

**Supplementary material**

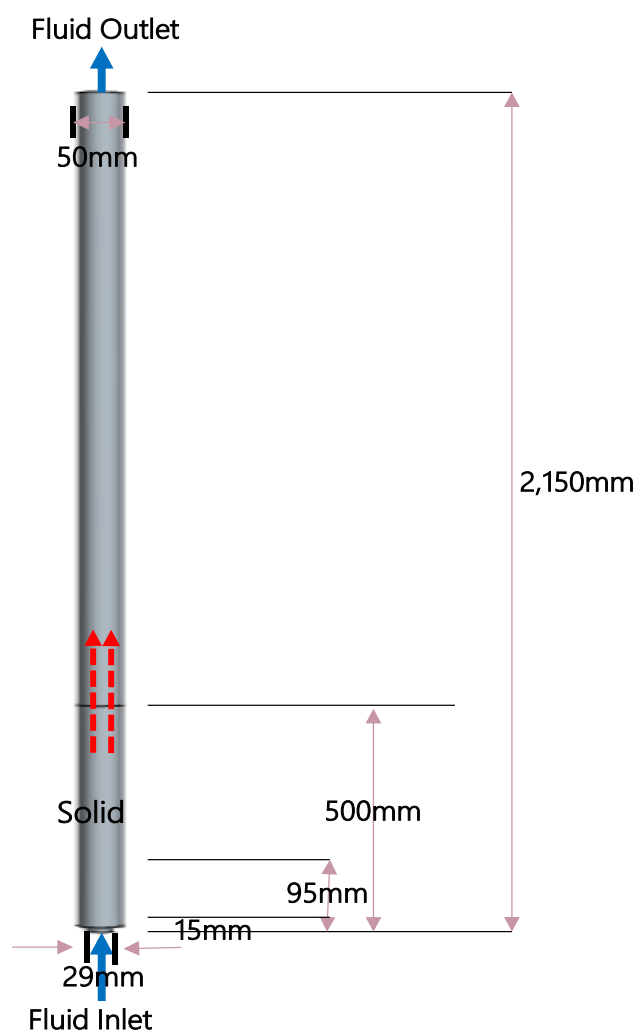
**Process intensification for enhanced fluoride removal and recovery as calcium fluoride  
using fluidized bed reactor**

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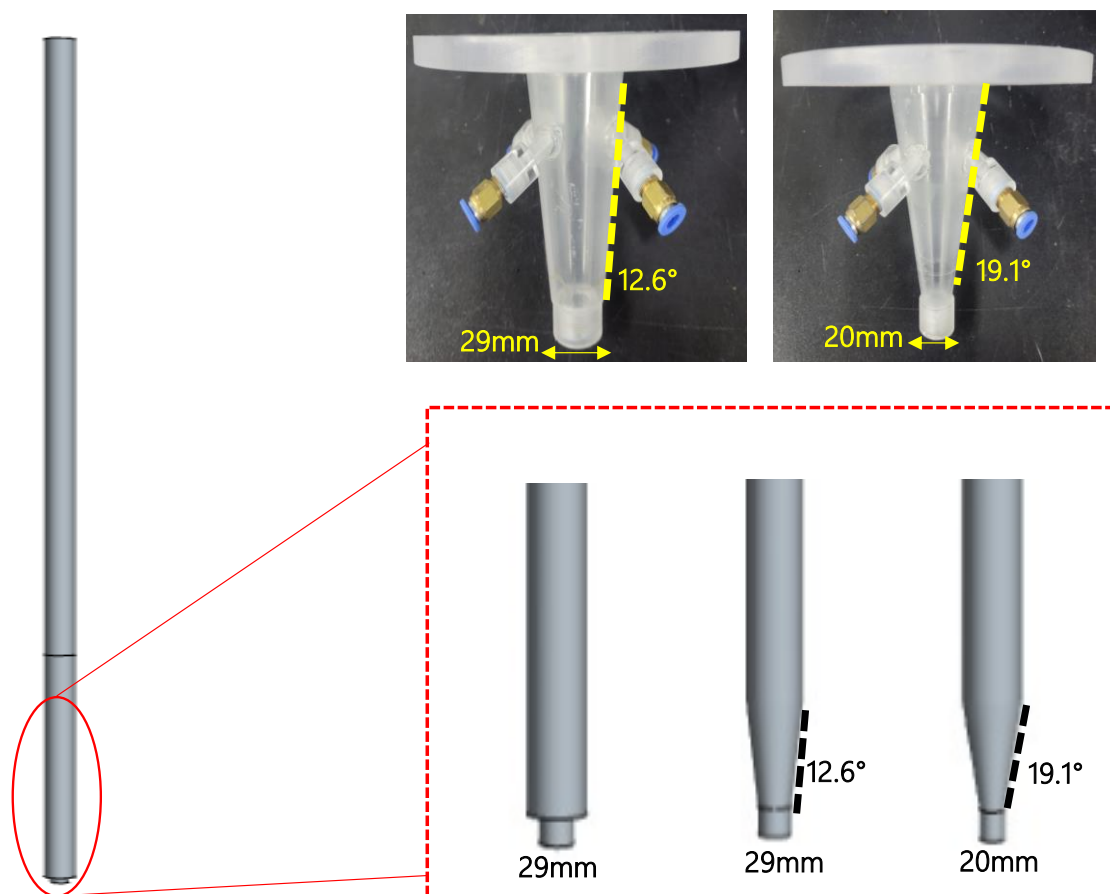
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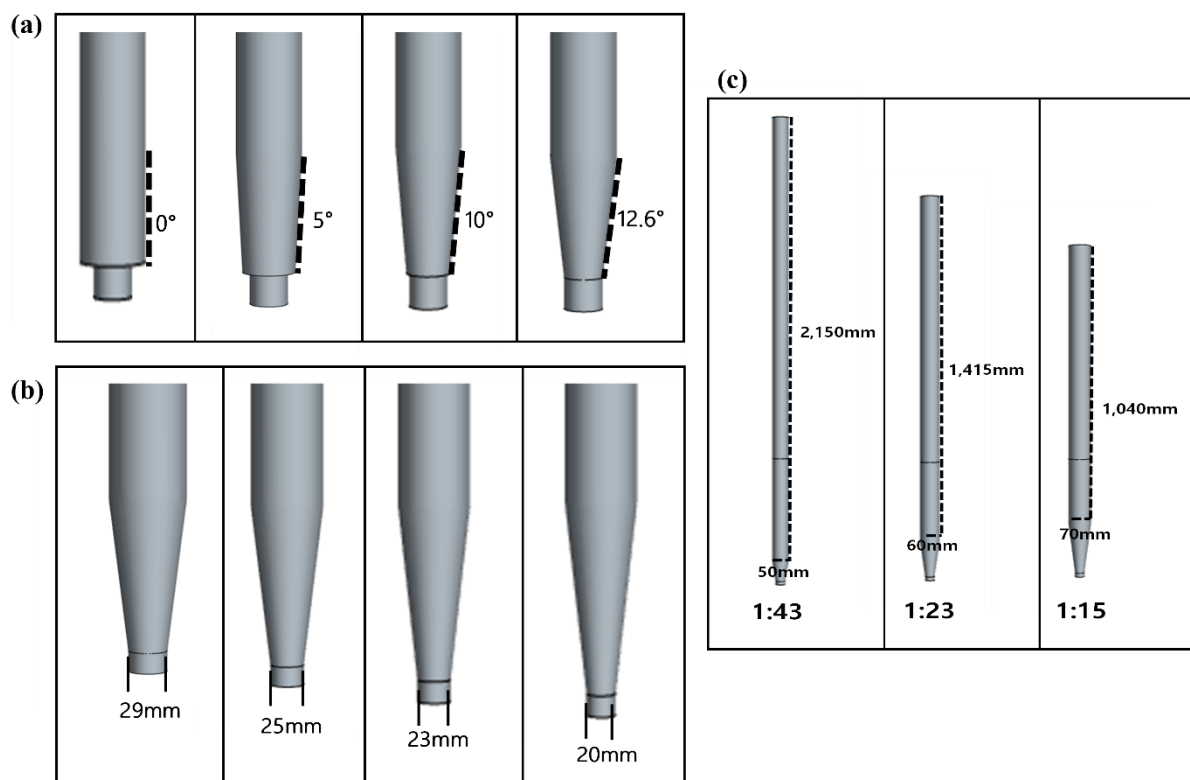
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**Figure S1.** Configuration of reactor used for CFD numerical analysis.



**Figure S2.** Configuration taken for CFD simulation under different conditions along with actual images of the reactor bottom.



**Figure S3.** Different reactor configuration taken for CFD simulation to optimize shape of the FBR treating fluoride containing wastewater. (a) different shape of the bottom of the reactor (according to the reactor bottom angle), (b) different reactor inlet diameter, and (c) different width to height ratio of the reactor.

### **Calculation of CaF<sub>2</sub> purity**

The purity of CaF<sub>2</sub> crystals = Total amount of the calcium fluoride crystals (assuming it to be 100 g) – amount of calcium present in the crystals with compounds other than CaF<sub>2</sub> (g) – all the other elements detected in ICP-OES apart from Ca and F (g)

The purity is calculated by first measuring the other compounds as given below:

Amount of Ca (in mol):  $53.2 \text{ g} / (40 \text{ g/mol}) = 1.33 \text{ mol}$

Amount of F (in mol):  $44.4 \text{ g} / (19 \text{ g/mol}) = 2.336 \text{ mol}$

As per the chemical formula for 2.336 mol of F 1.168 mol of Ca will be present in CaF<sub>2</sub>.

Hence the remaining amount of Ca is:  $1.33 \text{ mol} - 1.168 \text{ mol} = 0.162 \text{ mol} \times 40 \text{ g/mol} = 6.48 \text{ g}$

The purity of CaF<sub>2</sub> crystals:  $100 \text{ g} - 6.48 \text{ g} - (0.18 \text{ g} + 0.27 \text{ g} + 0.56 \text{ g} + 0.36 \text{ g} + 0.05 \text{ g} + 0.47 \text{ g} + 0.51 \text{ g}) = 91.12 \text{ g}$  which will be **91.12 % purity** as total amount of the calcium fluoride crystals is assumed to be 100 g.