CPC Extrusion: High Force or Filter Pressing?

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Abstract. Investigate CPC extrusion using delivered mass and composition alongside force. This note separates flow resistance from filter pressing and provides a comparison framework for the delivery system. A low extrusion force is insufficient when liquid and solids separate.

Keywords: CPC; extrusion; injectability; filter pressing; delivery system

1. Read the extrusion curve with the material

Needle geometry and powder-to-liquid ratio changed extrusion behavior in a specific TTCP/DCPD cement study [1]. For a new formulation, assess the paste and device as a system: barrel diameter, outlet, connector, needle length and elapsed time all belong in the comparison.

Collect the first, middle and last extruded portions separately. Compare their wet mass and solids fraction with the original paste, using a validated determination that does not confuse evaporated free liquid with changes in hydration water. A progressive composition shift indicates that delivered mass alone is misleading.

Illustrative calculation: loading 3.00 g and collecting 2.40 g gives 80.0% mass delivery. If the output is depleted in solids, this is not 80.0% delivery of the intended formulation. Report mass recovery and composition retention as separate results.

2. Run a controlled delivery comparison

2.1 Fix the device and clock. Use the same fill mass, barrel and plunger. Start timing at liquid contact; apply a defined mixing and loading sequence. Measure force at a fixed plunger speed. A smaller barrel may reduce required force at the same pressure but also changes delivered volume per unit travel.

2.2 Convert force carefully. For a 10.0 mm internal barrel diameter, area is 78.5 mm². An illustrative 100 N plunger force corresponds to 1.27 MPa nominal pressure. Seal friction means not all of this becomes paste pressure. Record the empty-device behavior if it contributes materially.

2.3 Change the suspected cause. If waiting time drives the failure, investigate the working window. If geometry dominates, compare suitable outlet dimensions. If separation occurs, investigate solids packing, liquid retention and dispersion. Adding more liquid may lower force while worsening composition drift, so repeat the fraction analysis.

3. Development decision

Select a usable interval in which both force and delivered composition remain acceptable. Define that interval with the intended device and temperature; do not report a single percentage as a material-wide injectability claim.

Table 1. Development comparison and interpretation controls.

Observed behavior	Working hypothesis	Discriminating check
Force rises with delay	Paste evolves during waiting	Test fresh mixes at fixed times
Force spikes abruptly	Local obstruction or clusters	Inspect outlet and retained paste
Watery first fraction	Phase separation under pressure	Compare fraction solids contents
High force from the start	Geometry or paste resistance	Repeat with a wider outlet

Scope. Force and pressure examples are calculations, not allowable clinical limits. Delivery-system and finished-product requirements remain application specific.

References

1. Burguera EF, Xu HHK, Sun L. Injectable calcium phosphate cement: Effects of powder-to-liquid ratio and needle size. J Biomed Mater Res B Appl Biomater. 2008;84(2):493-502. doi:10.1002/jbm.b.30896.

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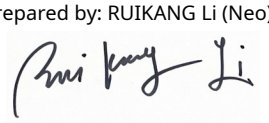

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