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GEOMETRY STAGE 3D MODELING OF A HEAT STATION PUMP

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ABSTRACT

The paper presents the stages of the 3D modelling of a circulation pump in a domestic low-power heat station. The possibilities of modifying the geometry by changing the numerical size of the geometric parameters are also emphasize.

1. Introduction

A heat/thermal station represents a heat source based on the conversion of any type of energy into thermal energy where there is a heat conveyer-thermal agent- which supplies heat from a central source to various consumers: heat systems, air conditioning appliances, hot water distribution system, technological systems etc.

A heat station usually consists of boilers, pumps, connecting and distribution pieces, fuel systems, burning products exhaust elements, automation devices, etc.

The paper describes a hot- water low – power heat station. Such stations are mainly designed for heating small buildings (residence, work-shops, shops, etc). They are provided with one boiler and supplies hot water for current consumption. They are marketed under the name of heat micro-stations containing under a single housing: the boiler, the burner, various expansion vessels, safety valves, pumps, the heat exchanger to prepare (instantaneously or by accumulation) hot water and the automatic controls; these are devices that ensure proper operation of a heat station and must only be connected to the fuel supply, power supply, funnel and the consumers ' internal systems

2. Study of the circulation pump geometry

In order to convey the fluid between the heat source and consumers, use is made of circulation pumps. Generally these are centrifugal, one-level pumps and the main process of the energy transformation (mechanical power into hydraulic power) is the result of the interaction between a rotor blades and the fluid conveyed. The increase in the fluid energy, therefore pumping, is the results of the centrifugation movement induced by the rotor blades that pump the working liquid radially.

The centrifugal one-level pumps are widely used in heat station and have flow rates within 0,5 and 125 l/s and pumping heights up to 600 kPa (60 mH_2O) being considered low-pressure pumps.

According to the criteria below the circulation pumps can be classified in terms of the construction configuration as:

- ✓ Type of electrical engine: dry rotor and wet rotor;
- ✓ Rotation speed: constant- adjustable, continuously adjustable;
- ✓ Construction of the rotating speed adjusting device: built-in rotating speed variation device (up to 5,5 kW), external rotating speed variation device (up to 55 kW).

The highest energy savings are brought about by the wet-rotor circulation pump and built-in rotating speed variation device. The 3D geometry was based on the real model of the rotor . Also in order to avoid an unfavourable effect upon flowing, the inlet blade edges are connected just like a hydrodynamic profile leading edge, which is an advantage for the blade in terms of wear resistance , reduced inlet hydraulic shock and a better pump behaviour to the cavitation phenomenon. The literature [1], [3] makes use of unique notations given in figure1 , such as: da – shaft diameter; d_b – hub diameter; D_1 – rotor blades inlet diameter; D_0 – rotor inlet diameter; b_1 – rotor inlet depth (thickness); b_2 – outlet rotor thickness; s – thickness of a rotor blade; t_1 si t_2 – rotor inlet /outlet blade step; z – number of rotor blades; $\beta_{1,2}$ – rotor blade seat angles (also called construction angles) corresponding to inlet and outlet.

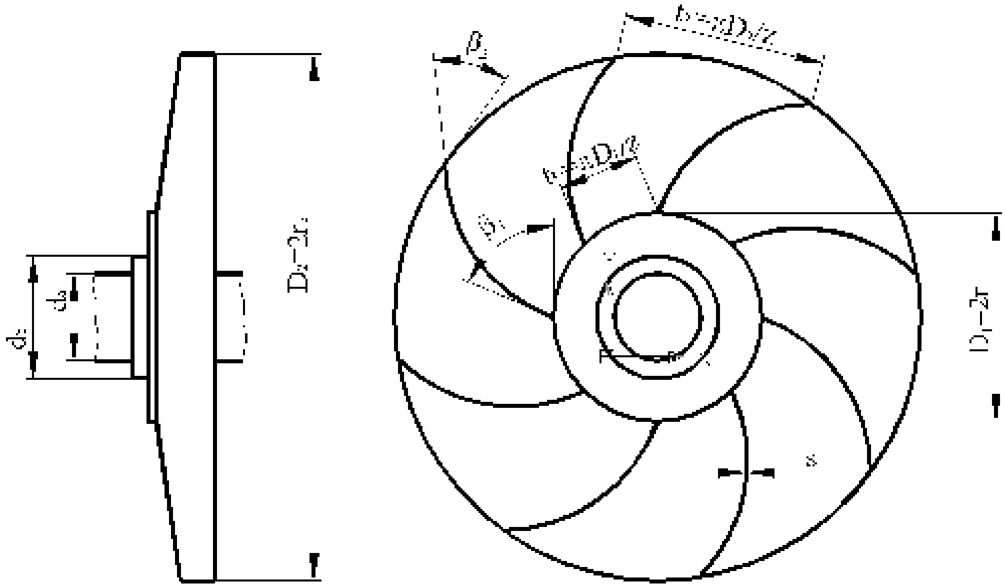

Figure 1. Geometric elements of a centrifugal pump rotor.

3. Modelling of each item geometry

Each piece/item is designed according to its geometric parameters drawings characterized by imposed geometric restrictions. The working plan always selected is the so called “New Sketch Plane” ; this is the drawing of a basic profile to which a command is given for the generation of a solid of type “Part”. The working plans have well-defined space positions as required by the generation of 3D solids .For a better relative positioning , at the beginning of each project, a set of basic plans is plotted perpendicular to one another by means of a Work Point which defines the origin of the reference system. With respect to this point all the geometric elements of the parametric project are spatially positioned. Since the pump body is complex enough solid, it is necessary to define 18 sketches of closed profile type and 2 of open profile type For the generation of the pump house by the control/command “Amextrude” the sketch in figure 2 is defined. To view the pieces inside the house a blue glass-type material is attached. The solid of the type “Part” generated by extrusion is assigned control “Shell” and the body in figure 3 is obtained. To reach the final shape/form as given in figure 4 of the pump housing various geometric elements are generated by means of “Amextrude”, “Amrevolve”, “Amhole”, “Amsweep”, “Amfillet” controls based on sketches arranged in well-defined working plans. Similarly each item is generated from the geometric parametric profile having the restrictions imposed in the sketch plan.

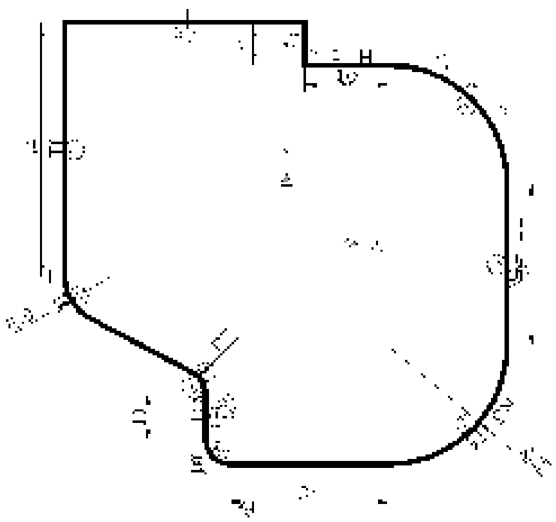

Figure 2. The sketch of the profile with restrictions geometrically which is the base of generating the pump body.

Figure 5 illustrates the blade rotor based on 8 geometrically restricted closed geometric profiles and 3 geometrically restricted open geometric profiles. After all items of the pump housing are plotted , the entire pump assembly is made by successive insertions and 3D geometric restrictions. The final result is given in figure 6.

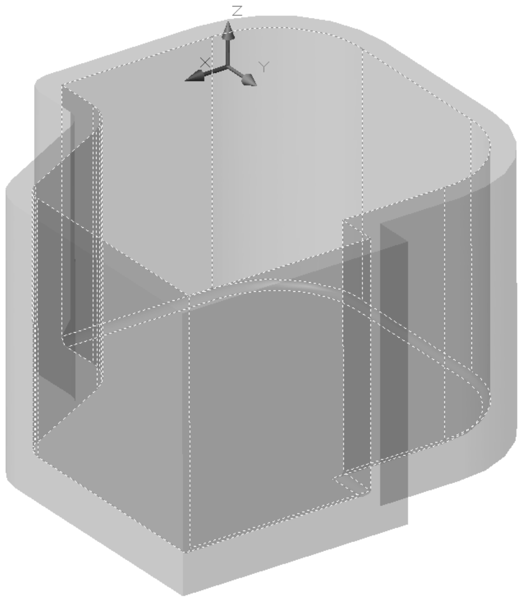

Figure 3. The solid *“Part”* obtained through the command *“Shell”*.

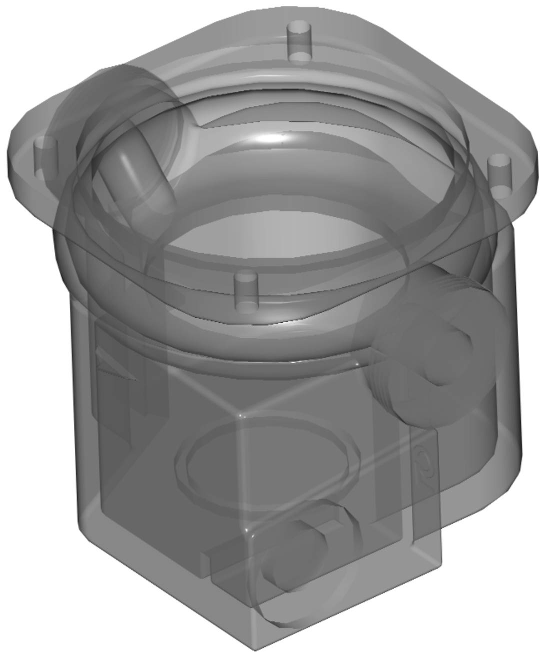

Figure 4. The final form of the pump body.

4. Modeling the subassemblies and assembly of pump type

In order to obtain the general assembly , each subassembly was modelled by activating control/command “Amcatalog” from the working directory of each item. In the following stage the items have been mutually positioned based on the 3D restrictions called by command “amdt_3dconstrn_tb”. Constrains used for the case studies have been of the type coaxiality , coplanarity, imposed vecinity. Also for a better understanding of both the operating principle and the vicinity relations, the external items were attached the glass-type material so as to view the internal pieces . This action of imposing certain properties can be carried out either in the item file , or directly in the subassembly file except that in the latter case each component of the subassembly should be transformed into an active component by option “Active Part”. Also for better clarity of the modeled subassembly , each plan which was not view as a result of the insertion operation can be hidden by “Amvisible”. Figure 6 illustrates the safety valve subassembly where all the working plans are hidden.

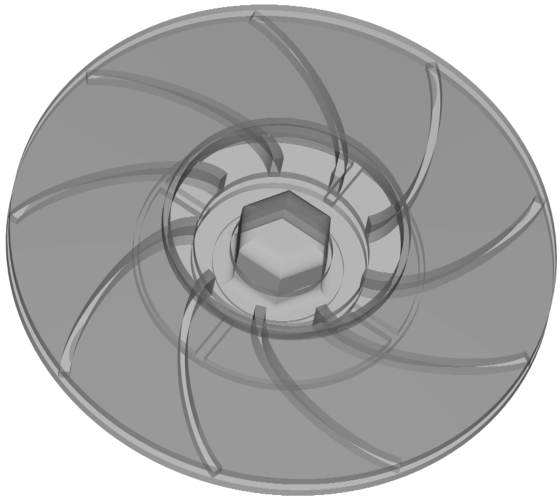

Figure 5**.** Final form of the blade rotor.

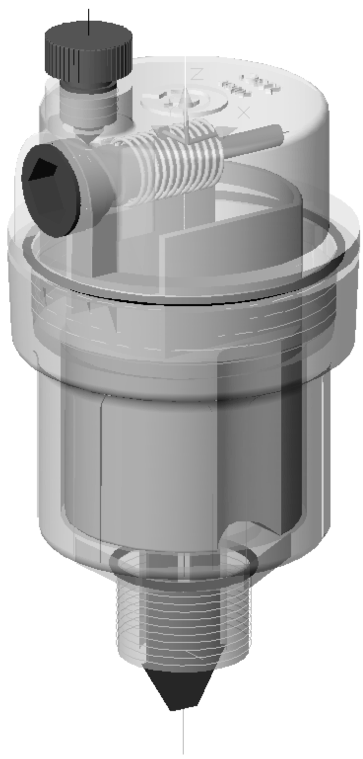

Figure 6. Safety valve subassembly.

5. Results and conclusions

The assembly corresponding to the modelled pump is obtained by inserting each assembly into a final file. Mention should be made that any subsequent modification to any item is transmitted automatically to the file of assembly type.

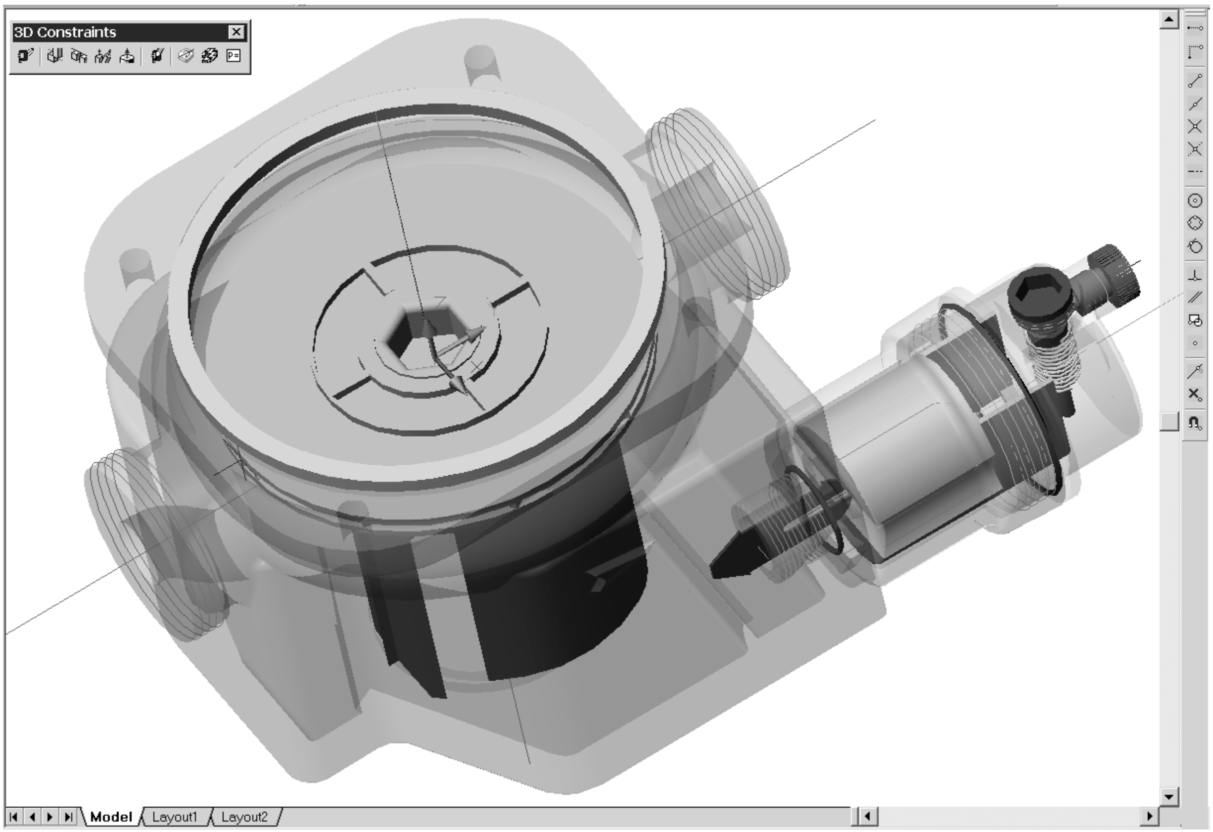

Figure 7. Final assembly of the modelled pump

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