Inductive Charging of Electric Vehicles - Challenges and Opportunities

The reputation of the automobile industry is tattered. The emissions scandal discredited the whole industry in an unprecedented extent. Software and hardware backfittings, trade-in incentives and driving bans for Diesel vehicles are short-term measures to get a grip on this topic. Independent of the discussion's dispassion or the single measures' meaningfulness, one fact is indisputable – the current situation pushes the vehicle manufacturers even more towards the development of electric vehicles.

Nobody exactly knows how fast customers will be willing to buy an electric vehicle instead of one with a combustion engine. Besides the price, one inhibition threshold for the customers is the shorter range and the charging behavior an electric vehicle requires. Contactless charging, say "hands-free charging technologies" can be a key factor to increase the acceptance of electric vehicles on the market.

There are different approaches for hands-free charging like inductive charging or different types of robot assisted charging. Goal of all these technologies is the best charging experience for the customers – the one where they do not need to deal with the charging process at all. For this, the inductive charging technology is the most promising one.

Inductive charging in the vehicle is based on the principle of induction where a current-carrying primary coil produces a magnetic flux and induces a current flow in a secondary coil that is within this field.

Due to its robustness and non-mechanical appearance inductive charging is the most suitable technology for a public charging infrastructure. Additionally, a wireless charging system can be flush mount on a parking lot or in the driving surface. In a first step, private customers can be targeted to position the technology on the market. When a standard is established and an interoperability of the inductive charging systems between the different vehicle manufacturers can be guaranteed, a public infrastructure for static charging can be built up. In a final stage of extension, this technology has the potential for dynamic charging while driving on a road. In the end, the customer does not need to worry about the vehicle's range anymore because it will be charged during almost every parking time or even while driving on the highway.

Coming from first prototypes that allow a reliable energy transfer between two coils, a primary coil offboard and a secondary coil mounted at the car, there are several challenges in the series development of an inductive charging system for vehicles. In the following, the major technical challenges are mentioned briefly.

The energy transfer must work for different air gaps between the coils since different vehicles have different heights and are loaded up differently. Here, vehicle features like the air suspension can be used to reach a defined charging window.

Ferro-magnetic objects in the magnetic field can heat up and injure the customer by contact or result in a fire. Thus, a robust and reliable foreign object detection is required that shuts down the power transfer as soon as a ferro-magnetic object is detected in the hazardous zone. Furthermore, living objects in the magnetic field must be detected due to possible negative effects like for pace makers. Thus, a robust and reliable living object detection is required that shuts down the power transfer as soon as a living object is detected in the hazardous zone. Ideally, the system restarts automatically as soon as the object disappeared again.

Another technical challenge is the alignment of the coils. Since the secondary coil is under the vehicle body and the coils must be aligned above each other, the customer needs to have a positioning support. Here, solutions of different technical complexity are possible, e.g. simple lines on the ground or sensors that can exactly detect the relative position of the coils to each other.

Not least, the magnetic field might heat up or electronically disturb other components in the vehicle underbody. Thus, a shielding of vehicle components against the magnetic field is required.

Summed up, inductive charging is an innovative technology with the potential to be a key factor for e-mobility. As soon as there is an interoperable system available on the market for a reasonable price, this technology might be an enabler for the vehicle manufacturers to lower the inhibition threshold related to e-mobility and thus to increase the portion of sold electric vehicles. However, it is a long way from a first prototype into a robust and reliable series solution, where auxiliary functions with cross effects have to be considered in addition to the main function of energy transfer.