Highlights on computational support and foreseen intelligent data analysis

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Overview

• Steps foreseen

• Highlights on computational support-sources of instabilities

• Data analysis and post-processing
Steps foreseen

- Intelligent and detailed data post-processing and data analysis
- Make use of current 2D and 3D models to provide computational data for comparison with experimental data
- Post-processing, analysis and interpretation of existing CFD-RANS data
- Keep current design or re-design some parts?
- Concept of new 2D and 3D model of the complete target (parametric!)
- Plan for further thermal-hydraulic calculations will consider the following: optional geometrical changes and operating conditions, as well as computational capabilities and assigned time
Existing 2D and 3D models
Velocity Fields

Model: K. Samec
Post-processing: R. Milenkovic

Velocity field near walls

Model: K. Samec
Post-processing: R. Milenkovic

Low Reynolds number cubic or quadratic turbulence models, $y+<1$, 15 nodes in the boundary layer
Coupled fluid-structure interactions

Example of flow instability
Flow induced force

Can be estimated as follows:

- acceleration of the structure is measured by acceleration sensors,
- velocity and displacement are determined by integration of the acceleration signal,
- The damping characteristic and the frequency of the fundamental mode can be estimated from free vibration test,
- The effects of $Re$, $p$, turbulence, etc. on Flow Induced Force can be investigated.
Sources of instabilities
Cavitation

$p$ (bar) is the relative pressure
Reference pressure is 1 bar.

<table>
<thead>
<tr>
<th>p (bar)</th>
<th>Mass Flow: 13 l/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;1.5$</td>
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</table>

Table:

<table>
<thead>
<tr>
<th>$\Delta$HM (J/mol)</th>
<th>$n_p$ (mol/mol)</th>
<th>$w_n$ (J/mol)</th>
<th>$R_n$ (mol/mol)</th>
<th>$C_n$ (J/mol)</th>
<th>$p_{in}$ (bar)</th>
<th>$p_{out}$ (bar)</th>
<th>$d_{HM}(\Delta)$ (bar)</th>
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<tbody>
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<td>2.37</td>
<td>1.63</td>
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<td>6.73</td>
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<td>8.50</td>
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Intelligent Data Analysis

The main goal of advance and extensive data analysis is to estimate the intensity of fluid-structure interactions, to correlate amplitudes with inlet flow condition (Re, p) and to search for various causes of instabilities that may affect safe operation of the target.

Input: acceleration signal, pressure signal

Fast data acquisition
Frequency resolution

Parlez-vous Wavelets?

Methods and techniques, which are to be used, are described in TM_EURISOL_RM34_005, PSI, 2008
Conclusions

• Perform data post-processing and analysis
• Make use of existing 2D and 3D models to provide computational data for comparison with experimental data
• Results to be considered before planning any further steps