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Guide
Data driven replication of a catalyst

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Replicating an OEM's catalyst in the absence of original performance metrics

Overview

In this project the CATAGEN toolset was used to generate catalyst hardware aged equivalently to a bespoke customer ageing protocol (for a German light duty auto application), with the added benefit of a reduction in ageing time. The CATAGEN Ageing Metric was used to specify the ageing approach with a 25% time reduction over the customer cycle (295 hours vs 400+ hours).

- Performance of CATAGEN aged hardware measured on partner engine test bench, with equivalency validated.
- The CATAGEN ageing approach and the patented OMEGA test reactor ensures repeatability and equivalent performance for each catalyst going forward.

The OMEGA recirculating gas reactor can simulate engine exhaust gas composition, temperature and flow rates without the need for an engine.

Challenge

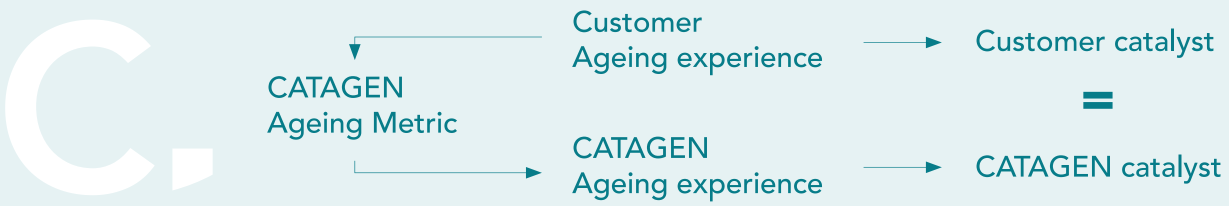
A key challenge for every OEM is to generate aged catalyst hardware accurately and repeatably for calibration and development. Uncertainty over the level of ageing and therefore the performance of aged aftertreatment hardware, transfers to design and calibration activities.

Reduced certainty over aftertreatment system performance can result in increased development times, or the requirement for larger safety margins when considering emissions performance. In short, reduced certainty in aftertreatment development results in an increase in cost and time.

Approach

- The CATAGEN toolset, specifically the CATAGEN Ageing Metric, was used to quantify the bespoke customer ageing experience.
- An equivalent CATAGEN ageing cycle was specified and executed with industry leading control and repeatability.

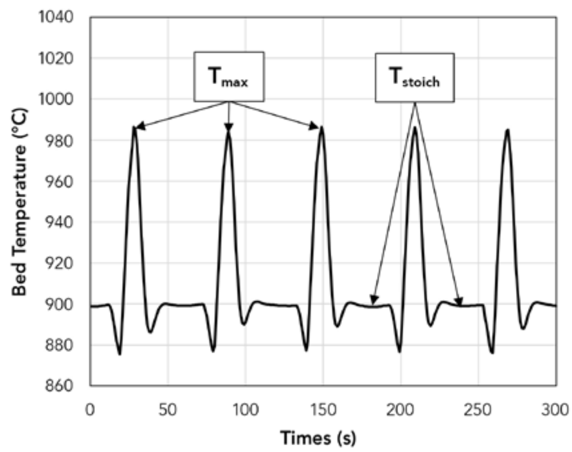
This is shown in the process diagram below. As the CATAGEN Ageing Metric evaluation is embedded into the in-house OMEGA control software, the catalyst ageing experience is monitored on a second-by-second basis, allowing certainty to be placed on the extent of the catalyst ageing.



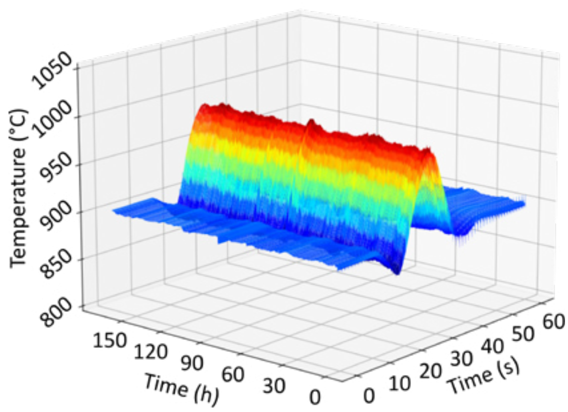
Outcome

The data centric approach and the CATAGEN Ageing Metric, combined with the patented OMEGA recirculating reactor, facilitated the generation of a representatively aged target catalyst. **This was achieved in a shorter timeframe than on the customer test bench, due to increased ageing temperatures and extended, uninterrupted ageing phases (up to 175 hours per phase in this case).** The equivalency of the CATAGEN aged hardware was validated through characterisation on a customer engine test bench across multiple evaluation conditions – validating the data driven ageing approach.

As identified above, the key challenge in aftertreatment ageing is repeatably and reliably generating catalysts with equivalent ageing. Whilst the CATAGEN Ageing Metric facilitates this, another key aspect is the control of the ageing experience in real-time. The ageing approach used in this study was the standard bench cycle (SBC) at elevated temperatures, with the cycle shown here.



The SBC ageing protocol calls for control of two temperatures: maximum and stoichiometric. These are legislatively referred to as upper and lower control temperatures. For the ageing of this catalyst, the upper and lower control temperatures remained comfortably inside the legislative tolerance for the entire 175-hour ageing phase. This highlights the strength of the OMEGA test vehicle.



Conclusion

Accurately and repeatably generating aged catalyst hardware is a challenging process. In this study, the CATAGEN toolset facilitated the development of a CATAGEN ageing cycle equivalent to a bespoke customer cycle. Ageing was complete with high repeatability and accuracy on the OMEGA test vehicle, with catalyst equivalency validated on the customer test bench.