, thus increasing fuel consumption of the vehicle [2]. A second generation Nissan Leaf draws 16 kW while cruising at 60 mph, so a 3 kW increase in load represents an 19% increase in power draw [3]. This results in the range being reduced from 65.3 miles on a full charge to 52.8 miles. While this is a concern for Internal Combustion Engine (ICE) operation, particularly due to emissions, Miles Per Gallon (MPG) and the environment. The majority of users would rather be cool and range reductions can easily be mitigated by increasing the size of the gas tank which has minimal cost to OEM's. This is not the case with EV's though which need to maximise battery range to overcome many customers range anxiety. In additon to this battery electric vehicles cannot be 're-fuelled' as quickly, hence this becomes a bigger concern to the end user along with the battery requiring cooling/ heating which isn't a concern for ICE vehicles. This presentation considers the use of System-CFD in the development process of a modern AC system ideally suited for a PHEV. It examines and addresses some of the main design options and solutions available to systems engineers in creating an effective thermal management solution both for the cabin and battery heating and cooling. It also considers sizing requirements, to ensure that the cabin and batteries can be cooled effectively while minimising costs. This highly optimised system is then integrated into a system of systems which includes the full battery heating/ cooling loop, cabin loop, dual motor and inverter cooling solutions and ICE thermal management to provide a complete vehicle thermal management solution. Simulations are conducted on over 20 different operating mode combinations, the most important of which are examined and discussed in this presentation. The results of this give a detailed system level response and demonstrates how these systems interact to provide a complete thermal management solution for the PHEV.
Please enter any additional comments or messages here	REFERENCES [1] R. J. Brown, "First Air-Conditioned Auto," Popular Science, p. 123, 30 November 1933. [2] R. Farrington and J. Rugh, "Impact of Vehicle Air-Conditioning on Fuel Economy," Earth Technologies Forum, Washington, D.C., 2000. [3] S. Salisbury, "2011 Nissan Leaf - Advanced Vehicle Testing - Baseline Testing Results," Idaho National Laboratory, Idaho, 2016.
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