Diesel Common Rail and Advanced Fuel Injection Systems

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Preface

It is a strange dichotomy, but true, that while in the heavy-duty sector North American manufacturers arguably lead the world with their diesel truck engine technology, to the extent that the engines are emulated and sold across the globe, in the diesel passenger car sector North America lags behind the world. To some extent, this is due to an unhappy experience with passenger car diesel engines in the early 1980s, but there are also several socioeconomic reasons for this situation. As a result, North America today is a strong bastion of spark ignition (SI) hegemony, a situation that might easily be expected to continue well into the future. However, the times are changing. Proposed CO$_2$ reduction legislation ostensibly favors the diesel engine, and the forward-thinking product planners can see that a gasoline/diesel mix in the fleet can open a new niche and bring flexibility to the Corporate Average Fuel Economy (CAFE) calculations.

Elsewhere in the world, diesel engine penetration into the light-duty vehicle market has advanced rapidly over the past twenty years and particularly over the last five years. In large measure, this recent growth spurt is due to the availability of the so-called “common rail” fuel injection system, which has almost single-handedly transformed the diesel engine, making it seriously competitive with the gasoline engine as a private vehicle powerplant. Now, a number of factors are converging that improve the prospect for the availability of diesel engines in the North American light-duty market, not the least of which is the market shift toward sport utility vehicles (SUVs), for which diesel engine characteristics are most admirably suited. These characteristics include fuel economy, invincible low-speed torque, and all-around good drivability enabled in part by sophisticated engine subsystems such as the fuel injection system and variable geometry turbochargers (VGTs).
However, if passenger car diesels are to return to North America in any volume, either through the import of engines produced elsewhere or particularly in the case of new engines designed and assembled locally, it is necessary to get all aspects of the process right this time. No one wants a repeat of the dismal experience of the early 1980s. Many factors are different this time. There is a greater understanding of diesel combustion now within the global diesel community, extensive experience with light-duty engines is available from Europe, and precision in manufacture has improved. However, by the same token, the performance and emissions challenges have intensified, too. Some things have not changed. The engineers in product development and manufacturing who will be charged with specifying, optimizing, and producing these engines will perforce be steeped in the lore and language of SI engines and may not be attuned to the subtle but important differences with the compression ignition (CI) engine. If that were not the case, there would be no need for this book.

Here, then, in fairly general terms, is a resource that addresses the important aspects relating to the diesel fuel injection system, explaining how we have arrived where we are, what systems are available today, providing pointers for what aspects are important and what aspects are not, and finally looking at the current state of development and projecting the likely technology path for the future. There is no doubt that diesel development requires a slightly different mindset, and this book should help in establishing that. The book is not aimed exclusively at either the light-duty or heavy-duty sector, but it points out where those sectors diverge in their solutions to the common problems.