XATICO PERFORMANCE MINERALS

SEMINAR ON GEOPOLYMERS

by Carine LEFEVRE

OUR GROUP

- **Foundation** : 2006
- **Activity** : Benelux, Germany, France, Spain, Portugal, Italy, Switzerland, Austria, Scandinavia, Baltics and the UK
- **Turnover** : 5,5 mio € per year
- **8.300 MT** sold per year
- ~ **500 active** customers
- **6 warehouses**
- **Collaboration** with external **laboratories**

OUR PRODUCTS

- Aluminium Trihydrate (ATH)
- Attapulgite
- Barium Sulphate (Barite)
- Bentonite
- Silicate based inorganic binding agents (Betol®)
- Betolin® - Sapetin® - Sikalon®
- Calcined Neuburg Siliceous Earth
- Calcium Carbonate (Cacite – Marble)
- Calcium Sulphate Anhydrite
- Collosil® – Special Adhesives
- Diatomaceous Earth
- Dolomite
- Geosil®
- Kaolin
- Ligasil® - Stabisil®
- Magnesium Hydroxide
- Metakaolin
- Metal Stearates
- Mica
- Natural Silica
- Nepheline Synite
- Neuburg Siliceous Earth
- Perlite
- Precipitated Silica
- Synthetic Sodium Magnesium Aluminium Silicate
- Talc
- Vermiculite
- Wollastonite
- Zeolite
- Zinc Borate
- Zinc Hydroxy Stannate
- Zinc Stannate

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FORMATION OF GEOPOLYMER

- The geopolymer is formed by reaction between an alkali silicate and an amorphous aluminosilicate
- The aluminosilicate is the hardener
- Alkali silicate = Geosil®

Stage 1
- Dissolution

Stage 2
- reorganisation

Stage 3
- Polymerisation

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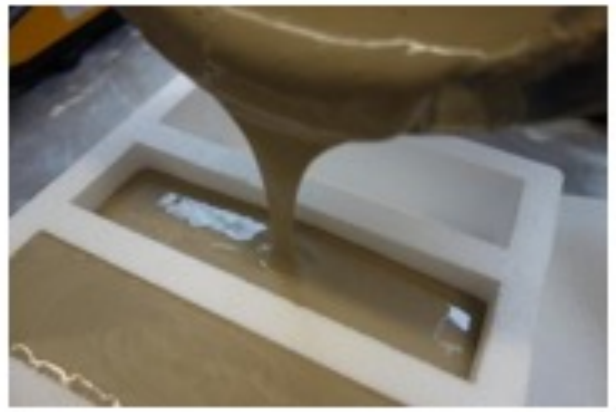
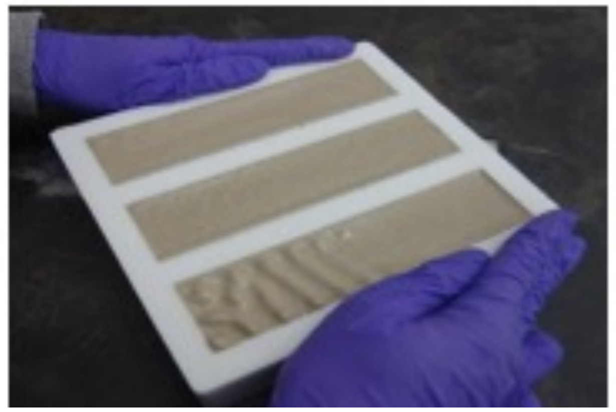
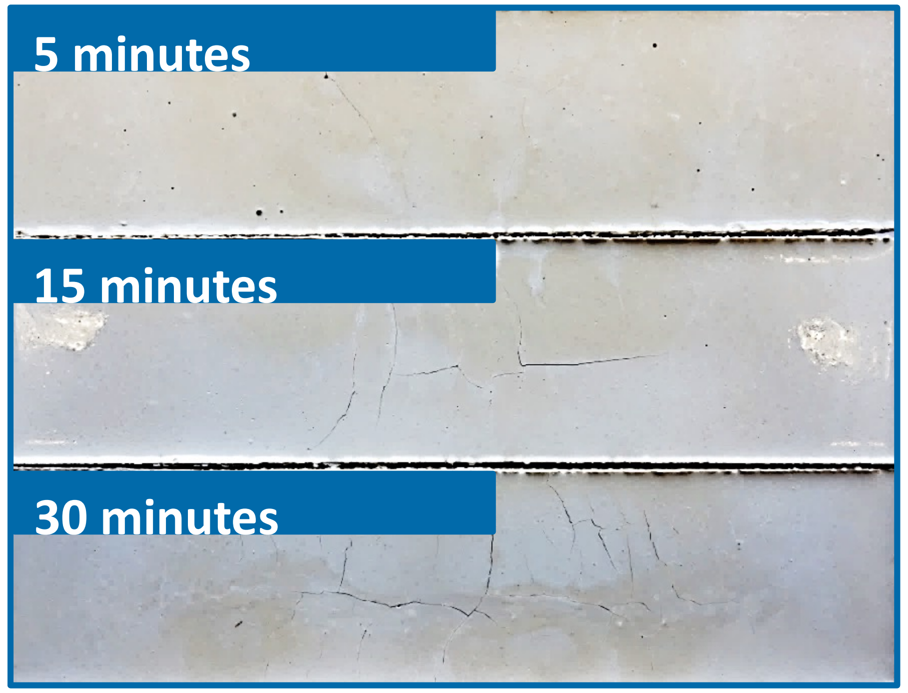
PARAMETERS INFLUENCING GEOPOLYMERISATION





- Composition of the hardener and the various mineral fillers added
  - Particle size
  - Composition in amorphous phase
  - Composition in SiO_2 and Al_2O_3
- Nature and composition of the alkali silicate (molar ratio and nature)
- Solid/liquid ratio
- Cross-linking temperature
- Humidity condition
- Time of mixing



ALUMINOSILICATES

- Materials rich in silica and alumina: SiO_2 + Al_2O_3> 80%
- Synthetic: metakaolin, fly-ash, calcinated by-products
- Mining, calcination process and milling will influence the final properties
- The more amorphous the material is, the more reactive it will be
- Acts as a hardener in the geopolymer formulation

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METAKAOLIN

Material delivered from kaolin which is dehydrated by heat treatment

- With heat, water is released from the crystalline structure
- This step generates the disappearance of the crystalline structure of kaolinite
- This disorganisation allows its reactivity

There are several industrial processes to calcine a kaolin clay

- Continuous furnaces (rotary kiln): residence time ~ 2h
- Flash kilns: residence time few second

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REAKTIVITY OF METAKAOLIN

- Their reactivities have been tested according to the standard method

https://www.geopolymer.org/news/26-standardized-method-in-testing-commercial-metakaolins-for-geopolymer-formulations/

Reactivity test, observing exothermicity

Sample: 100 g of K-silicate MR=1.7, 60 g of metakaolin,
10 min. mixing, 1 hour at 80°C
Blank: 55 g of water, 60 g of metakaolin

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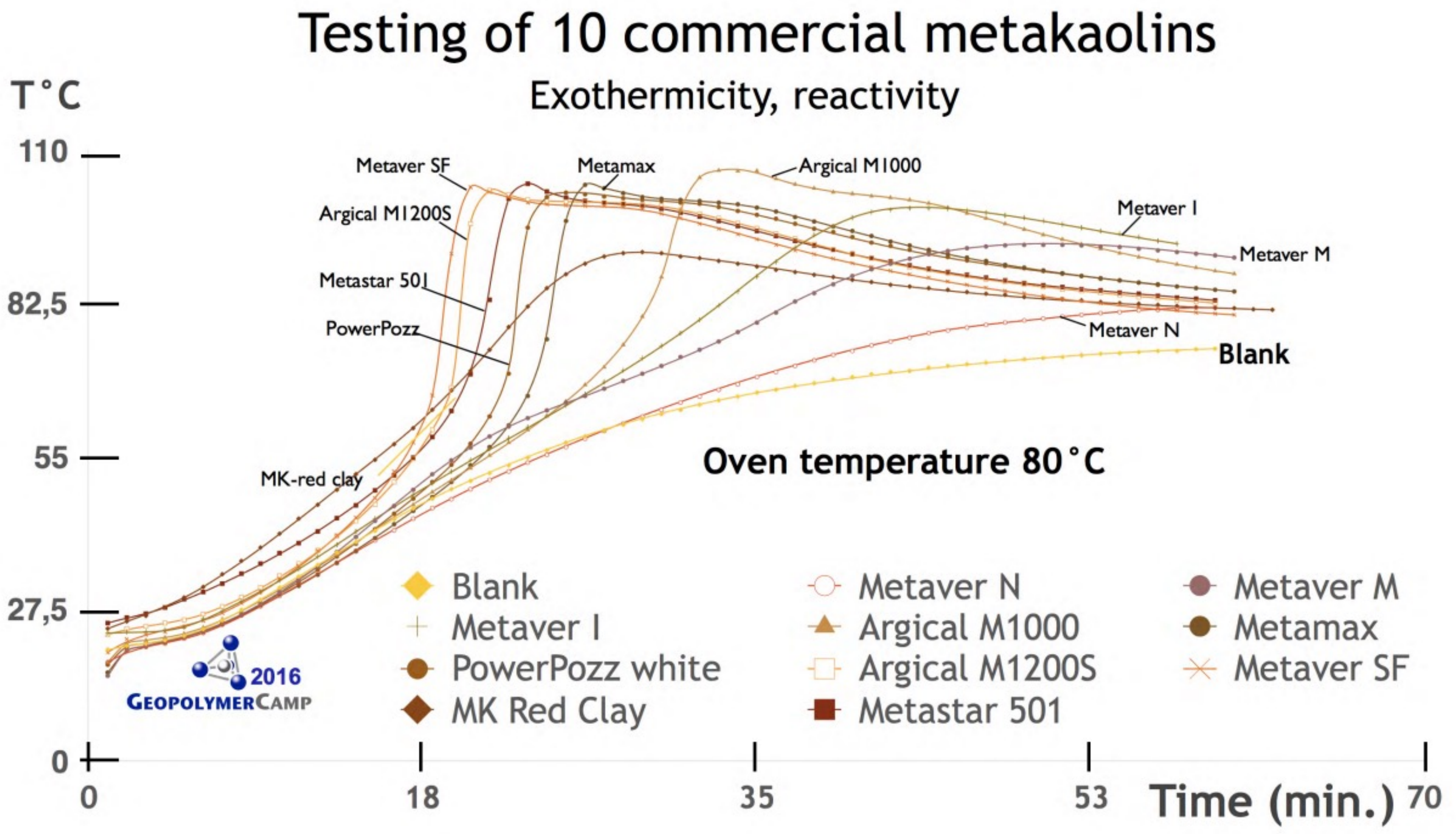
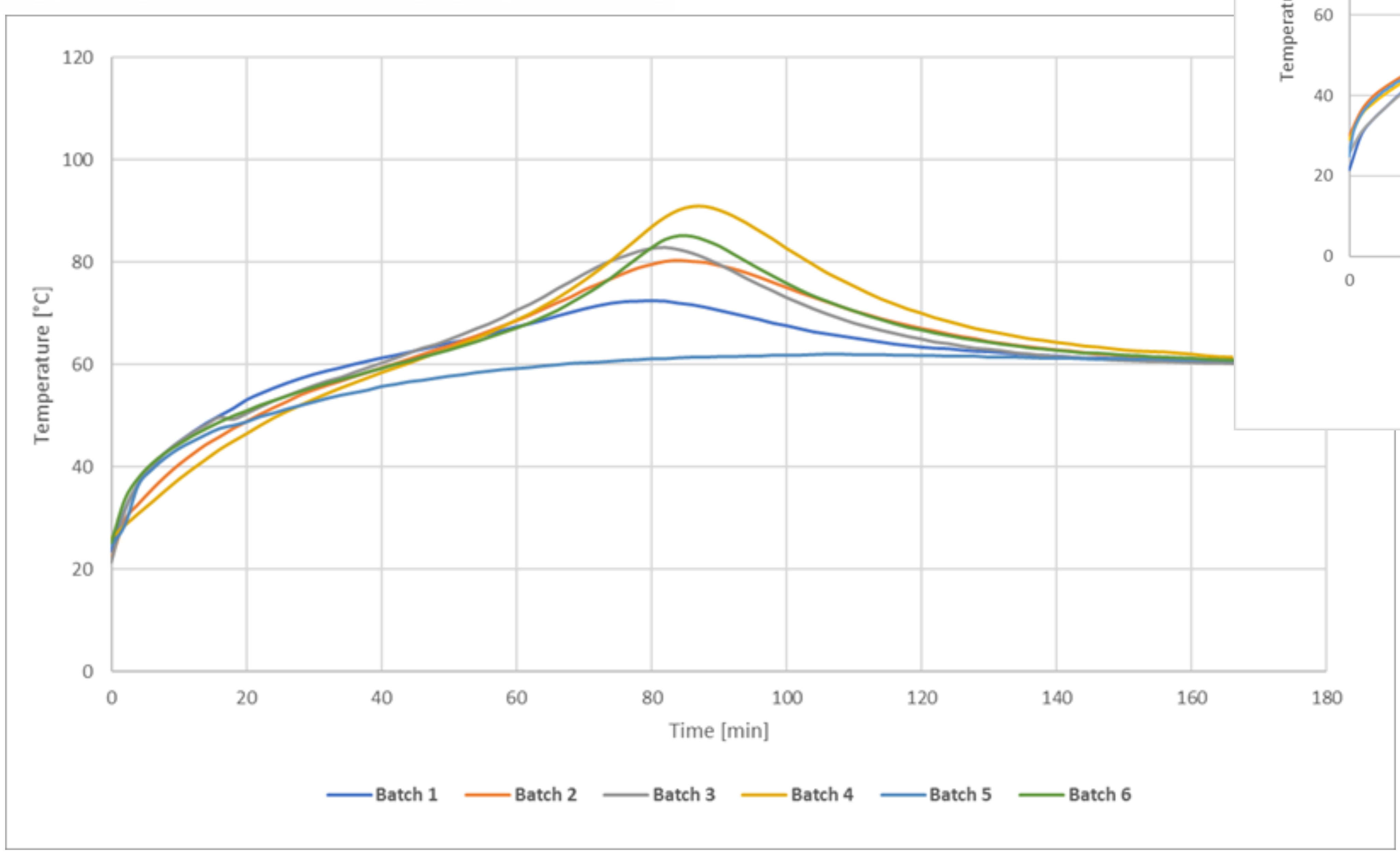
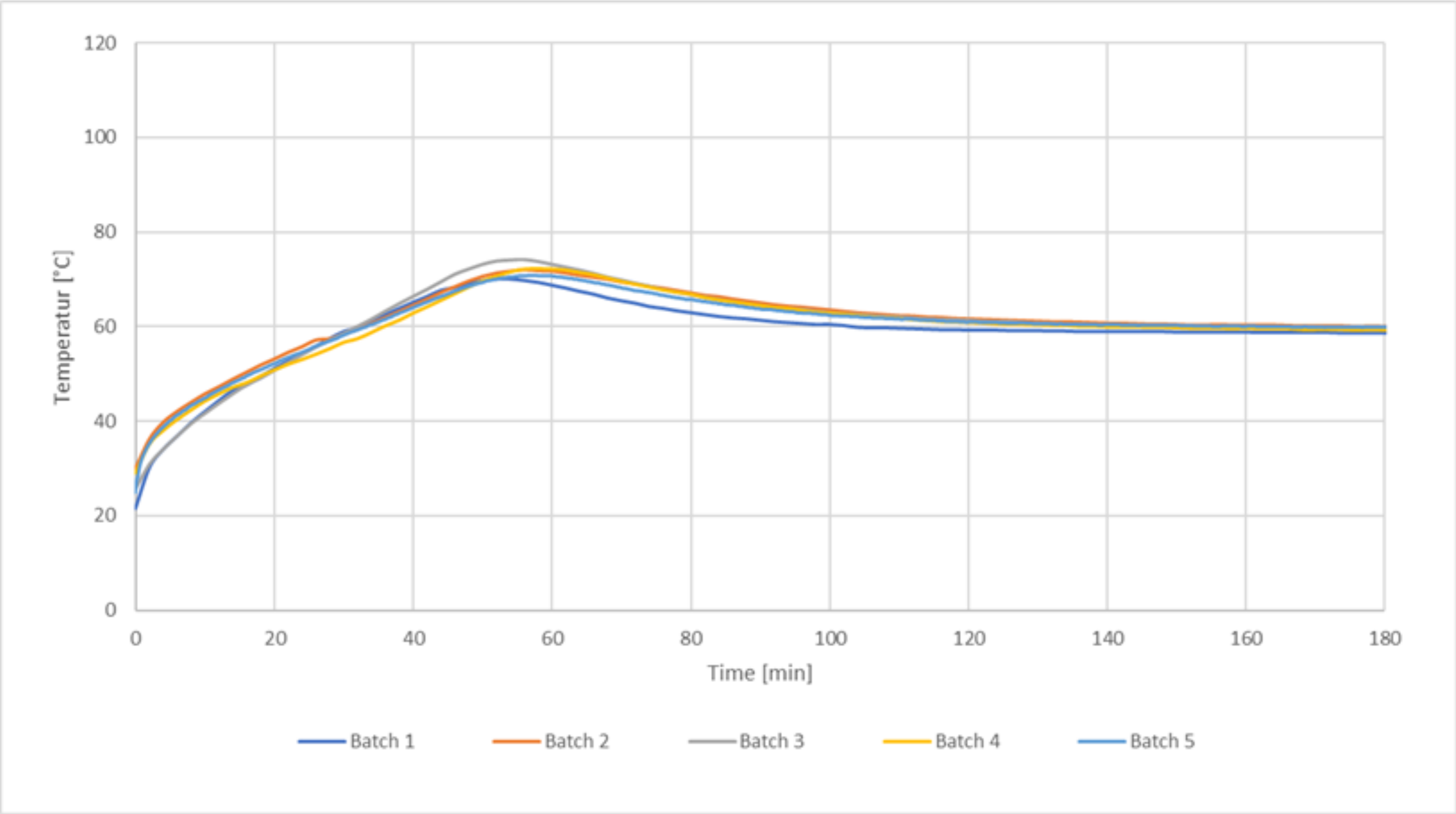
REACTIVITY OF METAKAOLIN



Variation from batch to batch



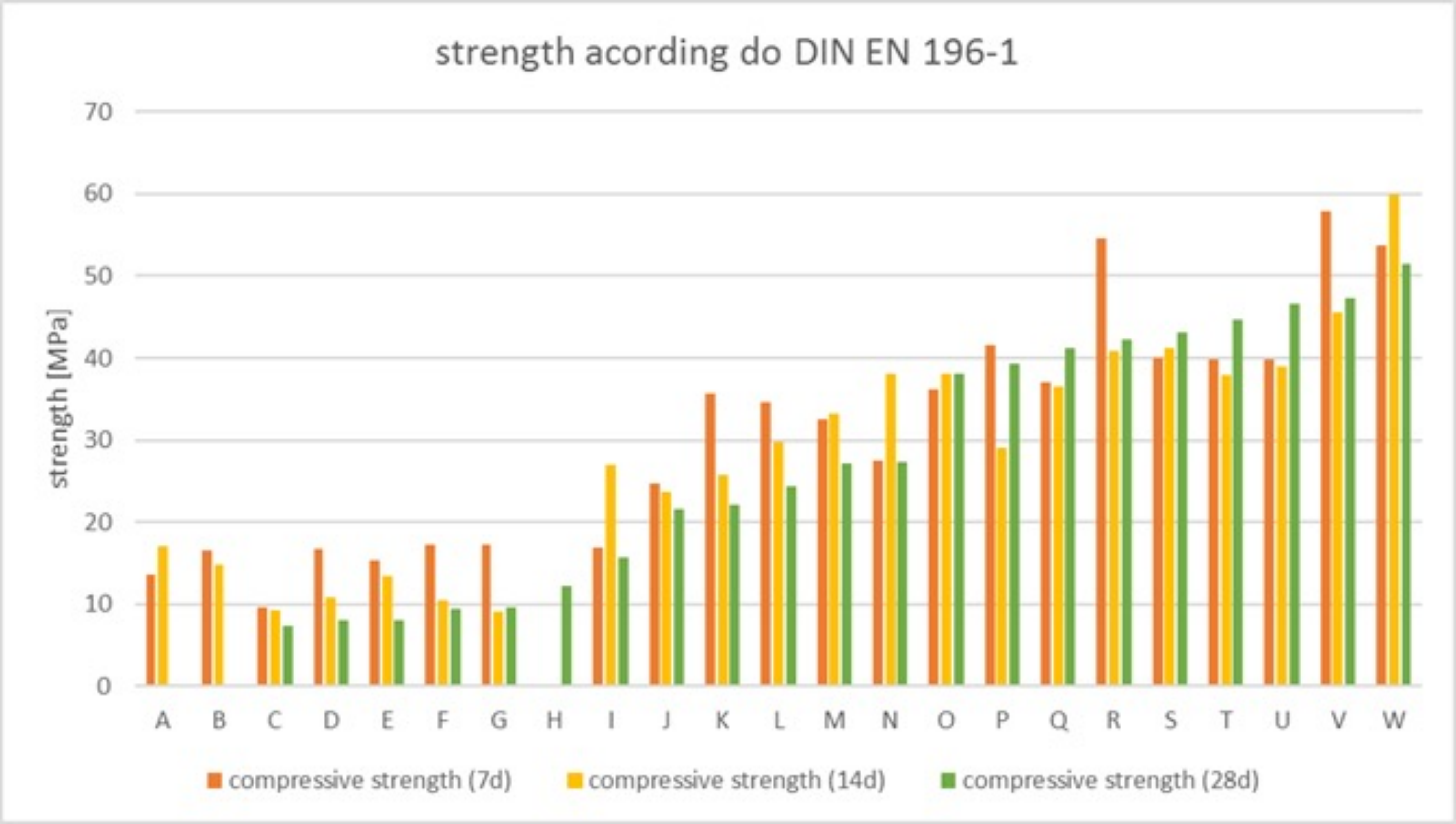
Poor reproducibility from batch to batch



Reproducibility from batch to batch

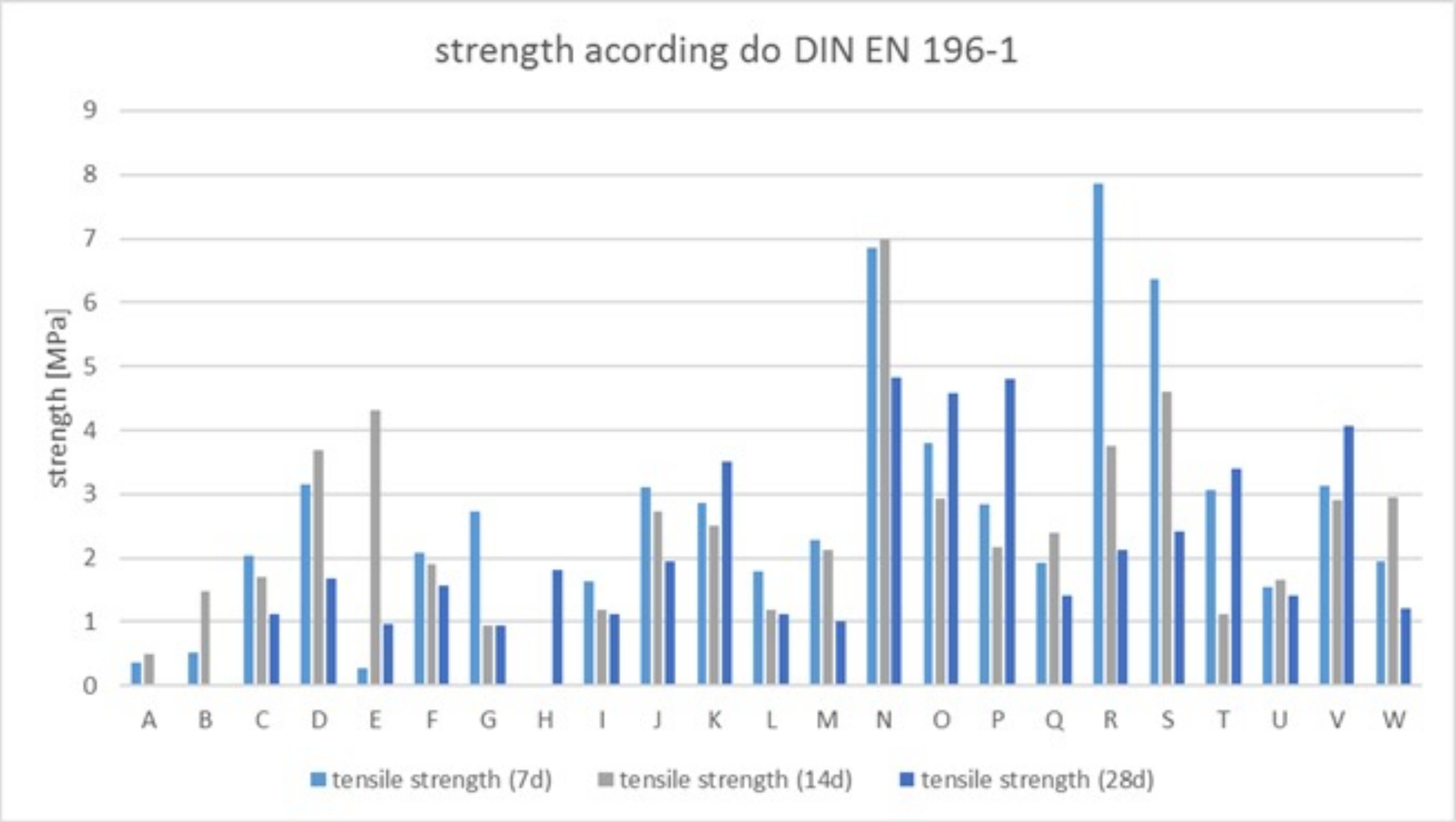
COMPRESSIVE STRENGTH

Compressive strength of 23 different Metakaolins mixed 55/45 with Geosil 14517



TENSILE STRENGTH

Tensile strength of 23 different Metakaolins mixed 55/45 with Geosil 14517.



INORGANIC FILLERS

Mineral fillers and reinforcements used to form a geopolymer composite

Fillers	Morphology	Material	Comment
Mineral fillers	Spherical shape Tubular	Silica Alumine Feldspar	Reinforcement Inert & thermal stability Reinforcement
Mineral fillers	Acicular shape	Wollastonite	Passive anti-corrosion pigment - Reinforcement
Mineral fillers	Lamellar shape	Mica	High lamellarity – Chemically inert – High T° resistance
Mineral Fibers	Various length	Basalte	Reinforcement
Mineral Fillers	Powder Microsphere	Glass Basalt	Corrosion resistant Hydrophil (no surface treatment) – Smoothing cements

INORGANIC ADDITIVES

- Feldspar : is produced from naturally occurring combination of alumina and silicate having mix oxides and no free crystalline silica. This material is hard and has angular particles that create a rigid reinforcing network (tubular grain).

  Various composition (aluminosilicate sodium, potassium or calcium)

  Few particle size available

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INORGANIC ADDITIVES

- Wollastonite : natural calcium silicate that can form needle shape during its genesis (acicular structure)

SiO_2	Al_2O_3	Fe_2O_3	CaO	d50	d98	Blancheur*
> 44%		< 0,3%	> 49%	21 µm 33 µm 18 µm 8 µm	189 µm 136 µm 78 µm 37 µm	75% 87% 91% 86%

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* Datacolor 200M, D65, 10°

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INORGANIC ADDITIVES

- Mica: Muscovite – high lamellarity – power & flakes

SiO_2	Al_2O_3	Fe_2O_3	K_20	Na_2O	MgO
46%	32%	< 5%	11%	0,30%	0,20%

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INORGANIC ADDITIVES

Silica SiO_2

It exists in the free state in different crystalline, amorphous or combined forms. In silicates, SiO_2 groups are linked to other elements: Al, Fe, Mg, Ca, Na and K.

Amorphous silica can be used as an additive.

Silicious earth of Neuburg – Sillitin V85

SIO_2	AL_2O_3	Fe_2O_3	Amorphous phase
87%	8%	<1%	8%

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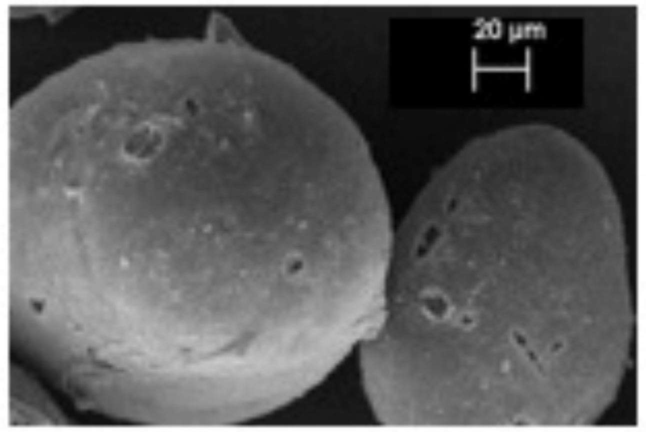
INORGANIC ADDITIVES

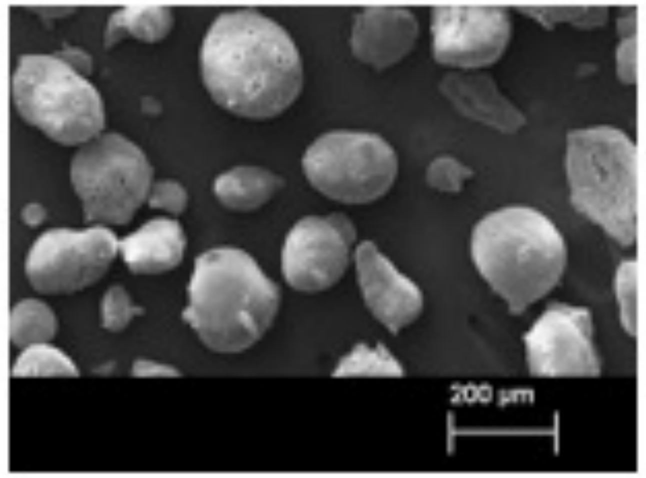
Hollow mineral spheres of the aluminosilicate group

Various granulometry

- 50-180µm
- 50-300µm
- 250-500µm
- 500-1000µm

SIO_2	AL_2O_3	Fe_2O_3	CaO	K_2O	Na_2O
74%	13%	2%	2%	4%	4%





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INORGANIC ADDITIVES

Basalt fibers

SiO_2	Al_2O_3	Fe_2O_3	CaO
74,28%			0,90%

Perlite

Microspheres:

volcanic origin

SiO_2	Al_2O_3	Fe_2O_3	CaO + MgO
70-80%	12,80%	0,90%	18-25%

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TANK YOU FOR YOUR ATTENTION

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