P.V.Giridharan

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Title: Mathematical Modelling - Multidomain Simulation & Model Based Design *(MATLAB/SIMULINK)*

All these projects and related research activities performed at Ballard Motive Solutions (formerly known as Arcola Energy).

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| Objective | **Mathematical modelling for Refuse Collection Vehicle – Hybrid FCEV powertrain configuration replacing Diesel configuration** |
| Abstract | At very early concept stage or from marketing team requirement from customer to develop a FCEV vehicle. The project need is to evaluate the powertrain requirements for duty cycle – and various systems - Fuel Cell’s Power and Batteries’ (Capacity, Chemistry), and other HV and LV components. To do this, have developed scalable mathematical model using first principles/physics based by capturing Vehicle’s Resistive forces, Fuel cell, Batteries, DC-DC converter, Traction Motors and other HV loads consumers using empirical and data driven models.  Provide the management with the minimal vial able and as well the optimal powertrain configuration which is evaluated for packaging the specified components. |
| Measurable Parameters | Vehicle Actual Speed vs Desired Speed, Gradient, Fuel Cell- (Power, Current, Voltage, H2 Consumption, Efficiency),Batteries (Current, Voltage, Power, SOC), DC-DC converter (Current, Voltage, Efficiency), Traction Motor (Power, Current, Speed RPM, Torque), Other HV and LV Loads |
| Tools Used | MATLAB/Simulink |
| Objective | **Development of Battery Management System’s Logic in plant models** |
| Abstract | Using Batteries Supplier Data, developed the battery management system’ logic – dynamic current/power protection based on current discharge/charge time, temperature. This captures the battery dynamic current threshold very close the reality which prevent batteries from failure - the dynamic maximum discharge/charge/recharge current (DMDC/DMCC/DMRC or IMD/ IMC/IMR) |
| Measurable Parameters | Batteries (Current/Max Cell Temperature, Ambient Temperature), the dynamic maximum discharge/charge/recharge current threshold (DMDC/DMCC/DMRC or IMD/ IMC/IMR) |
| Tools Used | MATLAB/Simulink |
| Objective | **Power Balancing – Fuel Cell & Batteries (Fuel Cell Hybrid Electric)** |
| Abstract | Formulated a power balancing function between Fuel Cell & Batteries using battery SOC as reference to request current from fuel cell. Initially evaluated using PID controller later moved to Lookup table for flexibility on the current request. This control logic is the heart of the FCEV hybrid power balancing – how batteries are discharged and charged, longevity. How the fuel cell are switched on/off, ramped up. And how the power is balanced between them to meet the power demand from traction motor and other consumers |
| Measurable Parameters | Fuel Cell- (Power, Current, Voltage, Efficiency),Batteries (Current, Voltage, Power, SOC), DC-DC converter (Current, Voltage, Efficiency), Power Demand |
| Tools Used | MATLAB/Simulink |
| Objective | **Cooling Circuit – Thermal model for FCEV** |
| Abstract | Developed the thermal model/ Cooling circuit model for FCEV powertrain, using the power demand for each components in circuit evaluate the heat rejection |
| Measurable Parameters | Heat Rejection component wise, Component wise Temperature rise of coolant, Radiator Temperature in/out, Cooling fan Speed and current draw |
| Tools Used | MATLAB/Simulink |
| Objective | **Simulation models with Version Control using GIT/REDMINE** |
| Abstract | As Simulation Models has maturated with design data and test data. there was urgent need for version control so the models could be share across the global business locations. As Administrator and moderator, take care new model and methodology development and incorporate the update in latest versions. |
| Measurable Parameters | Not Applicable |
| Tools Used | Git, Redmine, LINUX WSL and MATLAB/Simulink |
| Objective | **Model Correlation – Refuse collection vehicle’s prototype** |
| Abstract | Simulation models validation carried out using test data collected from Remote monitoring unit – live data which is fed in simulation model to correlate with test and fill up the gaps for continuous improvement of modelling and add new capabilities and features |
| Measurable Parameters | Not Applicable |
| Tools Used | Grafana, MATLAB/Simulink |