Porous CPC: Balancing Porogen and Binder

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Abstract. Adding a porogen also removes part of the cement binder from a fixed powder charge. This note tracks that change and outlines comparisons of pore formation, connectivity and mechanical retention. Recipe percentage should not be reported as measured open porosity.

Keywords: CPC; porogen; porosity; binder fraction; pore connectivity

1. Keep the replacement rule explicit

A published α-TCP system examined PLGA and sucrose together. Its total-powder compositions included 100% CPC, 80/20 CPC/sucrose, and 48/32/20 CPC/PLGA/sucrose [1]. These are distinct changes in binder amount and pore-forming components, not a single-variable sucrose comparison.

For an original, simpler first screen, replace 0, 10 and 20 mass% of one fixed reactive powder with one fixed porogen. Keep the porogen size fraction constant. This tests a practical replacement series, while recognizing that both cement mass and packing change.

Illustrative arithmetic: 10.0 g total solids with 3.0 mL liquid gives L/P = 0.30 mL/g at every level. Yet liquid per gram of reactive cement rises from 0.300 to 0.333 to 0.375 mL/g as porogen increases. Include this second ratio so a strength change is not attributed only to pores.

2. Follow pore opening over time

2.1 Measure before and after removal. Compare hardened specimens before extraction and after a defined extraction or degradation interval. Record solution, renewal schedule, temperature and specimen dimensions. A pore former that remains in place at the test time has not yet created its full accessible pore network.

2.2 Measure connectivity, not only area. Section images show local voids but cannot establish through-connected transport. Combine suitable three-dimensional or open-porosity measurements with uptake or permeability when transport matters. Report the resolution limit; pores below it are not proven absent.

2.3 Retain a mechanical time series. Measure wet mechanical behavior at the same stages used for pore analysis. Normalize comparison by geometry and loading method. A formulation that is strong before porogen removal may become fragile after channels open; a dry endpoint alone misses this transition.

3. Development decision

Advance the lowest porogen content that creates the required accessible network while retaining the intended handling and mechanical margin. If connectivity remains poor, change porogen size or distribution before simply removing more binder.

Table 1. Development comparison and interpretation controls.

Total solids 10 g	Cement / porogen	Liquid per reactive cement
0 wt% porogen	10.0 / 0 g	0.300 mL/g
10 wt% porogen	9.0 / 1.0 g	0.333 mL/g
20 wt% porogen	8.0 / 2.0 g	0.375 mL/g
Matched-liquid control	Adjust liquid separately	Separates part of dilution effect

Scope. The 0/10/20 series is a proposed screen, not a reproduction of the cited study. Porogen chemistry, residuals and biological suitability need separate assessment.

References

1. Lodoso-Torrecilla I, van Gestel NAP, Diaz-Gomez L, Grosfeld EC, Laperre K, Wolke JGC, et al. Multimodal pore formation in calcium phosphate cements. J Biomed Mater Res A. 2018;106(2):500-509. doi:10.1002/jbm.a.36245.

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