Chapter 1
Introduction to the Hybrid Power Train Architecture Evolution

ABSTRACT
The hybrid power train is a complex system. It consists of mechanical and electrical components, and each of them is important. The evolution of the Hybrid Electric Vehicle (HEV) power trains is presented from the historical point of view. This chapter discusses the selected review of the hybrid power train’s architectural engineering. It includes the development of the hybrid vehicle power train’s construction from the simple series and parallel drives to the planetary gear hybrid power trains. The fuel consumption difference between the pure Internal Combustion Engine (ICE) drive and the hybrid drive is especially emphasized. Generally, there are two main hybrid drive types that are possible to define. Both these hybrid drive types are not mainly differentiated by their power train architecture. The first is the “full hybrid” drive, which is a power train equipped with a relatively low capacity battery that is not rechargeable from an external current source, and whose battery energy balance—its State-Of-Charge (SOC)—has to be obtained. The second one is the “plug in hybrid,” which means the necessity of recharging the battery by plugging into the grid when the final State-Of-Charge (SOC) of the battery is not acceptable. Additionally, the chapter focuses on the fuel cell series hybrid power train, which is only shown because its operation and design are beyond the scope of this book.
INTRODUCTION

The initial image of the Hybrid Electric Vehicle (HEV) and the Electric Vehicle (EV), corresponding simply to the fuel efficient and environmentally friendly car, is now evolving in response to wider customer expectations. New power train architectures, and the augmented functionalities are required to provide increased performance, improved drive ability and comfort, as well as even the ‘fun-to-drive’ so strongly demanded from the new generations of vehicles.

Indeed, the main initial fuel–efficiency appeal of the hybrid electric vehicle has also been found to depend heavily on the conditions of its operation, which is good in city driving, but relatively poor on highways, or during uphill manoeuvres. Correspondingly, the new generation of HEVs follows a new trend, in which low fuel consumption is marketed together with the best overall performance.

This chapter first presents analysis of the possible hybrid power train architectures, and then follows an overview of the recent constructions of hybrid vehicles.

Since the year 2000, when one of my books, ‘the Fundamentals of Hybrid Vehicle Drives’ was published, the price of oil has doubled more than two times, while air pollution has increased enormously as well. In particular, the increasing emissions of CO2 have had a negative influence on the composition of the earth’s atmosphere, and this has presumably contributed to the recent climate changes. Now, about 25% of total industrial CO2 emissions are produced by vehicles. The world’s reservoirs of oil have been heavily exploited. The oil exploitation peak occurred about one year ago. The recent prediction assumes that oil, as we know it today, will probably be exhausted within the next forty years. These are important reasons for showing the necessity of road transport electrification. The growing market success of hybrid vehicles will be consolidated as an important part of the green electric transportation system. In 2020, about 15% of the total number of cars on the world’s roads is expected to rely on hybrid and electric vehicles. This means that the permanent improvement and development of hybrid engineering and technology must by necessity start now.

In this situation, an increasingly strong tendency to introduce hybrid or vehicle power trains is satisfied, and HEVs give us hope for achieving ecological balance in the future. Hope based on a simple rule which states that the less natural fuels are combusted, the less exhaust gases are emitted. Furthermore, the more stable combustion processes result in easier control over the combustion of the emitted gases, and the hybrid drive provides all these advantages.
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