New abrasive tools fixed by hybrid binder on base of inorganic polymers

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Classic abrasives tools

Matrix:

- Ceramic bonds:
  - Advantages: high mechanical strengths
  - Disadvantages: high manufacturing costs (firing - 1250°C, 10 hours)

- Epoxy resin bonds:
  - Advantages: lower manufacturing costs, quickly production
  - Disadvantages: low mechanical strengths under higher temperature, risk of firing and dangerous gases during grinding

Abrasive grains:

- Corundum (brown, white), silicon carbide, diamond powder, etc.
Abrasive tools fixed by geopolymers

**Matrix:**
- Mixture of industrially prepared clay material and blast furnace slag (1 : 1.8) with potassium silicate solution – too hard and compact matrix
- Softer matrix – addition of slate clay

**Abrasive grains:**
- Yes: Corundum (brown, white), waste garnet from glass sandblasting (content of glass powder), diamond powder
- No: Silicon carbide (metallic silicon - bubbles), washed silicon carbide (still content of metallic silicon), recycled silicon carbide (lack of material)
Application

- Semi-industrial grinding and polishing of stones
- Metal cutting by grinding wheel
- Metal cutting by lathe grinding
- Hand grinding stones
Semi-industrial grinding and polishing of stones

- Abrasives: brown corundum F36 (26 – 35 wt.%)
- Slate clay (5 wt. %)
- Addition of grinded stone - 28 wt. % (limestone, granite, marble, etc.)
Metal cutting by grinding wheel

- Use of grinding machine
  - Speed: 2800 revolutions per minute
  - Time of grinding: 3 minutes
  - Water cooling

- Wheel with diameters 30 cm
- Abrasive grains: corundum (brown, white)
- Different content of abrasives
- Various particle size

- Placement of wheel after dressing

- Hard metal bar

Overall arrangement
Results

- Matrix from industrially prepared clay material and blast furnace slag – too hard and compact matrix
- Addition of slate clay – maximum 9.5 wt. %
- Higher content of slate clay – low strengths, loss of compactness
Metal cutting by lathe grinding

- Universal centre lathe
- Speed: 224 revolutions per minute
- Time: 2 minutes
- Iron pipe - untreated
- Water cooling
- Clay-slag matrix
- Samples: 2.5 x 10 x 1 cm
- Abrasive grains: corundum (brown, white)
- Different content of abrasives
- Various particle size
Various particle size of abrasive grains

- F36, F100, F240, F500, F36 (different content of abrasives)

- Different particle size of grains – different abrasive marks
- The best way – use the big grains at the beginning and fine grains for finishing

Iron pipe after test
Different content of abrasives

- Abrasive grains: brown corundum F36

Preparation for SEM – cutting of samples (1.0 x 1.0 cm)
Original material before grinding

Scanning Electron Microscopy

Plan view on the surface  Auxiliary view
Materials after grinding (SEM)

Magnitude 500x

brown corundum F36 marks: 27.4 – 32 μm
brown corundum F100 marks: 13 – 20.9 μm
white corundum F500 marks: 8.74 - 8.76 μm
Hand grinder – mould pressing

- Metal multi-piece mold
- Prism 5 x 15 x 2.5 cm
- Clay-slag matrix
- Abrasives: brown corundum (content 75 – 80%)
- Water content: 6.5 % – 7.0 %
- Pressing power: 20 MPa
Conclusion

- Well matured geopolymer matrix in combination with uniform distributed abrasive grains creates an effective grinder.

- During grinding the matrix gives off the blunt grains and replaces them by new ones.

- Hardness of matrix could be adapted according to specific purposes (for example: high strengths for grinding wheel, lower strengths for hand grinding)

- Sort, content and particle size of additives depends:
  1) The way of preparation: mould casting or pressing, vibro-compacting, etc.
  2) The way of grinding: hand grinding, different grinding machines
  3) The way of utilization: stone or metal grinding, super finishing, etc.

- Next plans:
  - Certificated tests of grinding quality
  - Semi-industrial production (cooperation with CDA)
Thank you for your attention

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