Modeling approach for bridging the gap between laboratory tests and the application scale performance

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ABSTRACT

The general challenge related to experimental testing is, how to interpret the results of small-scale tests and apply them to larger scale components, pilot cases or even to performance of products operating in the field. In order to facilitate reliable transfer of experimental results and to enable the scale jump to bridge the gap between the model test scale and the component scale, a modelling-based Lab-to-Field upscaling tool will be generated. The validated Lab-to-Field upscaling functionalities will decrease the need to build expensive components for testing purposes and diminish the number of higher scale experiments thereby speeding up the materials up-scaling process.

For the upscaling process, experimental tests are performed on different scales. On each scale, measurement data is collected and a numerical model is constructed of the test situation (i.e. a digital twin of the test apparatus). The digital twins are calibrated against the measurement data so that they can be sufficiently reliably used also outside of the calibrated parameter ranges to give new predictions, which do not require physical measurements anymore. Moving to higher test scales means more expensive and more time intensive experimental testing. Therefore, the higher one moves in the materials upscaling chain, the more one should rely on computer modelling to gain significant savings in the product design process. The generation of the upscaling functionalities is based on two-level (laboratory scale and pilot scale) process consisting of modelling and experiments related to practical use case, which includes the construction of the digital twins. For the upscaling functionalities, where large parameter space must be scanned (e.g. for performance optimization), faster surrogate type models will be generated, inter alia, via machine learning methods. The surrogates can be integrated into a multi-scale model chain, which represents the Lab-to-Field virtual upscaling process.

Keywords: modeling, experimental, digital twin, upscaling

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