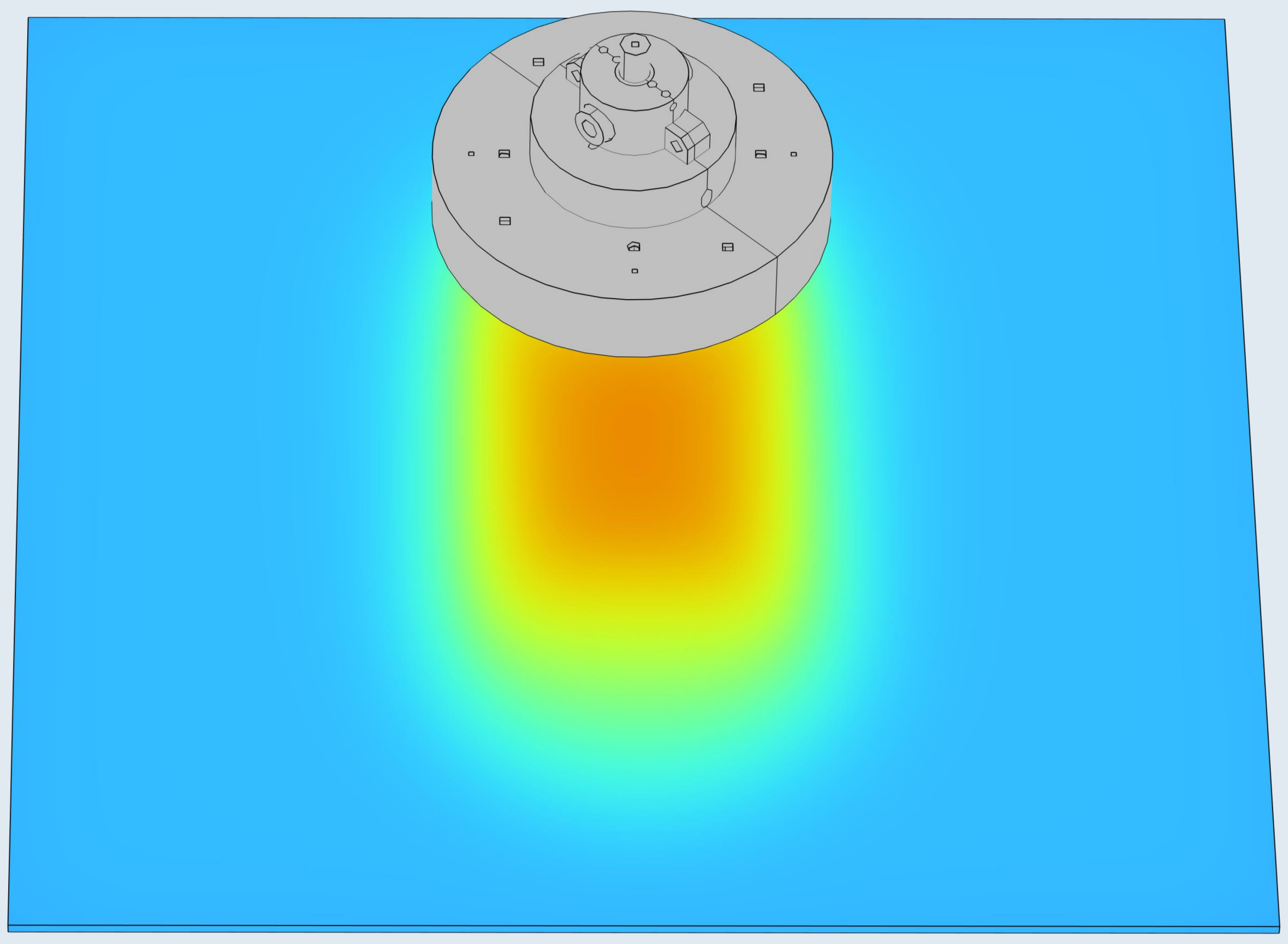

Parametric study of a modified 3D printing nozzle head

A modified nozzle head for better thermal management (by localized heating) of the molten PEKK polymer during deposition, to achieve improved interlayer adhesion.

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Abstract:

A parametric study of a modified 3D printing nozzle head from Maraging steel is numerically conducted to validate the process conditions required for the additive manufacturing of thermoplastics. A cylindrical ring (*SLS method [1]*) containing 4 heating cartridges is manufactured to be mounted on the nozzle in order to locally heat the printing plate around the zone of plastic deposition. The heated ring together with the nozzle head, radiates thermally and heats the printing plate with a back and forth movement prior to plastic deposition. Three geometric parameters of the ring, notably the external diameter (D_e), internal diameter (D_i) and the height above the plate (H_p) have been varied. A comparative study is presented to view their effect on the evolution of plate temperature along time. Results show that changing the diameters has a more profound effect on the temperature profile of the plate than that of the height (within the range considered).

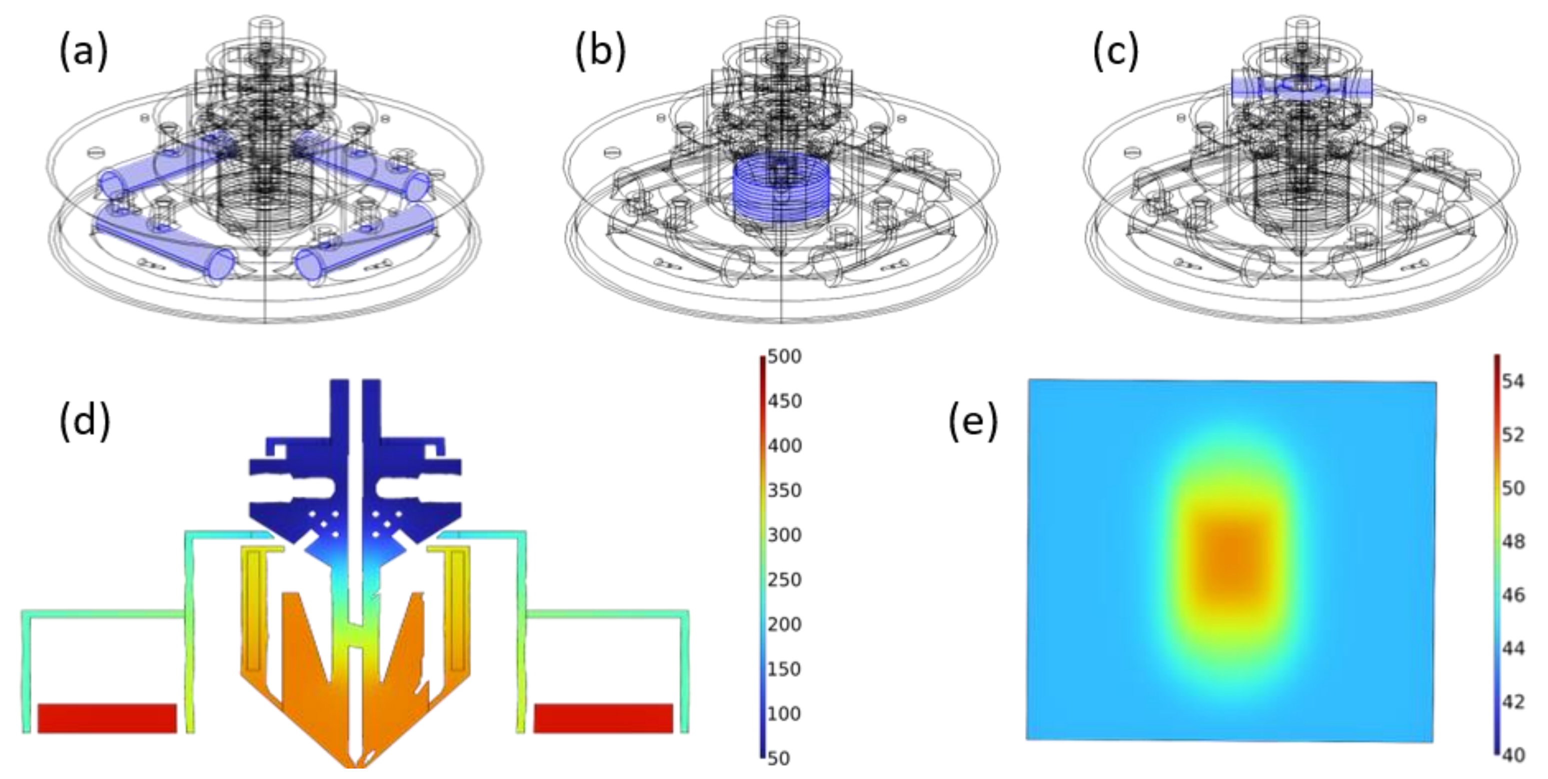

Figure 1: Boundary conditions for heating via (a) catridges in the ring; (b) coil around the nozzle; (c) Water cooling channel; (d) Steady state temperature profile of the nozzle head; (e) Temperature profile of the base plate @8.6s

Methodology:

The circular ring contains 4 heating catridges at 120W maintaining the temperature at 450°C while a heating coil of 125W maintains the nozzle temperature at 390°C. Water flowing through the cooling canals is kept at 55°C. A steady state analysis of the nozzle head is first conducted as shown in Figure 1 (d).

Next, this heated nozzle head is then moved to and fro, from one end of a steel base plate ($T_{ini} = 40°C$) to the other at a speed of 30 mm/s and covering a total distance of 260 mm. Every surface on the nozzle head is modeled to radiate heat to each other, which in return radiates heat to the base plate. The temperature profile at the end of the temporal analysis for 1 oscillation (8.66s) is shown in Figure 1(e).

Results:

The parametric study contains the variation of three parameters. The height of the circular ring from the base plate (H_p) is varied between 2.5, 4 and 5.5mm. The ext diam of the ring (D_e) is varied in between 68, 78 and 88mm. Finally the int diam (D_i) is only tested for 34 and 44mm. The temperature is measured directly under the nozzle at the center of the base plate (Figure 2). Results show that:- (i) Increasing both the int and ext diam increases the radiating surface and hence gives rise to highest temperatures. (ii) Varying the height seems to nominally affect the temperature within the considered range. (iii) Decreasing the int diam helped in homogenizing the temperature profile in the transversal direction as the air gap beween the nozzle and the ring surface is reduced. (iv) The best case thus obtained was with $H_p2.5$ D_e88 D_i34.

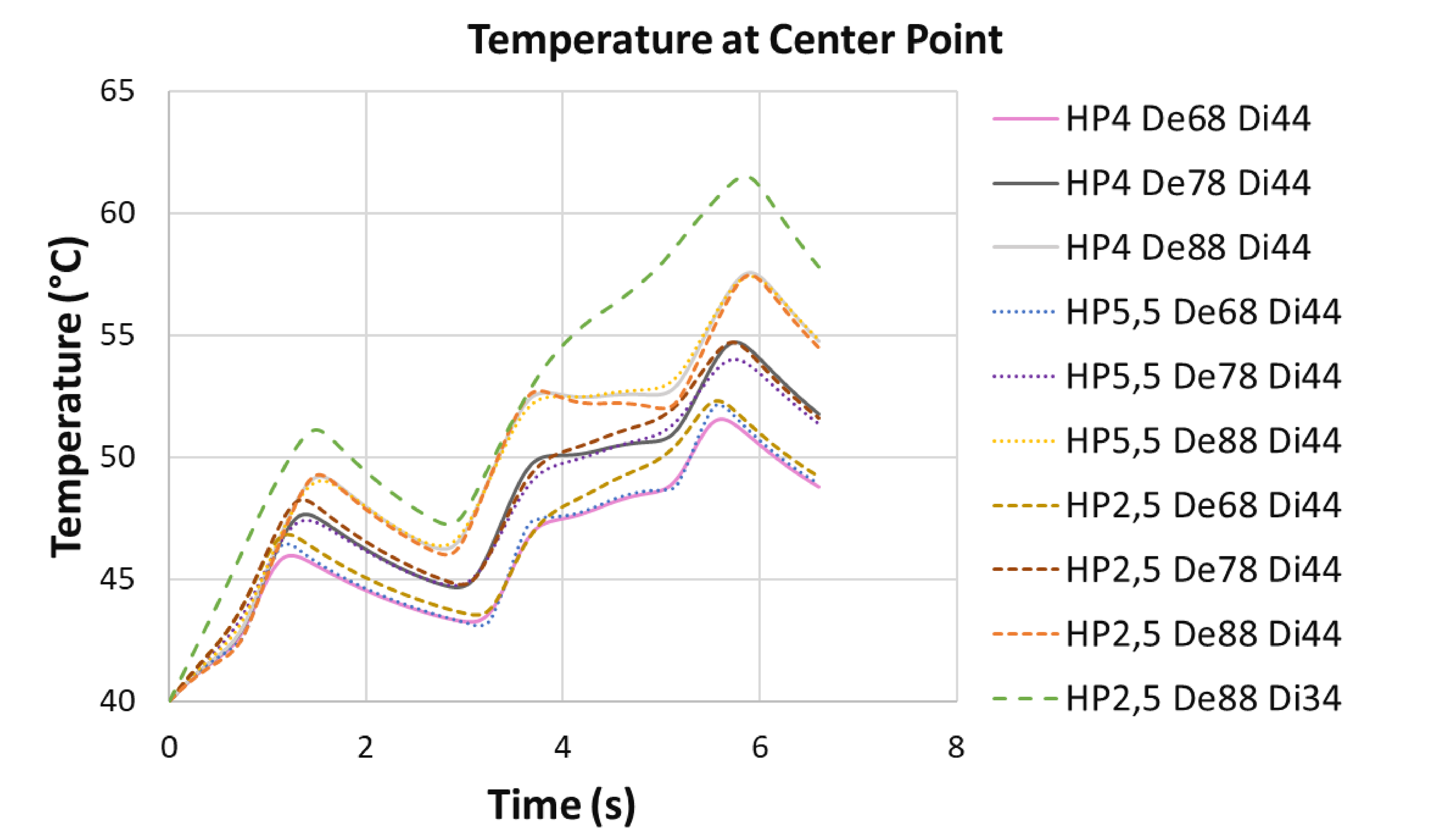

Figure 2: Temporal evolution of temperature at the central point on the base plate directly under the nozzle for all the 10 parametric cases.

REFERENCES

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