

Figure 1. Schematic diagram

Table 1. Physical properties

Gas phase	
Viscosity	$1.8 \times 10^{-5} \text{ Pa} \cdot \text{s}$
Density	$1 \text{ kg/m}^3$
Solid phase	
Density	$1500 \text{ kg/m}^3$
Spring constant	$50 \text{ N/m}$
Coefficient of restitution	0.9
Coefficient of friction	0.3

Table 2. Calculation conditions

Particle diameter	$250 \text{ }\mu\text{m}$
Number of particles	500,000
Grid size	$0.5 \text{ mm}$
Calculation time	$0.24 \text{ s}$

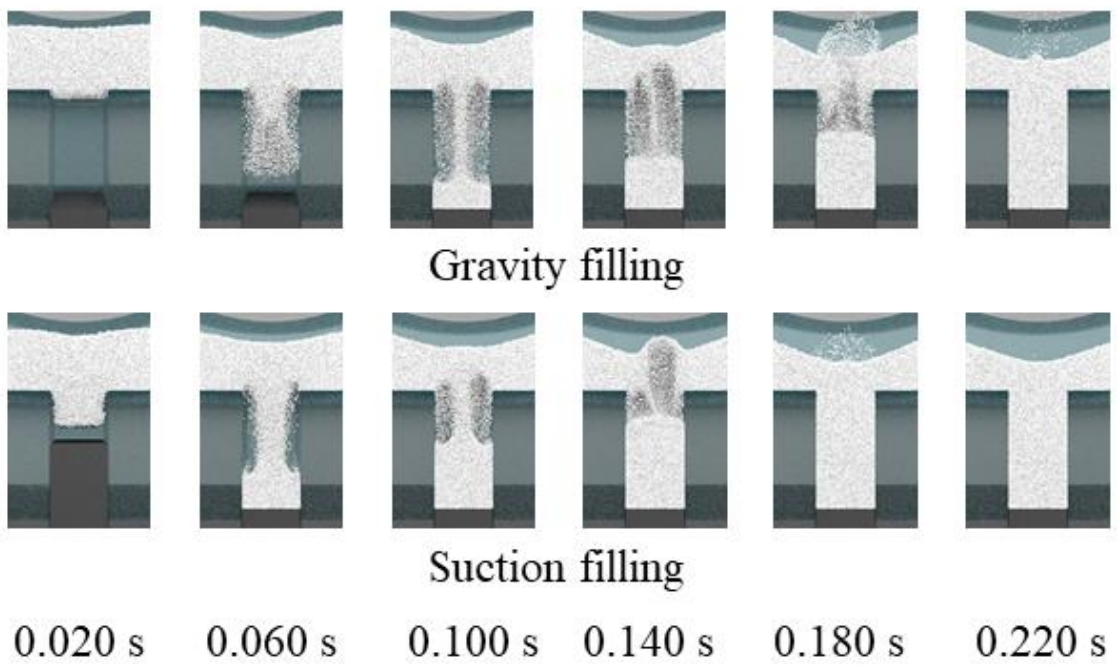


Figure 2. Powder distribution  
In case suction filling, the punch speed was 500 mm/s.

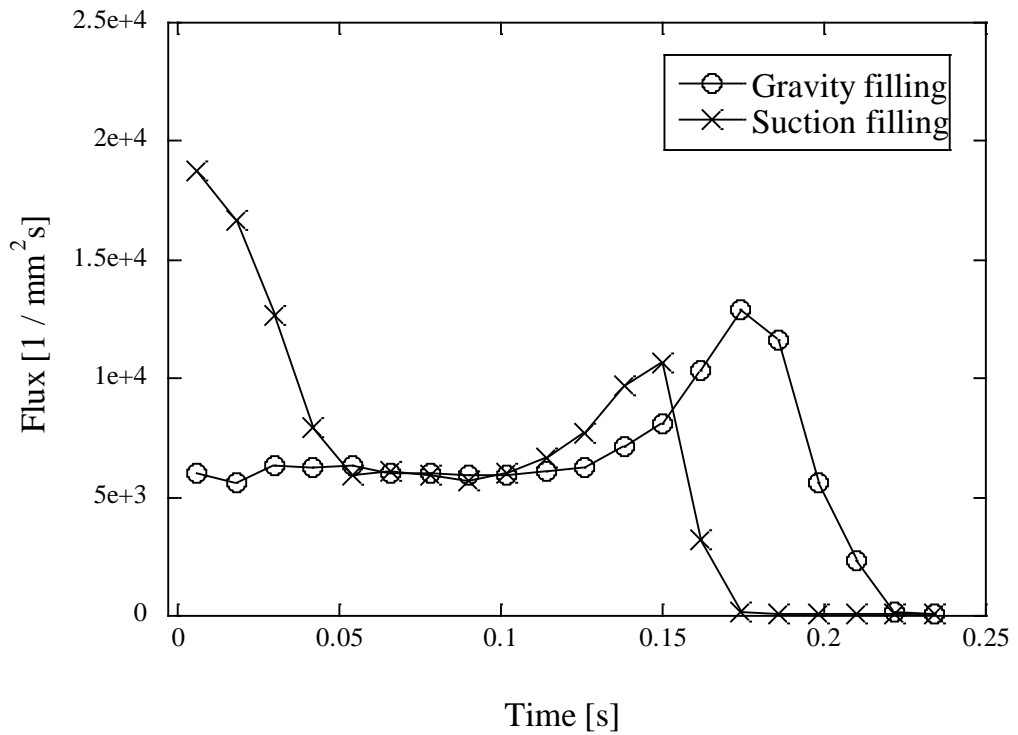


Figure 3. Flux of powder into die region

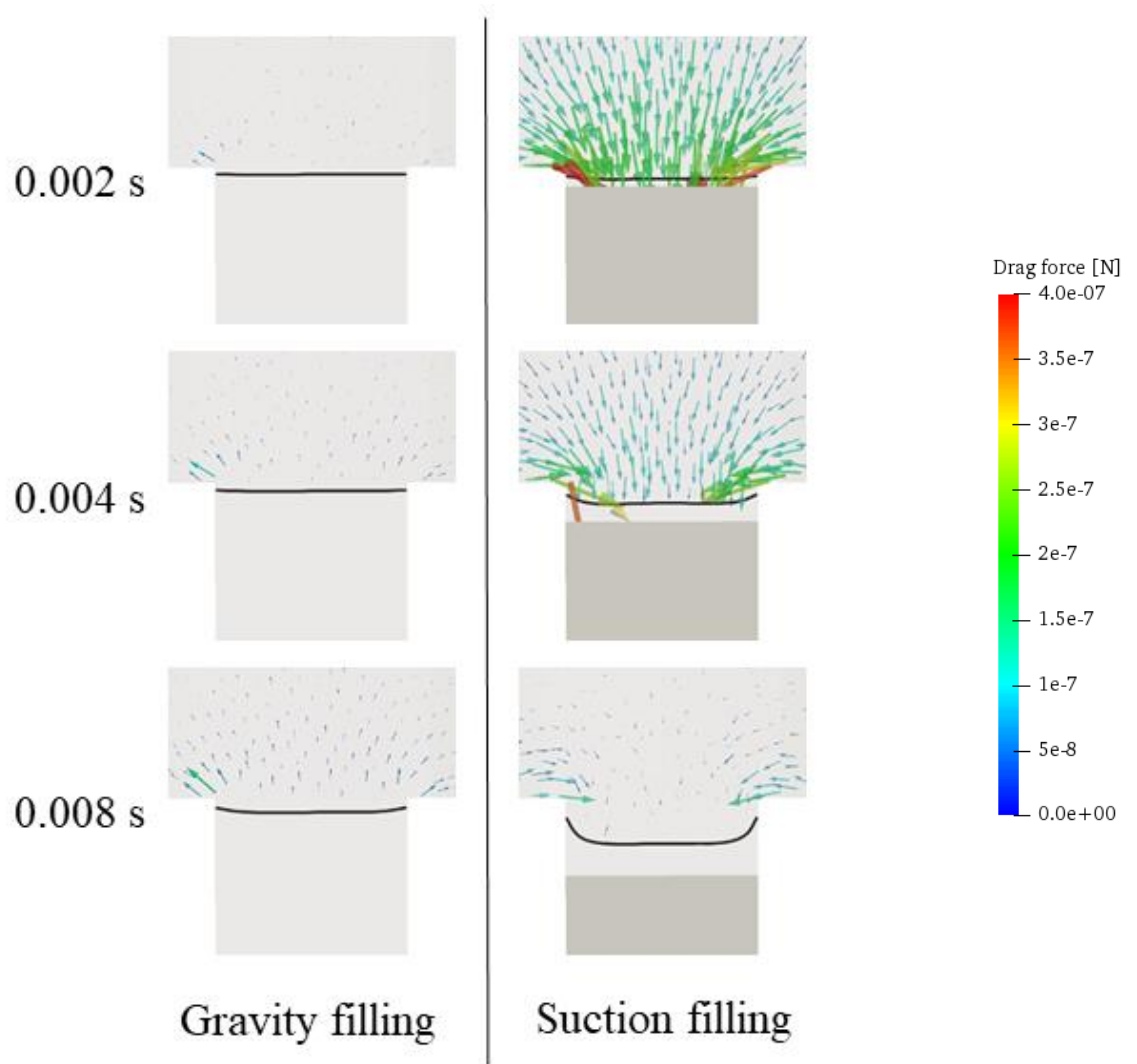


Figure 4. Drag force

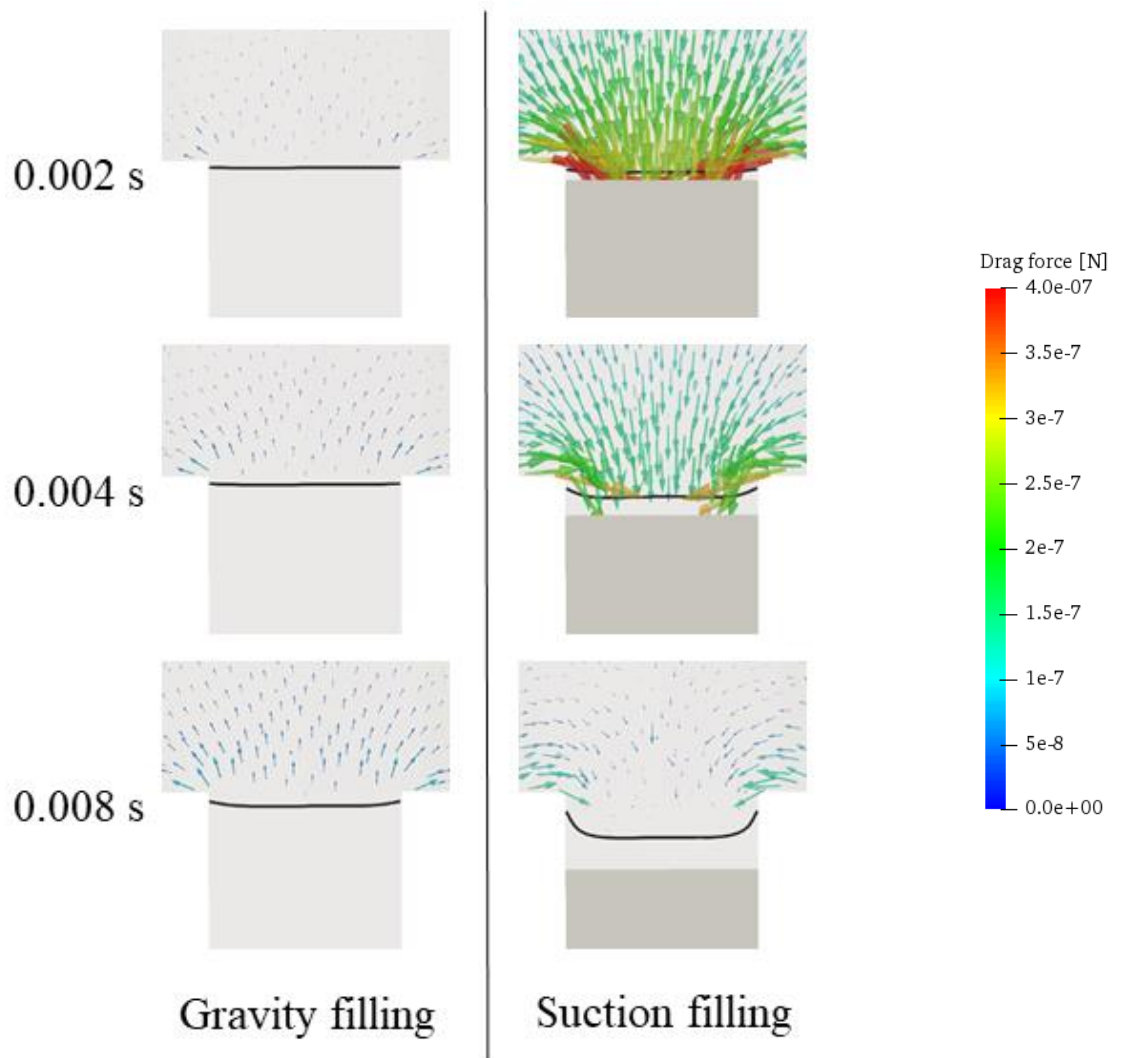


Figure 5. Pressure force

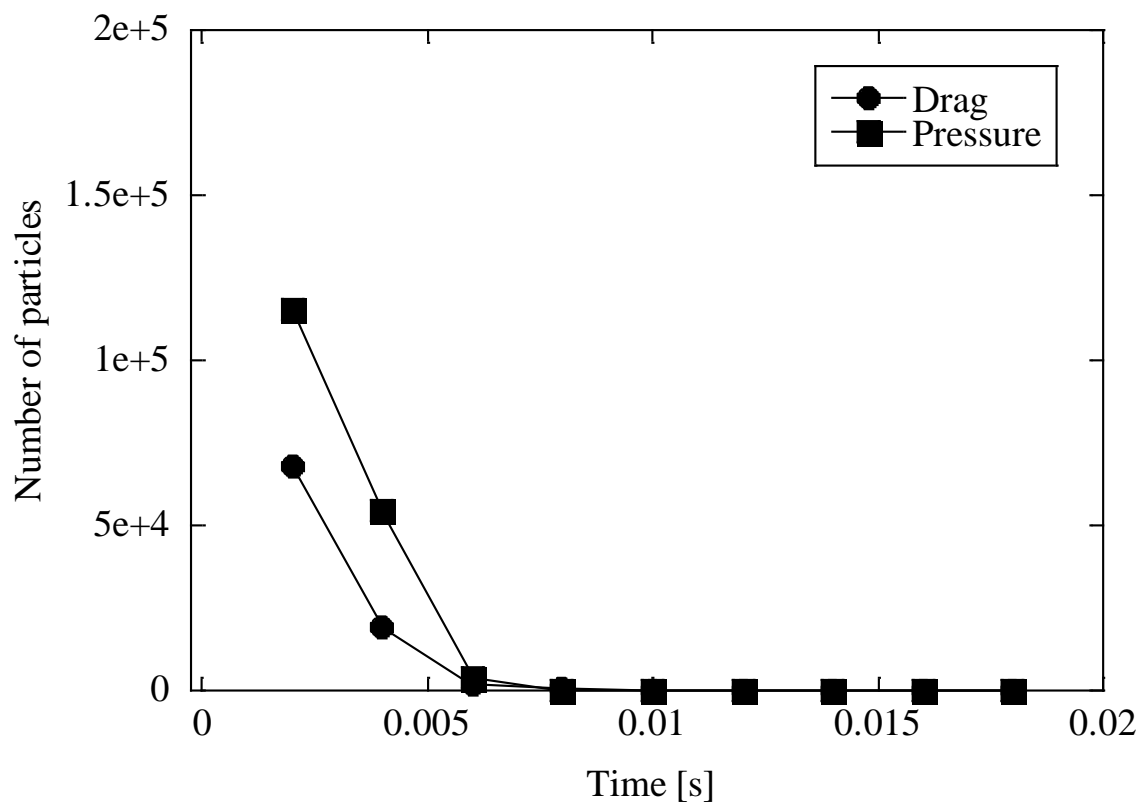


Figure 6. Number of suctioned particles

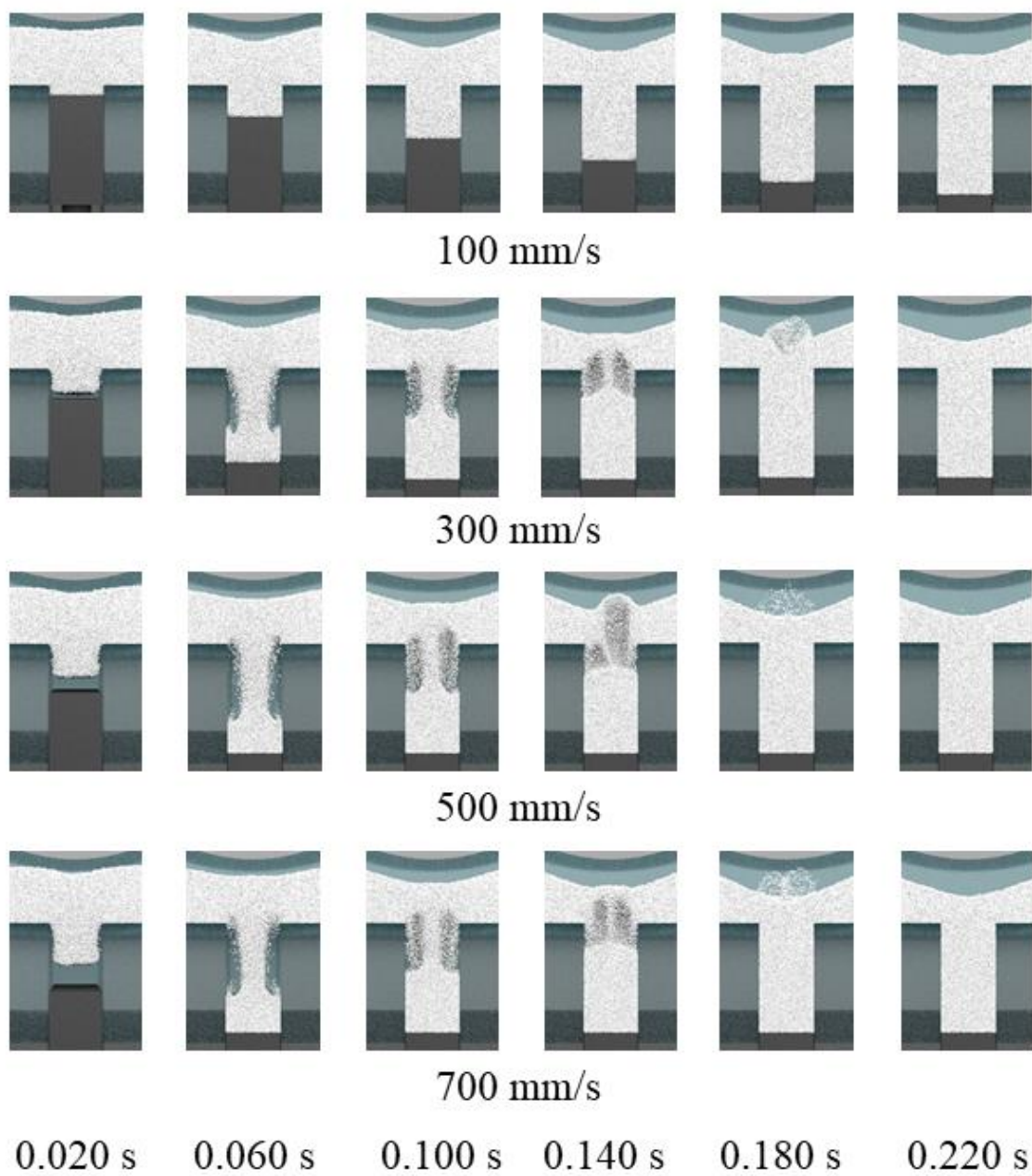


Figure 7. Powder distribution

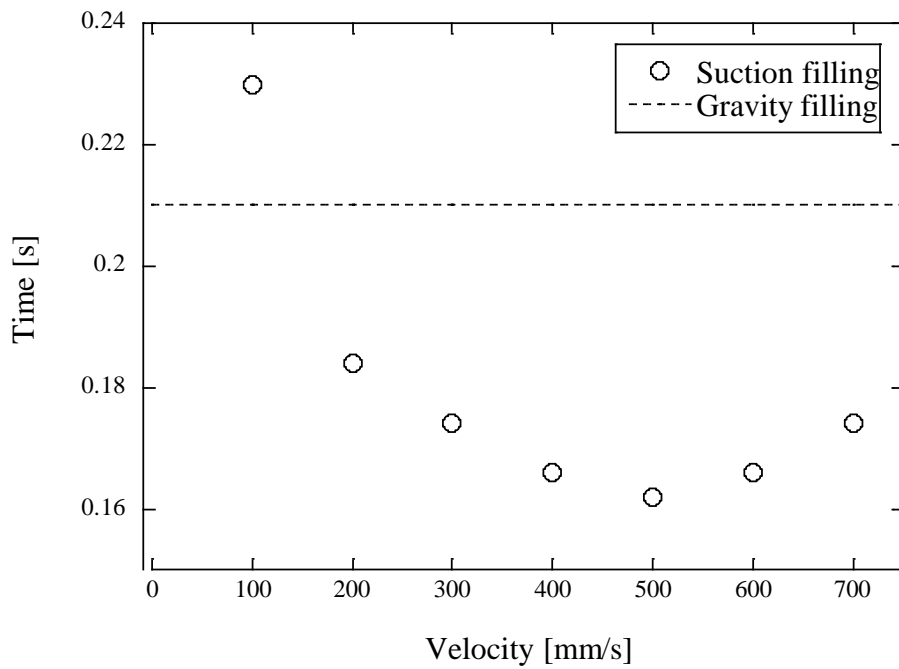


Figure 8. Filling time

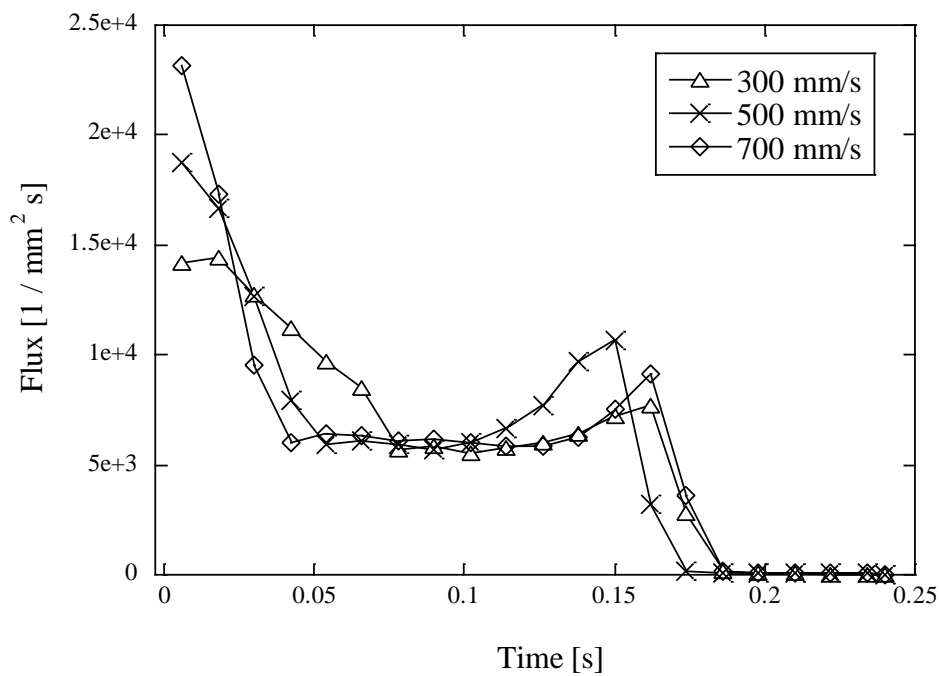


Figure 9. Flux of powder into die region



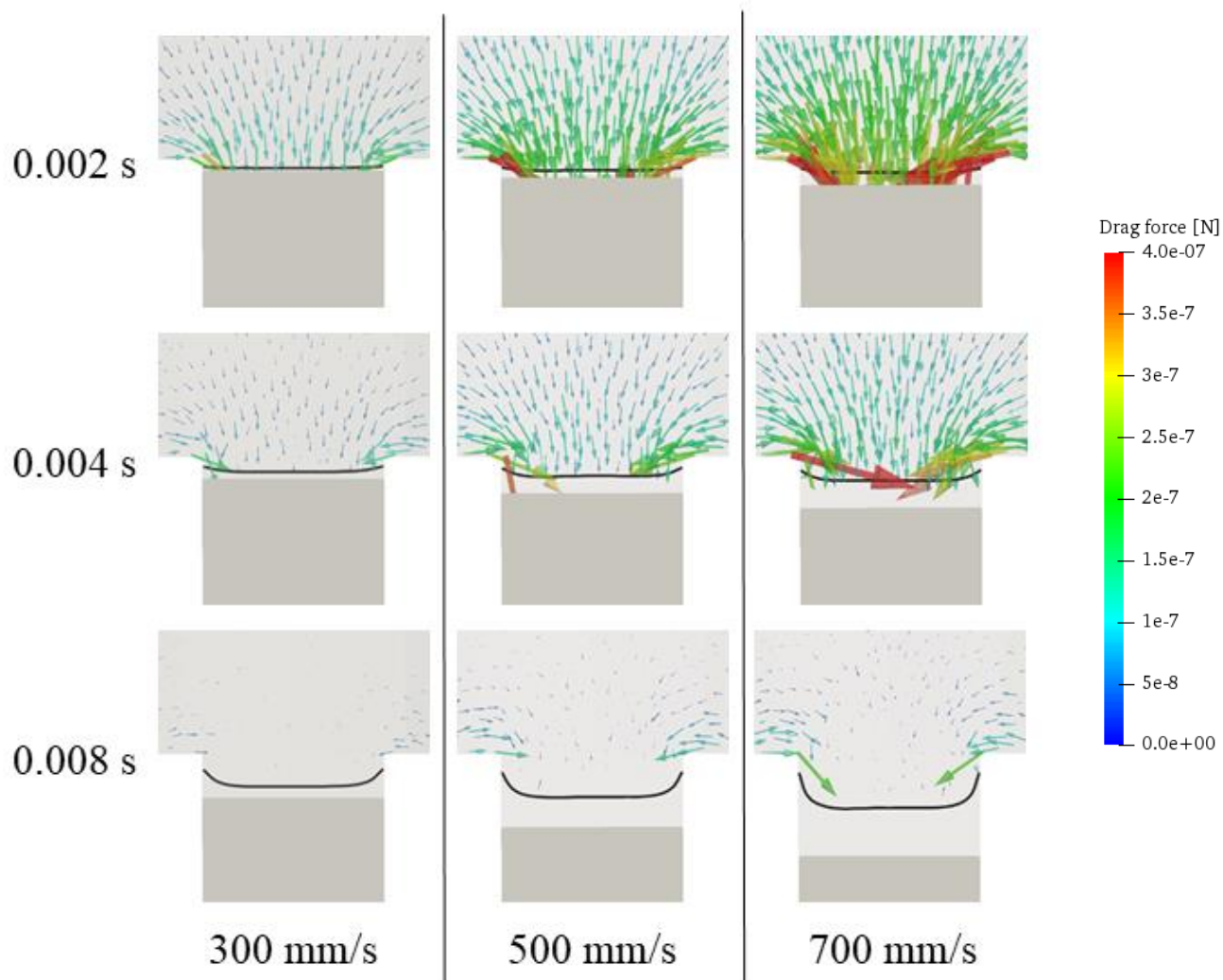


Figure 10. Drag force

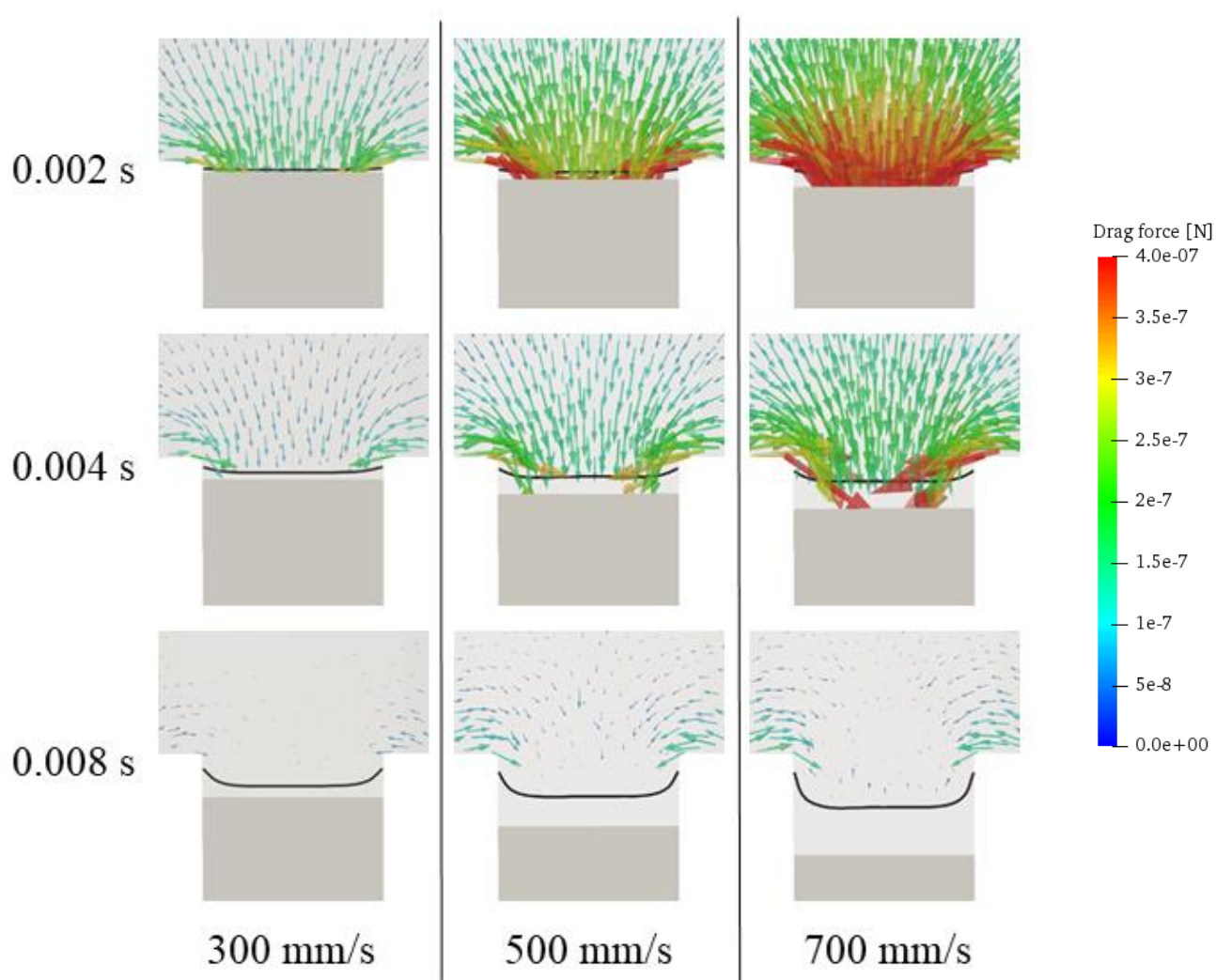


Figure 11. Pressure force

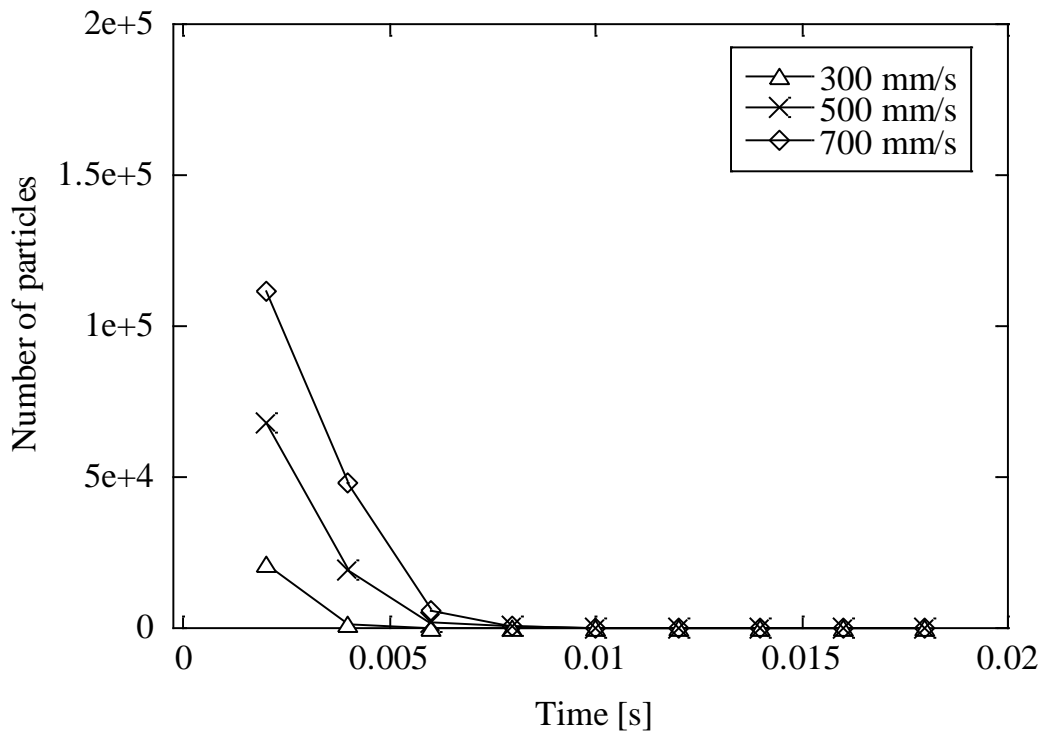


Figure 12. Number of suctioned particles by drag force

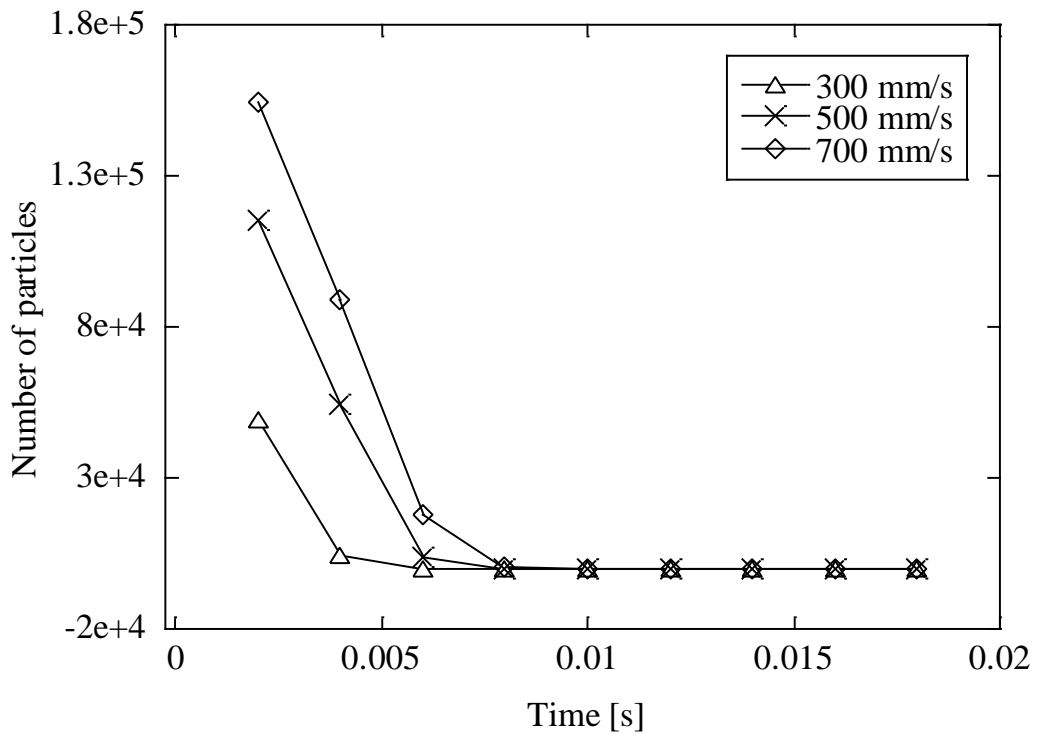


Figure 13. Number of suctioned particles by pressure gradient

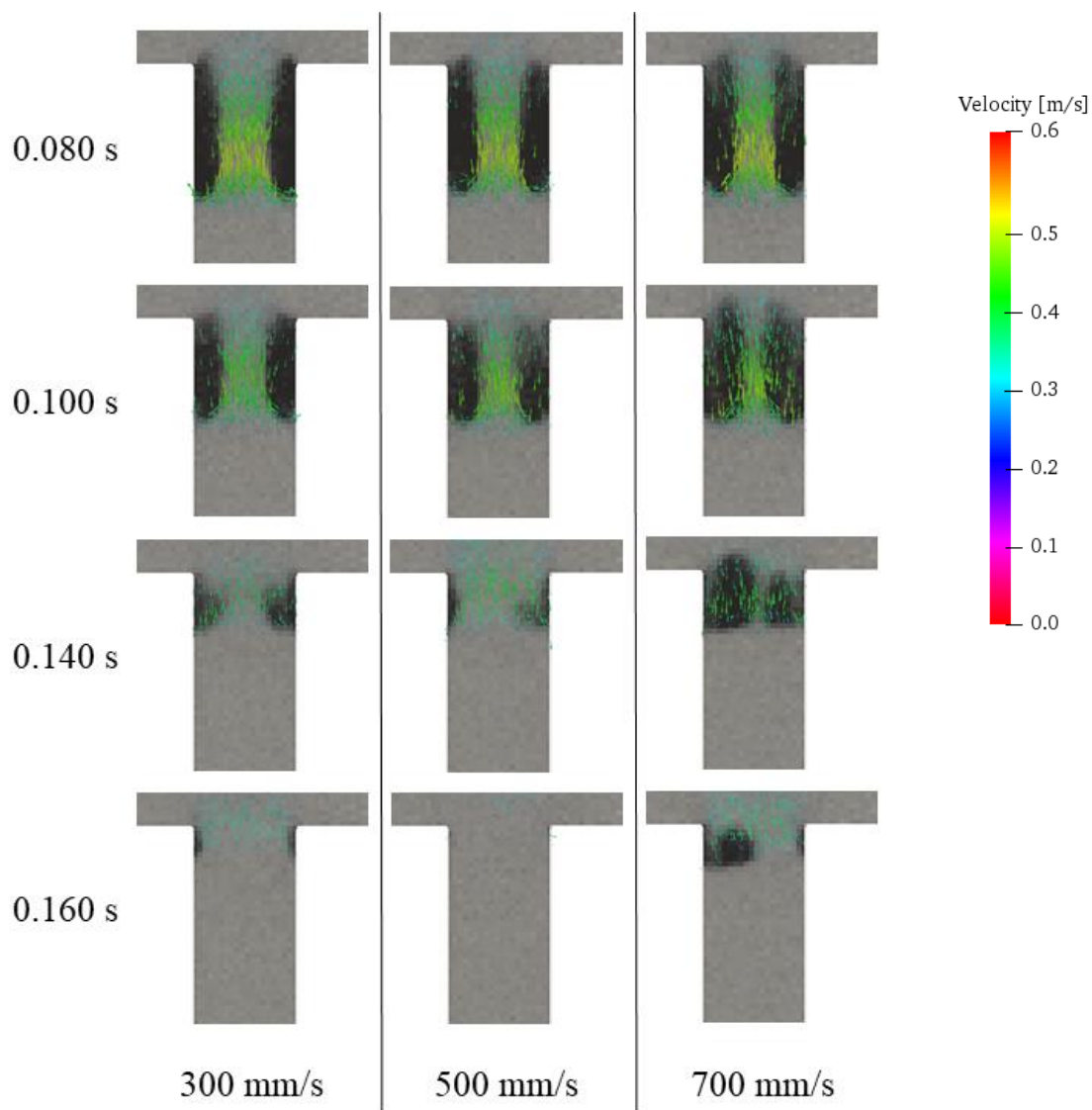


Figure 14. Bubble movement

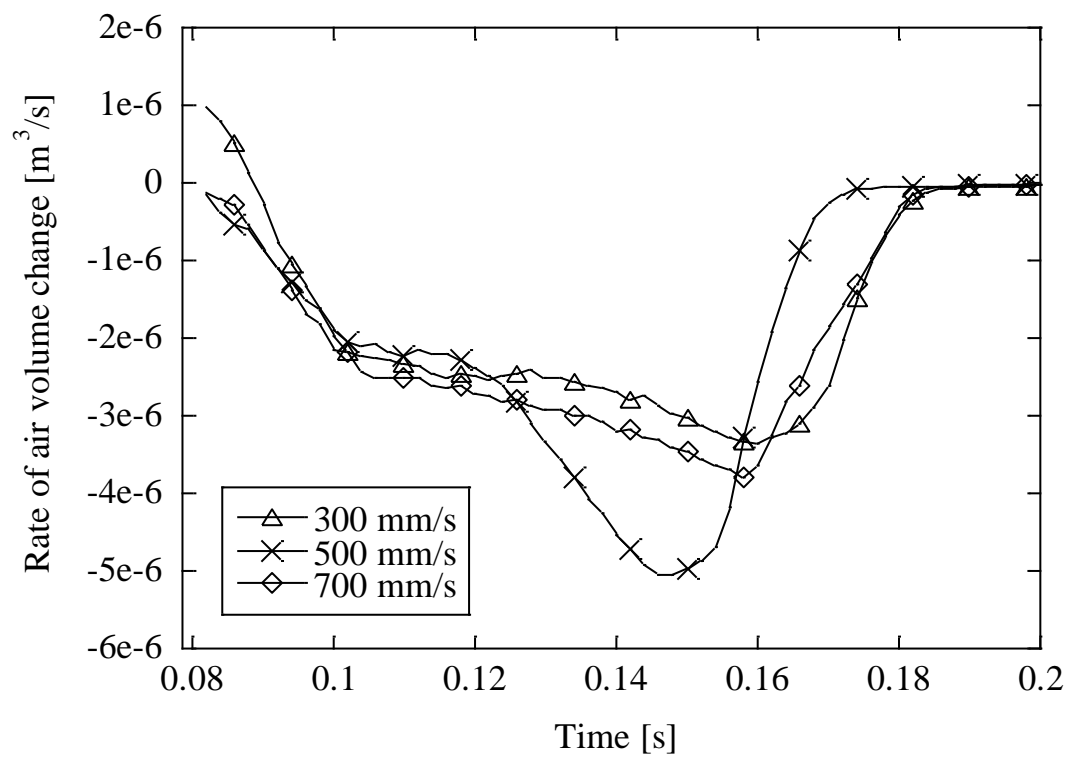


Figure 12. Rate of air volume change