# Developing a Ceramic Water Filter

Jean Simonis

## Special Reminders

**Safety**

Use lab coat for processing and finishing steps

Surgical gloves when handling final product

Leather gloves or clamp tool when loading and off-loading kiln

☐ Picture on front side

☐$_1$ Carbon former

☐$_1$ Plaster moulds

☐$_1$ Slip Casting

☐$_1$ Pre- Firing

⌗$_1$ Enlarged picture on reverse side

⌗$_1$ Milled PSD

⌗$_2$ Permeability

⌗$_3$ Finishing

⌗$_4$ Operating filter

⌗$_5$ Micro-biological testing

Related SOPs,.

PFM 1: Microbiological Testing

PFM 2: Constant Head Permeability

PFM 3: AP, WA, ASG, BD testing by boiling wate

## Procedure Overview

1 Source and prepare raw materials

2 Make and condition mould

3 Cast the slip into plaster moulds

4 Dry and pre-fire the product

5 Fire the product

6 Finish and glue filter to plastic fitting

7 QA Test the filters

8 Assemble filter system

## Instructions & Explanations

1.1 Batch raw material (RM)

1.2 Prepare RM by ball milling into 2 fractions ⌗$_1$

1.3 Add carbon source to milled fractions and condition for 1hr in ball mill. ☐$_1$

1.4 Remove from mill and pour into slow RPM planetary mixer.

1.5 Test for flow and slip density

2.1 Clean master mould

2.2 Position master on clean glass plate and centralize PVC pipe ring around master.

2.3 Close all gaps between plate and PVC ring with sticky plaster

2.4 Mix plaster into water (2:1 ratio), remove all lumps. Cast into mould and wait for hydration to start (plaster heats-up)

2.5 Remove master using a twisting action

2.6 Leave overnight to harden then dry for 24 hr at 50ºC ☐$_2$

2.7 Pour water into mould and decant immediately

3.1 Remove slip from mixer into beaker, pour into plaster moulds.

3.2 Keep mould full and leave slip in mould until sufficient wall thickness has been achieved

3.3 Decant excess slip and leave up-side down for casting to dry and excess slip to drain ☐$_3$

3.4 Strip product, and place in drier at 90ºC ☐$_2$

4.1 Remove product from drier (24 hr) ⚠

4.2 Pack filters on expanded metal trays in kiln

4.3 Pre-fire using pre-determined firing cycle

4.4 Ensure that kiln is well ventilated for removal of volatiles ☐$_4$ ⚠

5.1 Check for cracks or defects

5.2 Cover kiln trays with 3-5mm layer of fused silica fines. Re-pack onto kiln trays.

5.3 Fire using pre-determined firing cycle ☐$_4$ ⚠

6.1 Use surgical gloves when handling and inspecting for cracks or defects.

6.2 Finish filter on disk sander, ensure that product bottom is sanded evenly ⌗$_3$

6.3 Drill 1.5mm hole in plastic flange

6.4 Heat-seal screen onto flange opening.

6.5 Clean plastic with acetone to remove oil layer.

6.6 Brush primer (Primer 3-N) on filter base. Leave to stand for 2 hours.

6.7 Fill ceramic with activated carbon granules.

6.8 Glue ceramic onto plastic fitting and remove excess glue. Leave to dry for 24 hr and package.

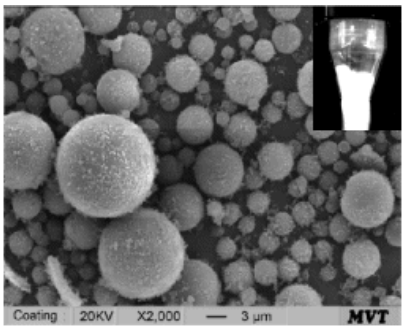
7.1 Determine porosity, water absorption, specific gravity and bulk density of the filter ⌗$_2$ & 4

7.2 Perform constant head permeability test on filter

7.3 Conduct microbiological testing of the filtrate ⌗$_5$

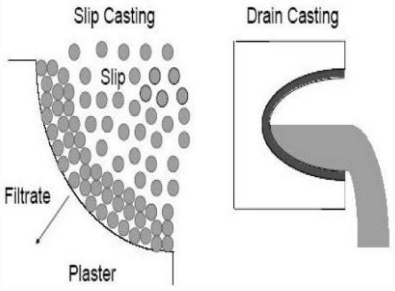
8.1 Drill holes in buckets and lid for filters and tap. Assemble and package

☐$_1$ **1.3** Carbon pore-former

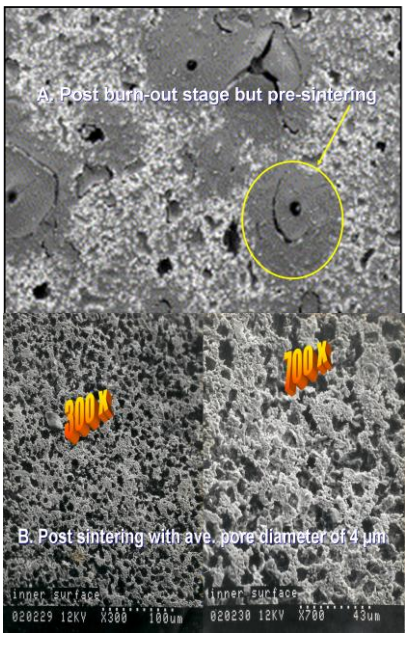



☐$_2$ **2.6** Moulds and product after stripping

☐$_3$ **3.3** Slip casting process




☐$_4$ **4.4** Pre- and final firing



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## ✓ Pre-Checks (Things to check before starting this process)

- ☐ Raw material particle size distribution
- ☐ Plaster mould cleanliness and state of drying

## Tools & Materials Required

| ID | Qty | Description | Step |
|---|---|---|---|
| | 1 | ☐ Ball Mill | 1 |
| | 1 | ☐ Planetary Mixer | 1 & 3 |

## ✓ Post-Checks (Things to check after completion)

- ☐ 100% Inspection for cracked items (reject all items with cracks)
- ☐ Apparent Porosity, water absorption, specific gravity test results

| Sample Type | (%) AP | (%) WA | (g/cm3) ASG | (g/cm3) BD | Remarks |
|---|---|---|---|---|---|
| Standard 1 | 68 | 86 | 2.44 | 79 | Standard Filter (carbon as pore former) |
| Benchmark | 67 | 78 | 2.65 | 86 | Benchmark |

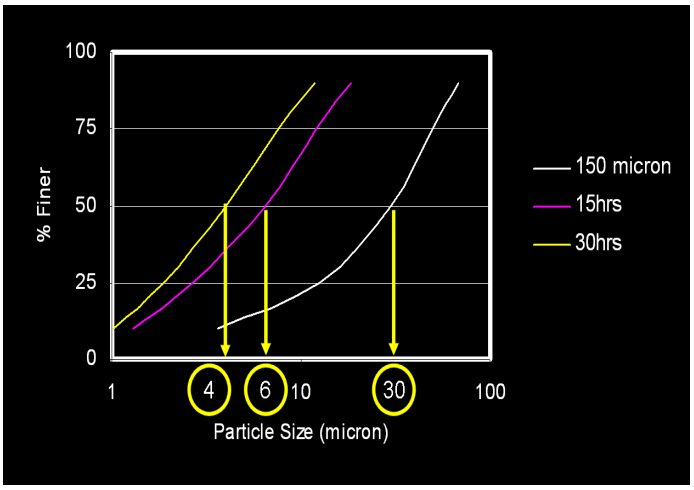
*Note: AP – apparent porosity; WA – water absorption; ASG – apparent specific gravity & BD – bulk density*

- ☐ Pore Size Distribution

| Standard | Median | Average | SSA (m2/g) |
|---|---|---|---|
| AVE | 0.07µm | 4µm | 10 m2/g |

- ☐ Microbiological test results (See Table at bottom of page)

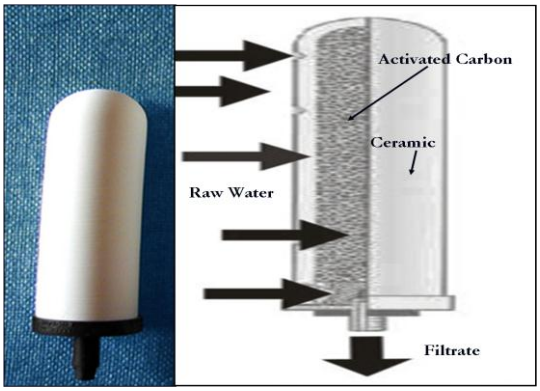
### 1 1 PSD of milled raw material




### 2 7 Filter permeability testing

### 3 6 Finishing of the filter

### 4 7 Operating the filter




### 5 7 Microbiological Testing

| Type | Influent water (CFU/ml) | Filter Type: Effluent Filtrate (% retained) Standard | PSD | Coated | Silver | Dex | Benchmark |
|---|---|---|---|---|---|---|---|
| *E. coli* | 6 x $10^6$ | 99.99968 | 100 | 100 | 100 | 100 | 99.929783 |
| *S. feacalis* | 1,49x $10^4$ | 100 | | 100 | 100 | 99.99329 | 96.630872 |
| *B. cereus* | 1.06 x $10^6$ | 99.97712 | | 100 | 99.9794 | 100 | 100 |
| *Sewage* | 4,6 x $10^3$ | 100 | | 100 | 100 | 99.1139 | 99.697428 |