Masters Thesis Abstract

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Due to the global rising concern regarding humanity's impact on the environment and the consequences that will arise from it, many engineering industries are moving towards a more sustainable level of production, material usage and system operation. Institutions and corporations have a common goal in uncovering novel solutions to mitigate this impact. Supporting this notion, the European Institute of Technology has proposed a project involving several partners in investigating the viability of utilizing recycled permanent magnets in permanent magnet synchronous motors (PMSMs) for application in the automotive industry, a sector that has an undeniable impact on the world's progression towards a more sustainable future. In addition, the project aims to decouple the EU from a dependency on natural resources necessary for NdFeB magnet production, the most efficient and widely implemented magnet type within PMSMs.

The following study is an interdisciplinary activity that follows the project from the Politecnico di Torino's involvement, mainly in testing of the virgin and recycled magnet motors at component and vehicle level. A formulation of a testing methodology that can be applied to virgin magnet (VM) machines as well as recycled magnet (RM) machines is discussed, where the exploration of various evaluation routes are presented. Particularly, the static and dynamic characterizations of the machines are separated into numerical and experimental routes, with the development of an Equivalent Consumption Minimization Strategy (ECMS) with temperature feedback for the vehicle control.

The structure of the thesis is guided by certain working points of the project, where firstly a state-of-the-art analysis on the various methods of magnet recycling and their viability is performed. It investigates the main solutions that are beginning to emerge such as hydrogen decrepitation, as well as their economic and environmental advantages and disadvantages in comparison to virgin magnet production. Following this, the numerical modelling and control of the P2 hybrid powertrain on MATLAB and Simulink is discussed, which is necessary for the dynamic characterization of the two machines. Here, the conventional ECMS and temperature based ECMS are presented, generating two routes from which an analyst may use to evaluate the performance of the selected machine implemented. Subsequently, the testing methodology of the machines is explored, where the static characterization experimentation including the design of the mechanical interface between the electric machines (EMs) and the prime mover of the CARS center test rig is presented. Here, the outline of the dynamic characterization is also discussed, experimentally and numerically.