

APPENDIX J

TURBINE: MAXIMAL SPIN SPEED

As can be seen in Fig. 4.2, the turbine is positioned against the step on the threaded right side of the shaft (6). In order to fix axially the turbine, it could be possible to add a tap hole in the turbine so as to screw it on the shaft but it would not be resistant enough, as the turbine is manufactured using 3D printing. To address this issue, an emplacement for an hexagonal nut was added. Besides, the nut allows to transmit the torque exerted by the compressed air on the turbine to the rotor, leading to its rotation. Obviously, this transmission system is possible only because the counteracting torques are extremely small.

The maximal spin speed that the rotor must be able to reach is 30 000 [rpm]. Let us verify that the turbine can withstand this speed. As mentioned above, the turbine is manufactured using 3D printing in ABS-plus P430. The main mechanical characteristics of this material are reported in Table J.1.

Table J.1: Mechanical characteristics of the ABS-plus P430 [Van Naemen, 2015].

Parameter	Value
Young modulus E [GPa]	2.16
Yield strength σ_Y [MPa]	30.66
Density [kg/m ³]	1040
Poisson ratio	0.35

Fig. J.1 shows the resultant displacement in the material with a scale factor of 113. The color indicates the amplitude of the displacement. As expected, the surface under the nut does not present high displacement while the top of the part suffers from large displacements because it is less rigid due to the hexagonal hole. Fig. J.2 shows the resulting Von Mises stress in the material, whose amplitude is represented by the color. It can be observed that the stress is larger around the hexagonal hole and that there are stress concentrations in the corners. The same noticing can be made for the edges of the notches. The maximal Von Mises stress is 14.67 [MPa], which is less than the yield strength σ_Y . The safety factor is then equal to 2.1, validating the strength of the turbine for the targeted spin speed.

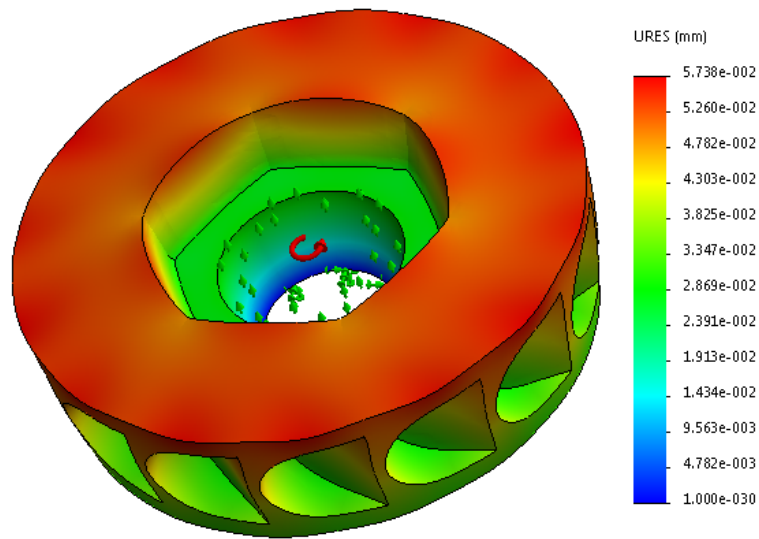


Fig. J.1: SOLIDWORKS simulation: resultant displacements.

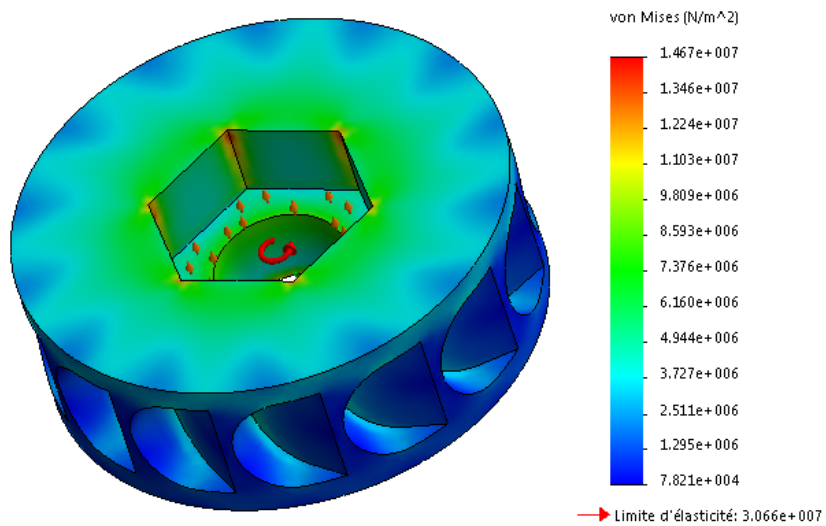


Fig. J.2: SOLIDWORKS simulation: resulting Von Mises stress.