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Computer Aided Design of the Link-Fork Head-Piston Assembly of the Kaplan Turbine with Solidworks

The paper presents the steps for 3D computer aided design (CAD) of the link-fork head-piston assembly of the Kaplan turbine made in SolidWorks.The present paper is a tutorial for a Kaplan turbine assembly 3D geometry, which is dedicated to the Assembly design, figure 12, and Drawing Geometry and Drawing Annotation, figure 1.

Keywords*: Kaplan turbine assembly, SolidWorks, 3D geometry*

1. Introduction

The link-fork head-piston assembly of the Kaplan turbine has a complex 3D geometry, figure 1, which must be generated in CAD software for the final drawing and for finite elements strenght calculus. As a CAD software it has been chosen Solid Works [1]. The Kaplan turbine assembly CAD modeling is described in step by step in the following.

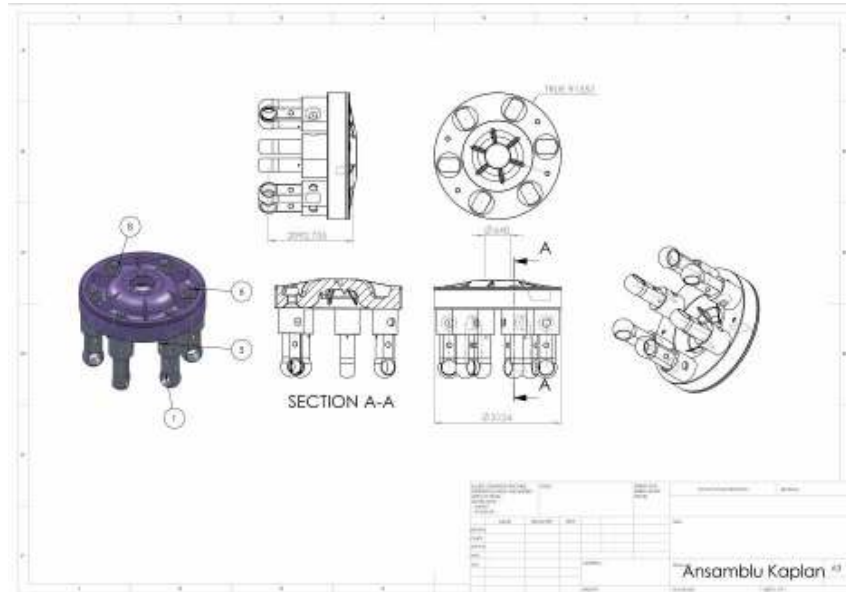One uses mates to create geometric relationships between the components of the assembly.

Figure 1. The link-fork head-piston assembly of the Kaplan turbine.

2. The parts components

This assembly uses the following parts: the Kaplan turbine piston; the Kaplan turbine fork head; the Kaplan turbine link; the slotted set screw flat point ISO 4766-M16x20; the hexagonal nut M225x4; the bush Φ 340; the bush Φ 194; the pin.

The **Insert Components** command will be used to add more components to the assembly. In the graphics area will be placed the component approximately as shown in figure 2.
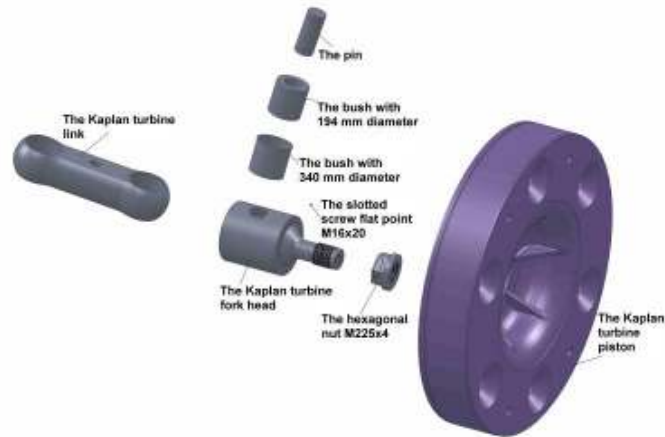
Figure 2. The components of the Kaplan turbine assembly

3. The geometric relationships between the Kaplan turbine link and the bush Φ340

The face with 340 mm diameter of the Kaplan turbine link and the face with 360 mm diameter of the bush Φ340 will be selected with the **Mate** command.

Concentric option is selected in both the **Property Manager** and the pop-up toolbar. A preview of the **Concentric Mate** appears.

The faces of the Kaplan turbine link and the face of the bush now lie in the same infinite plane, figure 3. The mate appears in the **Property Manager** under **Mate**.

For the three concentric threaded holes M16 of the Kaplan turbine link and the bush Φ340 is selected **Concentric** option in the **Property Manager**.

In the graphics area will be selected the top face of the Kaplan turbine link, then will be selected the outside face with 375 mm diameter. As the **Mate Type** will be used the **Coincident** option .

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Figure 3. The Kaplan turbine link concentric with the bush Φ340

4. The geometric relationships between the bush Φ340 and the bush Φ194

The interior of cylinder Φ340 will be selected, then will be selected the corresponding face on the bush Φ194. To create geometric relationships between the components of the assembly will be used **Mate** command with **Concentric** option.

The position of the bush Φ194 is not fully defined yet. It still has some degrees of freedom to move in directions that are not yet constrained by mates.

The component will be dragged from side to side to observe the available degrees of freedom, figure 4.

The same steps will be followed as before but will be selected the top faces of the bushes with **Mate** command, **Coincident** option with 0.5 mm as distance between the two top faces, figure 5.
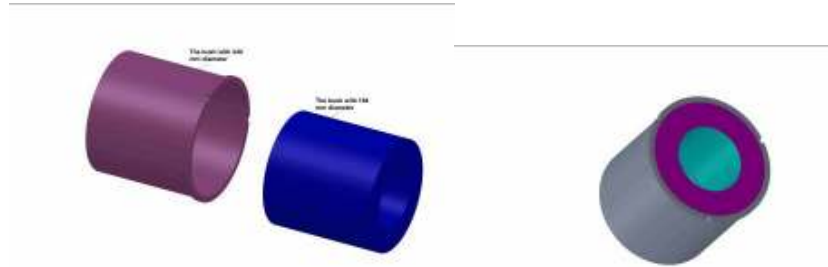
Figure 4. The bush Φ340 concentric with the bush Φ194

Figure 5. The geometric relationships between the bush Φ340 and the bush Φ194

5. The geometric relationships between the Kaplan turbine link and the slotted set screw flat point ISO 4766-M16x20

To create geometric relationships between the slotted screw flat point and the Kaplan turbine link will be selected the threaded holes M16 concentric with the outer screw thread ISO M16x20.

In the graphics area will be selected the top edge of threaded holes M16 then will be selected the corresponding edge on the other component. Another **Coincident Mate** appears under **Mate** in the **Property Manager**, figure 6.
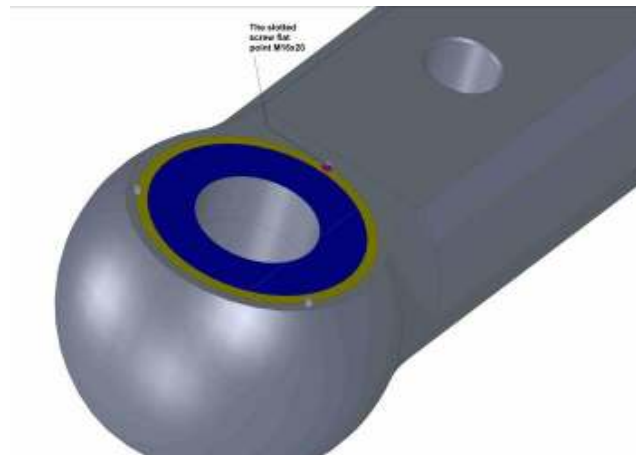

Figure 6. The geometric relationships between the Kaplan turbine link and the slotted screw flat point ISO 4766-M16x20

6. The geometric relationship between the bush Φ194 and the Kaplan turbine fork head

Will be established a relationship of concentricity and the coincidence between the Kaplan turbine fork head and the bush Φ194, figure 7.
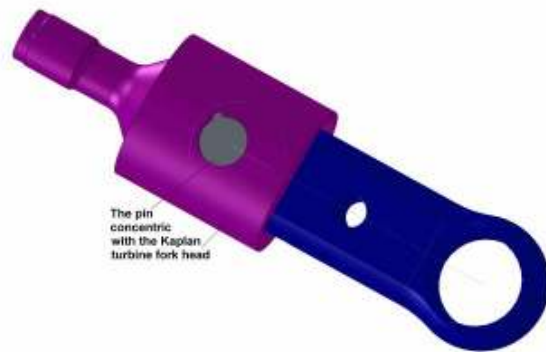

The pin
concentric
with the Kaplan
turbine fork head

Figure 7. The geometric relationships between the bush Φ194 and the Kaplan turbine fork head.

7. The geometric relationships between the pin - bush Φ194 and the pin – Kaplan turbine fork head

Pin and bush are concentric using **Mate** command and **Concentric** option, figure 8.

The same steps will be followed, but will be selected the top face of the pin and the circle Φ200 with 3 mm distance between the top face of the pin and the circle with 200 mm diameter.
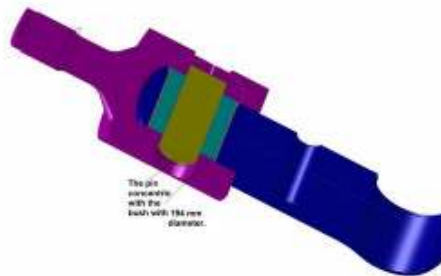
Figure 8. The geometric relationships between the pin - the bush Φ194 and the pin – Kaplan turbine fork head

8. The geometric relationship between the Kaplan turbine fork head and the Kaplan turbine link.

Will be established a relationship of concentricity and coincidence between the Kaplan turbine fork head and link, figure 9.

Figure 9. The geometric relationship between the Kaplan turbine fork head and the Kaplan turbine link

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9. The geometric relationship between the Kaplan turbine fork head and the Kaplan turbine piston

Will be established a relationship of concentricity between the Kaplan turbine piston and fork head, figure 10.

Figure 10. The geometric relationship between the Kaplan turbine fork head and the Kaplan turbine piston

10. The geometric relationship between the Kaplan turbine fork head and the hexagonal nut M225x4

For the concentric threaded hole of the hexagonal nut M225x4 and the thread M225x4 of the Kaplan turbine fork head is selected. **Concentric** option in the **Property Manager**, figure 11.

Figure 11.The geometric relationship between the Kaplan turbine fork head and the hexagonal nut M225x4

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11. The six symmetrical Kaplan turbine links and Kaplan turbine fork heads

With the **Reference Geometry/Axis** command will be generated the axis of the revolution body of the Kaplan turbine fork head.

The three symmetrical slotted set screw flat point ISO 4766-M16x20 will be generated by **Circular Component Pattern** command.

In the same way, with the **Reference Geometry/Axis** command will be generated the body's axis of the revolution of the Kaplan turbine piston.

The six symmetrical Kaplan turbine link and Kaplan turbine fork head will be generated by **Circular Component Pattern** command.

12. The link-fork head-piston assembly of the Kaplan turbine 3D geometry.

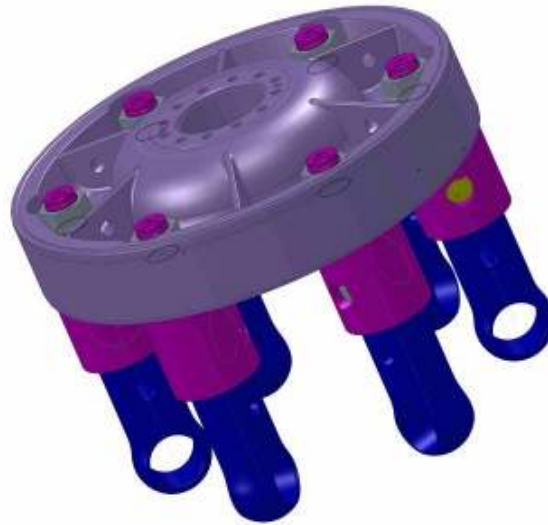The final 3D geometry of the Kaplan turbine assembly is presented in figure 12.

Figure 12. The Kaplan turbine assembly 3D model

13. Conclusions

SolidWorks is a powerful CAD software for 3D geometry modeling, which can be used for: Parts Sketch, Assemblies, Drawing Geometry and Drawing Annotation, Weldments, creating Adaptive Parts, creating Derived Parts, Motion Presentation of the Assemblies, CosmosMotion and CosmosWorks, Stress Analysis.

The Kaplan turbine assembly will be analyzed with finite element method, with CosmosWorks, to obtain stress distribution [2], [3].

References

[1]***** *SolidWorks 2009 Bible* Published by Wiley Publishing, Inc, Indianapolis, Indiana,ISBN:978-0-470-25825-5.

[2] Nedelcu D., *Stress Analyse of an Admission Valve with Finite Element Method*, Analele Universităţii „Eftimie Murgu", Reşiţa, Fascicola 1, Facultatea de Inginerie, 2007

[3] Mănescu T.Ş.,Nedelcu D., *Analiză structurală prin metoda elementului Finit,,* Timişoara, Orizonturi Universitare, 2005.

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