EVALUATION OF FLUID-STRUCTURE INTERACTION INVOLVING ABAQUS AND STAR-CCM+ FOR INDIVIDUAL USE

M .Hodapp, A. Avci

Festo AG & Co KG, Germany

ABSTRACT

In factory automation, flow control valves are commonly used to adjust the air flow rate through cylinders. The main component of these valves consists in an elastomeric membrane. This membrane acts as a non-return sleeve allowing an air flow in one direction, but preventing the flow in reverse direction. The forces exerted by the fluid flow on the compliant membrane cause large deformations which have a retroactive effect on the fluid flow. Hence for the optimisation of the flow rate, fluid-structure interaction (FSI) has to be considered. Computational FSI can help to understand the complexity in the reciprocal coupled system of compressible turbulent internal flow and non-linear structural deformation.

In this work FSI is carried out as a two-way coupling of the computational fluid dynamic (CFD) code STAR-CCM+ and the structural finite element (FE) code Abaqus. Results are passed at the level of the inner iterations (implicit coupling) or at the level of time steps (explicit coupling). Aim of this work is to investigate the degree of maturity of the commercially available FSI procedure involving both codes for the use in the context of the pneumatic industry.

Therefore a simplified model of a flow control valve is considered in this work. It consists of a circular tube in which a ¾ inch elastomeric non-return sleeve is concentrically mounted. Due to the mounting situation, the sleeve is pre-stressed and shows initial deformation. Inlet and outlet are positioned in opposite radial directions on the outside of the tube inducing a non-axisymmetric flow field. The structural and the fluid domain are discretised in 3D space. The non-linear deflection and deformation of the non-return sleeve and the resulting flow field are simulated for sub- and supersonic flow regimes. The compressible flow characteristics as well as the structural response are transiently solved.

Furthermore the flow rate and deformed geometry have been obtained by experiments for both flow regimes. The results are used for the validation of the co-simulation.

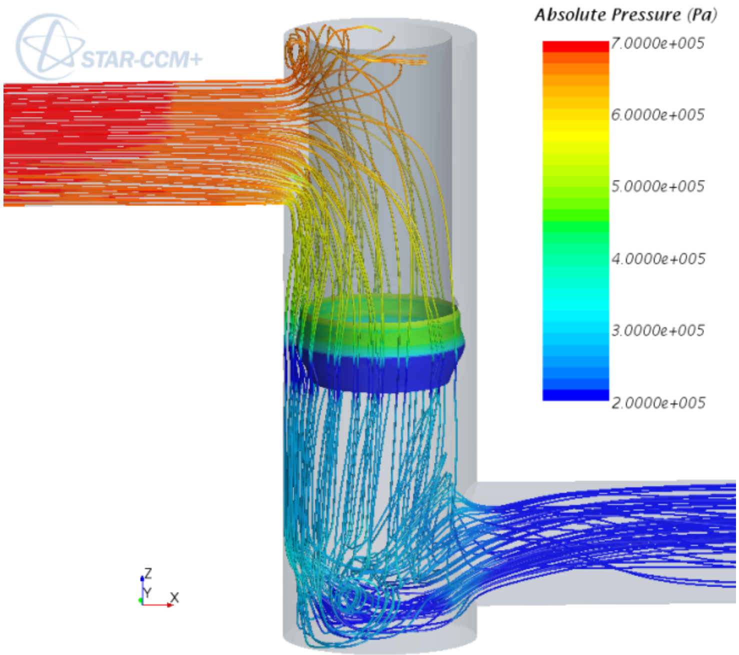

Fig 1: Supersonic flow regime due to an absolute pressure difference of 7 to 2 bar, streamlines and absolute pressure on deformed non-return sleeve

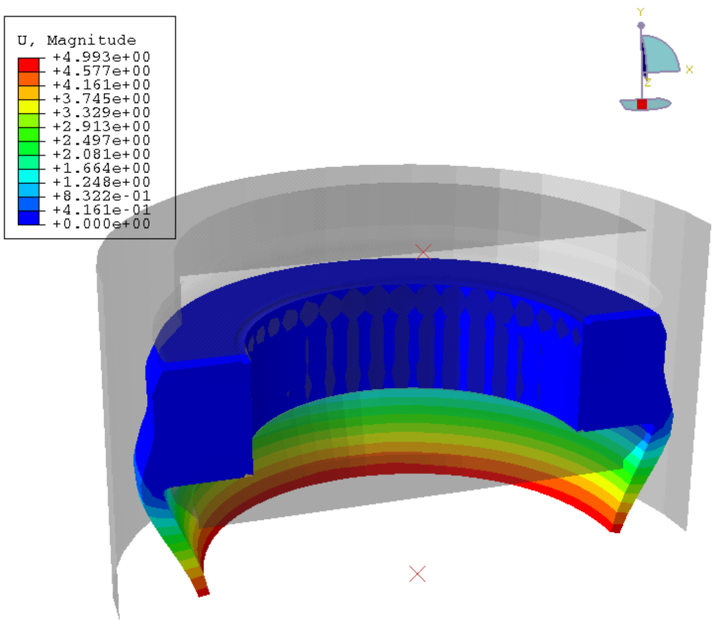

Fig 2: Deformation obtained by Abaqus due to pressure distribution resulting from STAR-CCM+