Online Performance Monitoring of Industrial Compressors
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**Problem statement**

- The gas-path geometries of industrial turbomachinery are mechanical degraded with consequences on performances and availability.
  - **OBJ1**: Assess the compressor operative range and its performances in degraded states.
  - **OBJ2**: Detect performance drops online (compressor running line).
  - **OBJ3**: Assess the effect of degradation on the compressor operating range and performances (actual degraded state).
  - **OBJ4**: Correlate the mechanical degradation dynamics to the compressor operating conditions.

**Proposed solution**

- **Offline baseline model development** [1-2] (OBJ1):
  1. The model includes mass and energy balances, equation of state, 1D flow models and less correlations.
  2. The model is calibrated and validated offline using historical data from the compressor running line.

- **Online baseline degradation adaptive modeling and performance monitoring** [3] (OBJ2 & OBJ3):
  1. Undegraded model predicts outputs (analytical redundancy) for real-time degradation detection.
  2. The degradation-adaptive baseline model is updated using newly available data sets.
  3. The adaptive and the undegraded models are simulated and actual test results are compared.
  4. The effect of degradation is assessed in the complete operating range.

**Discussion**

1. The final model accuracy is close to 99%.
2. After 3250 operating hours the efficiency (η) drops of circa 5% and the pressure ratio (PR) of circa 2%.
3. For lower inlet guide vanes opening (IGV) the PR drops of 2% and η drops of 6%.
4. For higher IGVs the PR drops of 3% and η drops of 6%.

**Conclusions and future works**

1. The degradation dynamics are long and the magnitude of effects on performance small.
2. The effect of mechanical degradation on performances is a function of the operating conditions.
3. The relationship between mechanical degradation dynamics and operational conditions is yet to be estimated.
4. The proposed solutions can be used for predictive monitoring and performance-based optimization frameworks (condition based maintenance (WP3: ESR-D) and operation scheduling, real-time optimization (WP5: ESR-G)) and surge control (WP2: ERS-I).

\[\text{References}\]

