Advanced catalyst aging for future emission requirements

LEV III and EURO VI increase the catalyst durability requirements to higher mileage and reduce the full useful life as well as OBD emission limits. Therefore, legislators and car manufacturers are working on procedures to reduce durability testing time and to implement alternative methods to generate aged catalysts. There is an increasing demand for fast availability of precisely aged aftertreatment systems for gasoline and diesel engines. In addition, more than ever, cost and time frame advantages are demanded, in order to survive on today’s competitive markets.

When using engines for durability aging, only less than 40% of the fuel energy is converted into exhaust enthalpy. FEV’s hot gas aging bench uses up to 90% of the fuel energy, see fig. 2, therefore reducing the fuel consumption compared to an engine by 50 to 60%. Both gasoline as well as diesel fuel can be used. The dedicated burner technique is characterized by variable swirl and high pressure injection as well as exhaust gas recirculation and allows an AFR map operation from 0.7 up to over 2. The exhaust gas mass range covers up to 2x 150 gram/sec with the new double burner test stand. For several years, catalyst and aftertreatment system aging runs have been carried out certified by customers and authorities.

The most frequent aging cycles employed are:

- ZDAKW - fuel cut-off cycle for gasoline exhaust systems (Zyklus des Abgaszentrums deutscher Automobilhersteller zur Katalysatorweiterentwicklung)
- Standard Bench Cycle (SBC) for gasoline exhaust systems (US / EU durability aging for homologation)
- Durability aging of diesel oxidation catalysts / diesel particulate filters / DeNOx-systems
- Production of EU- / US-OBD limit catalysts

![Fig. 1: Hot gas aging test bench](image1)

The aging bench is capable of reproducing dynamic aging cycles as defined by customer or legislation and to simulate the engine in the vehicle or the engine test bench.

![Fig. 2: Thermal efficiency of the hot gas aging bench](image2)

![Fig. 3: Comparison of burner / engine test bench](image3)
Fig. 4 gives for a ZDAKW catalyst aged on FEV’s hot gas bench the tailpipe emissions in the FTP test on chassis dynamometer compared to a catalyst aged on engine test bench. The correlation was done by the customer and shows comparable results.

![Fig. 4: FTP test result comparison with ZDAKW aged catalysts](image)

A critical situation for diesel exhaust systems with particulate filter is the filter regeneration, which is frequently activated. The high temperature created to regenerate the collected soot in the particulate filter is typically the hottest temperature period in diesel oxygen catalyst and particulate filter. The legislation defines aging programs repeating this situation the number of times relevant in order to reach full useful life. The realization of the regeneration operation on the hot gas aging bench is done with diesel fuel operation and direct hot gas production or post injection of diesel fuel into the lean exhaust gas provided by the burner, see fig. 5.

![Fig. 5: Set up for diesel aftertreatment aging](image)

The hot gas aging bench can simulate the dynamic gas profile during regeneration in a representative urban driving cycle. Figure 6 shows the exothermic reaction of the regeneration cycle. A full cycle consists of soot creation up to a filter load threshold and regeneration. Aging status monitoring can be done by light-off tests in regular intervals.

Legislation requires on board monitoring of emission-relevant components and especially the aftertreatment system. A malfunction of the aftertreatment system has to be detected when the defined OBD emission limits are exceeded.

Proper OBD functionality requires that catalysts have to be aged to a point where the OBD monitor has to evaluate if the catalyst is still as good or close to the threshold level or is defective. In order to provide catalysts that are representative for typical damage found in the field, catalysts can be produced on FEV’s hot gas aging bench. The method is fast, flexible and produces stable threshold aged catalysts.

**Advantages of burner aging vs. engine test bench:**
- Fuel consumption -50%
- Project time -20%
- Project costs -30%
- Higher reproducibility

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Status: 01.04.2010