Emission standards soon to be introduced worldwide will make it necessary to reduce NO\textsubscript{x} and CO\textsubscript{2} emissions in mobile applications ranging from passenger cars to heavy-duty trucks. Technologically speaking, the most favorable way of complying with future standards is to lower NO\textsubscript{x} emissions by selective catalytic reduction (SCR) which, in thermodynamic terms, allows the lean-burn engine to operate at the best level of efficiency.

Integrating SCR technology demands an approach that embraces the entire system because it involves incorporating various components in existing vehicle platforms. The tank / reservoir contains the reductant used for converting emitted NO\textsubscript{x} into nitrogen. A supply system, including pump, lines and an injector driven by a control unit – either of standalone type or virtually in the engine control unit – are responsible for dosing reductant into the exhaust line. The chosen SCR catalysts and flow conditions optimized by a variety of measures complement the hardware. Sensors for model-based control and diagnosis permit robust calibration and precision operation throughout the system’s life cycle.

IAV’s strength lies in its ability to cover the entire development process from detailed component level to validating the entire system for volume production. IAV is also setting new trends in hot-end NO\textsubscript{x} aftertreatment. Systems being developed for the future focus on close-coupled reductant dosing and integrated catalyst technologies, such as SCR / DPF. Both liquid AdBlue® and gaseous ammonia systems are being engineered.
Requirements Analysis
Developing exhaust gas aftertreatment systems starts with assessing customer-specific demands, statutory requirements and market trends. This phase examines various concepts to establish which one is best suited to the planned vehicle / engine combination.

Aftertreatment Concept
For efficiency reasons, simulations are used for assessing and validating the chosen exhaust gas aftertreatment concept for the particular application. This provides the basis for configuring the exhaust line and defining the specifications for the catalysts to be used. Specifications meeting the exacting demands placed on reductant distribution are then drawn up for the reductant mixing section components using three-dimensional fluid simulation.

Component Testing
Once an aftertreatment concept has been defined, detailed specifications are compiled for each single component. Prototypes of all components from different suppliers are tested to verify their performance and readiness for mass production. IAV has a wide range of testing facilities for checking all specifications on aftertreatment components.

Algorithm Development and On-Board Diagnostics
Besides engineering the hardware, IAV develops electronic algorithms for controlling and monitoring individual components. Robust calibration is crucial to the way in which the exhaust gas aftertreatment system operates. The use of variable test environments allows virtually any hardware to be adapted and integrated in the overall system.

System Integration
The exhaust gas aftertreatment system is integrated into the vehicle in several development stages. The exhaust system must be adapted to suit the vehicle’s boundary conditions, optimize reductant mixture preparation and minimize pressure loss. System integration also involves coordinating virtually all components.

Initial System Calibration
After selecting the hardware, basic calibration of the exhaust gas aftertreatment system takes place on the simulation engine test bench and provides the starting point for enhancing it in the vehicle. This is where the interaction between engine emission control, temperature management and emission levels undergoes iterative optimization.

Vehicle Calibration
Once the system has been defined in full and undergone basic calibration, it is validated for mass production. A concept developed is only successful if it provides faultless performance under all operating conditions occurring in the real world throughout the vehicle’s lifespan. IAV has gathered a vast range of experience and can draw on established processes for developing and calibrating turnkey SCR systems for mass production.

Cost Engineering
System cost analysis is based on a thorough knowledge of functions and processes. Combined with a high-quality database of the input parameters involved, this makes it possible to predict anticipated component costs early on. Detailed analysis reveals the system’s cost drivers and identifies optimization potential. IAV provides support at all stages in the product development process and can estimate the cost of every single component.