MESH MOTION STRATEGIES AND MULTI-COUPLED MESH INTERFACES FOR THE 3D SIMULATION OF EXTERNAL GEAR PUMPS

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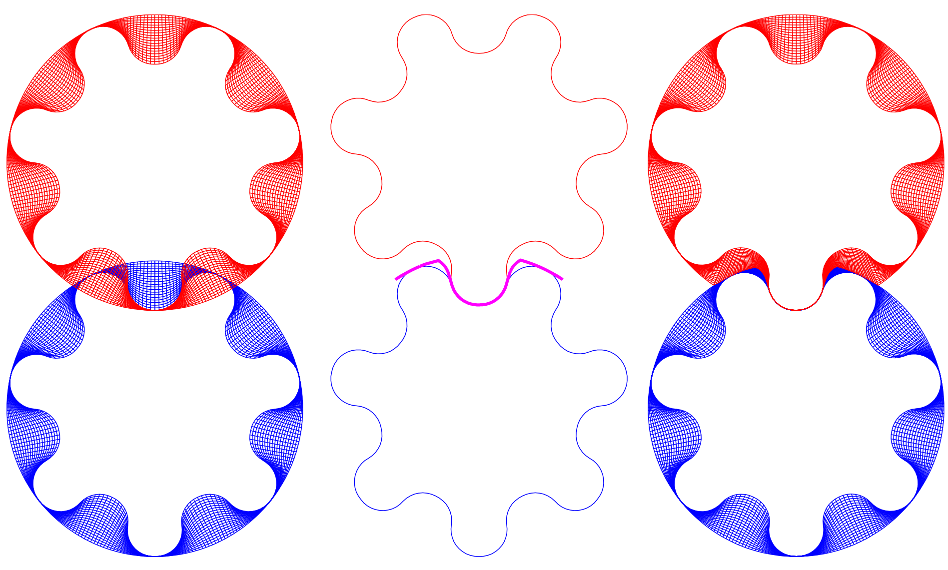
Given their low manufacturing cost and their good performance, external gear pumps are one of the most widely employed source of power in hydraulic applications [1]. Attempting to improve their efficiency and to reduce the noise produced by pressure pulsations, numerical simulations of external gear pumps have been greatly developed during the last years to accurately predict the three-dimensional pulsating flow through the pump. One of the main difficulties associated to the numerical simulation of gear pumps is the dynamic mesh handling. Even if consistent results can be obtained with simple 1D or 2D models [2, 3], a detail description generally requires the use of complete three-dimensional simulations in which mesh handling becomes critical.

Most of the mesh handling algorithms proposed for 3D simulations are based on cycles of deformation-replacement of the mesh. When mesh quality lies below a certain threshold, a new mesh is generated and physical magnitudes are interpolated. The most significant problem of this methodology is time consumption. In order to avoid mesh quality deterioration, the mesh needs to be replaced very often, leading to an increased computational time.

In this paper a dynamic mesh handling methodology for the 3D simulation of external gear pumps is proposed. A continuous mesh deformation allows the simulation of the gear turn without the need of a mesh replacement. A rigidly rotating structured mesh is associated to each gear (Fig. 1(a)) and projected to a common interface located in the gearing zone (Figs. 1(b) and 1(c)).



(a) (b) (c)

Figure 1: 2D mesh generation process: Rigidly rotating mesh (a); Interface (b); Projected mesh (c).

The procedure can be easily extended to handle three-dimensional straight-cut or parallel helical gears by applying the same methodology to the mesh points located in a given plane perpendicular to the axis of the gear. An example is shown in Fig. 2(a). Additional correction must be taken into account in the case of 3D geometries to improve mesh quality for the cells located in the intersection between external cylindrical boundaries as shown in Fig. 2(b).

An extended Arbitrarily Coupled Mesh Interface allows the treatment of the boundary condition between mesh regions (3). The procedure is generalized for its application to several gear tooth profiles and an additional utility is also proposed in order to simplify the mesh generation process. The mesh generation and dynamic mesh handling algorithm are tested

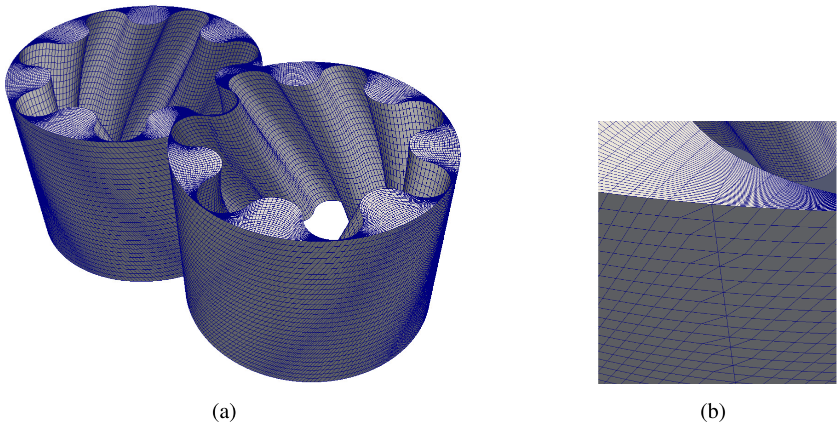


Figure 2: Example of a 3D parallel helical gear pump mesh. Projected gears (a); Detail of mesh corrections for one of the gears in the cylindrical boundaries intersection zone (b).

in several 2D geometries using a variety of tooth profiles and in a 3D helical lobe pump. An improved pressure-velocity coupling algorithm [4] is used to perform the transient simulations of all these cases.

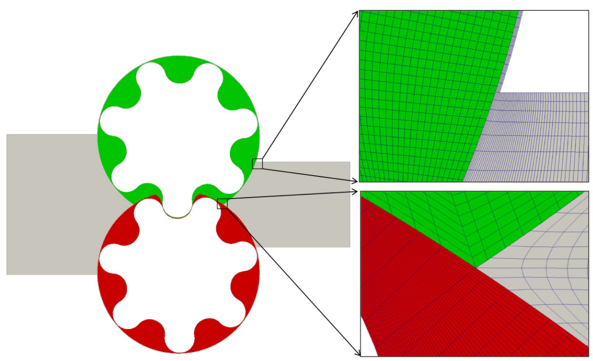


Figure 3: Mesh regions in a simplified 2D case and detail of mesh interface boundaries.

Acknowledgments

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