Advanced CFD and Optimization solutions for Hydro Engineering

Nonlinear Harmonic Method: A Major Breakthrough in Unsteady CFD simulations
- Accurate Rotor/Stator interactions
- Single passage mesh simulations
- Accurate unsteady solution with low number of harmonics (Blade Passing Frequencies)
- Reconstruction in time of the solution

Comparison of Nonlinear harmonic and sliding grid simulation: instantaneous blade pressure distribution and pressure fluctuation amplitude through FFT

<table>
<thead>
<tr>
<th>Nonlinear Harmonic</th>
<th>Sliding Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesh size</td>
<td>900,000</td>
</tr>
<tr>
<td>RAM</td>
<td>1.5Gb</td>
</tr>
<tr>
<td>Iterations</td>
<td>500</td>
</tr>
<tr>
<td>CPU Time w.r.t.</td>
<td>5</td>
</tr>
</tbody>
</table>

CPU cost comparison for Nonlinear Harmonic and Sliding Grid simulations w.r.t. steady Mixing Plane simulations

Also available in FINE™/Turbo and FINE™/Open with OpenLabs™:
- Steady Mixing Plane and Frozen Rotor
- Unsteady Sliding Grid
- Unsteady Phase-Lagged

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High Quality and Fast Meshing with AutoMesh™

Full 3D blade optimization with FINE™/Design3D

- Multi-point and multi-objective optimization
- Fully automatic process with no user intervention
- Optimization featuring Design of Experiments, Artificial Neural Network and Genetic Algorithms
- Powered by AutoBlade™, 3D parametric blade modeler

Advanced Cavitation modeling

Centrifugal Pump – Cavitation increase on suction side of the impeller with decreasing NPSH

Unstructured mesh for spiral casing and distributor (HEXPRESS™ - 1 hour CPU time)

Structured mesh for Francis turbine stay vane, guide vane and runner (AutoGrid5™ - mesh generated in a few minutes on a standard PC)