Development of predictive emission monitoring system algorithms for Qatargas turbine

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Qatargas and Total Research Center Qatar (TRC-Q) established a collaboration to study Predictive Emissions Monitoring (PEMS) algorithms for pilot application on a Qatargas gas turbine to predict NOx emissions. This pilot study was intended to demonstrate to local authorities that PEMS could be a reliable technique in both an alternative and complimentary capacity to Continuous Emissions Monitoring Systems (CEMS).

PEMS is an emerging algorithmic solution utilizing process and turbine operational data to estimate emissions from combustion units. Consequently, PEMS do not require routine maintenance and calibration, thus reduced costs, higher availability than CEMS.

The approach adopted for the study was a blind-benchmarking comparison of three main PEMS algorithms (first principle, statistical and neural networks). The study was comprised of two phases. Phase 1 was PEMS model development and validation using turbine operational data and corresponding NOx data. Phase 2 involved PEMS model testing, where a different set of only operational data were used to predict NOx emissions. Predicted results of models were then assessed by comparing with corresponding NOx data from CEMS.

The study continues, and this paper provides an overview of preliminary study results, challenges encountered and key lessons learned with regard to PEMS development. The initial study results indicated that there is no one specific PEMS algorithm that can be regarded as 'best-suited' to gas turbines that is able to cover a wide range of turbine operational conditions. Preliminary study results for the pilot turbine suggest that PEMS are best suited to predict NOx emissions within the operational range they have been trained for. Hence it is critical to have high quality and reliable turbine operational and monitored NOx data which covers the required range of likely operating conditions. Based on these initial results, the first principle and feed-forward neural network algorithms were found to perform better than the statistical algorithm. The full study results, incorporating improvements based on the above lessons learned, will be discussed in a future paper.