diameter of each concentric inflatable toroidal structure can be chosen according to the specific purpose(s) to be served by that structure.

Adjacent concentric inflatable toroidal structures can be separated by a flexible or rigid wall that bears the vertical (axial) load between the bottom and the top to prevent undesired axial expansion and thereby to help to maintain the desired overall shape of the assembly. The walls can incorporate penetrations, including windows and hatches. In an extreme case, a wall can be removed if it is replaced with rigid bars that are (1) attached to the tops and the bottoms of the adjacent toroid and (2) connected together with circumferential tension-bearing members. Rigid or flexible floors can be integrated into the inflated toroidal structures. Preferably, the floors in adjacent toroids should be joined to the wall between the toroids at the same level.

This work was done by Christopher J. Johnson, Jasen L. Raboin, and Gary R. Spexarth of Johnson Space Center. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-24215-1.

Investigating Dynamics of Eccentricity in Turbomachines

Rotordynamic and hydrodynamic forces are measured under prescribed rotor-whirl conditions.

Marshall Space Flight Center, Alabama

A methodology (and hardware and software to implement the methodology) has been developed as a means of investigating coupling between certain rotordynamic and hydrodynamic phenomena in turbomachines. Originally, the methodology was intended for application in an investigation of coupled rotordynamic and hydrodynamic effects postulated to have caused high synchronous vibration in the space shuttle's high-pressure oxygen turbopump (HPOTP). The methodology can also be applied in investigating (for the purpose of developing means of suppressing) undesired hydrodynamic rotor/stator interactions in turbomachines in general.

The methodology and the types of phenomena that can be investigated by use of the methodology are best summarized by citing the original application as an example. In that application, in consideration of the high synchronous vibration in the space-shuttle main engine (SSME) HPOTP, it was determined to be necessary to perform tests to investigate the influence of inducer eccentricity and/or synchronous whirl motion on inducer hydrodynamic forces under prescribed flow and cavitation conditions. It was believed that manufacturing tolerances of the turbopump resulted in some induced runout of the pump rotor. Such runout, if oriented with an inducer blade, would cause that blade to run with tip clearance smaller than the tip clearances of the other inducer blades. It was hypothesized that the resulting hydraulic asymmetry, coupled with alternating blade cavitation, could give rise to the observed high synchronous vibration.

In tests performed to investigate this hypothesis, prescribed rotor whirl motions have been imposed on a 1/3-scale water-rig version of the SSME LPOTP inducer (which is also a 4-blased inducer having similar cavitation dynamics as the HPOTP) in a magnetic-bearing test facility. The particular magnetic-bearing test facility, through active vibration control, affords a capability to impose, on the rotor, whirl orbits having shapes and whirl rates prescribed by the user, and to simultaneously measure the resulting hydrodynamic forces generated by the impeller. Active control also made it possible to modulate the inducer-blade running tip clearance and consequently effect alternating blade cavitation. The measured hydraulic forces have been compared and correlated with shroud dynamic-pressure measurements.

This work was done by Daniel Baun of Concepts NREC for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32563-1.