**Supplementary Information**

**Microscale mechanism of tailing thickening in metal mines**

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Table S1. Pilot-scale continuous thickener

|  |  |
| --- | --- |
| Component | Dimensions and parameters |
| Settlement column | Diameter 10 cm, height 100 cm |
| Flocculant feed pump | BS100-1A |
| Agitator | Height 60 cm, width 10 cm |
| Rake | Height 90 cm, width 8 cm |
| Low speed motor | Speed 0–10 r/min |



Fig. S1. Continuous shear thickening test: (a) slurry preparation, (b) settling column, (c) flocculation–sedimentation, (d) deposited bed, (e) tailing bed sampling, and (f) tailing specimen.

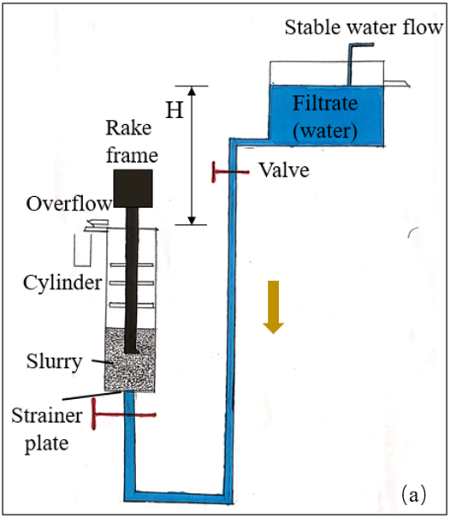
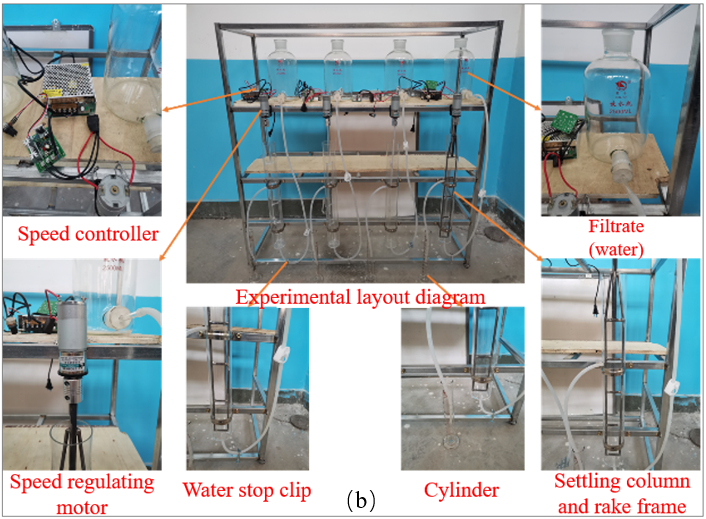
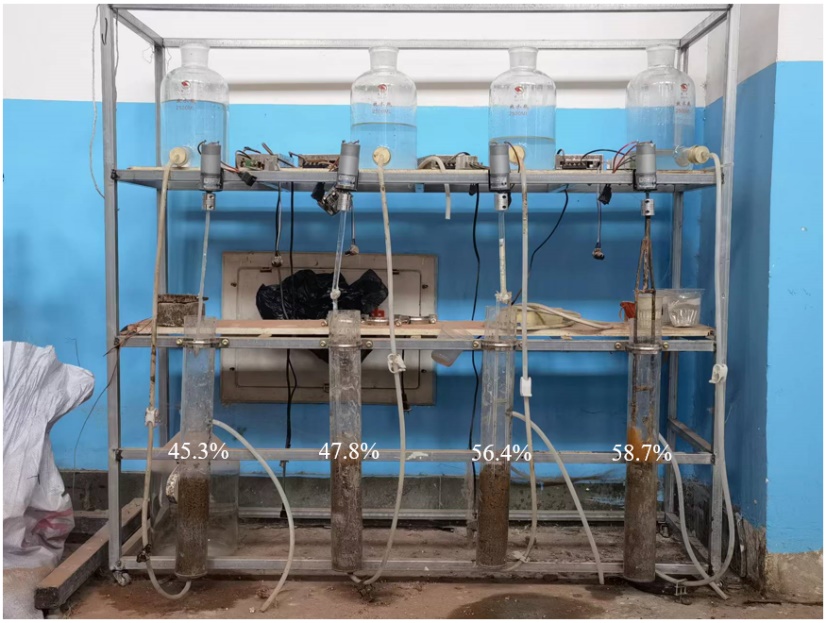
 

Fig. **S2.**  Rotating reverse seepage test device: (a) experimental device scheme and (b) layout of the laboratory device



**Fig. S3. Reverse seepage test device.**

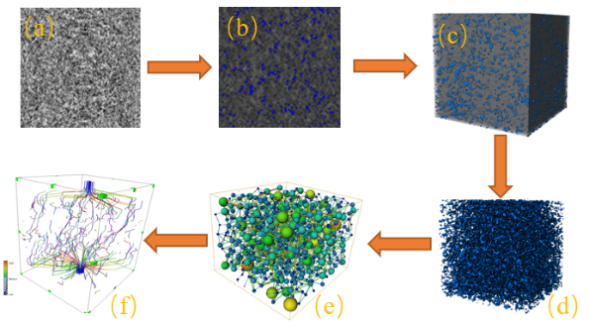
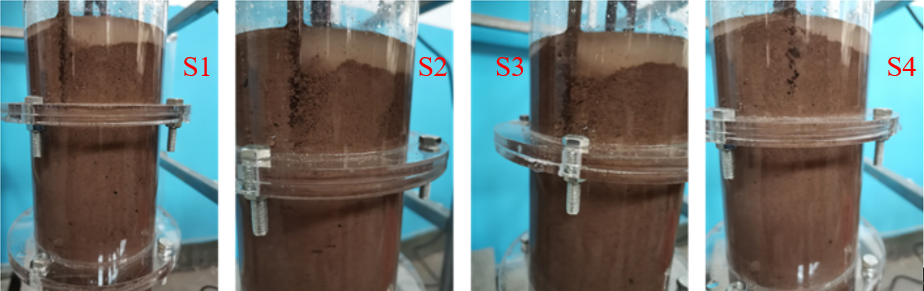


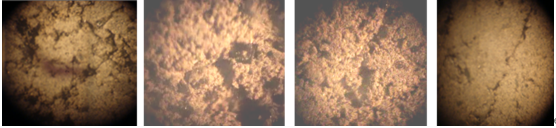
Fig. S4. Three-dimensional reconstruction process: (a) slice chart, (b) threshold segmentation, (c) binarization, (d) 3D reconstruction, (e) pore network model, and (f) channel characterization.

Table S2. Details of PNM

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameters | | S1 | S2 | | S3 | | S4 |
| Model size / mm | | 222 | 222 | 222 | | 222 | |
| Shearing time / min | | 0 | 10 | | 30 | | 60 |
| Model porosity | | 0.494 | 0.358 | | 0.302 | | 0.277 |
| Number of spheres | | 1332 | 1229 | | 1089 | | 806 |
| Number of throats | | 525 | 478 | | 371 | | 339 |
| Radius of sphere / μm | Minimum value | 0.85 | 0.78 | | 0.53 | | 0.26 |
| Maximum value | 117.62 | 115.02 | | 106.11 | | 94.66 |
| Average value | 76.79 | 73.21 | | 68.65 | | 66.36 |
| Radius of throat / μm | Minimum value | 0.93 | 0.91 | | 0.56 | | 0.25 |
| Maximum value | 94.69 | 87.61 | | 86.52 | | 83.75 |
| Average value | 28.66 | 31.34 | | 25.12 | | 20.78 |
| Coordination number of pore throat | Minimum coordination number | 2 | 1 | | 1 | | 1 |
| Maximum coordination number | 35 | 35 | | 32 | | 25 |
| Average coordination number | 10.83 | 11.07 | | 9.16 | | 7.39 |
| Radius ratio of pore throat | Minimum value | 1 | 1 | | 1 | | 1 |
| Maximum value | 23.18 | 2.95 | | 3.71 | | 3.78 |
| Average value | 2.69 | 2.34 | | 2.74 | | 3.19 |



**Fig. S5.**  Observation of the tailings bed shear thickening process.



**Fig. S6.**  Evolution of the seepage flow channel.

Table S3. Boundary parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fluid density,  *ρ* / (kg∙m−3) | Dynamic viscosity,  *μ* / (Pas) | Inlet pressure,  *P*in / Pa | Outlet pressure, *P*out / Pa | Model size,  *V* / mm3 |
| 1000 | 0.001 | 1.3 × 105 | 1.0 × 105 | 1 |

Table S4. Reserve direction seepage simulation result

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Specimen | | S1 | S2 | S3 | S4 |
| Sampling time / min | | 0 | 10 | 30 | 60 |
| Number of flow lines | | 452 | 489 | 423 | 363 |
| Absolute permeability / (10−3 μm2) | | 13.70 | 14.32 | 11.07 | 10.63 |
| Pressure value / Pa | Maximum value | 129724 | 129866 | 129852 | 129906 |
| Minimum value | 98820 | 99445 | 101107 | 101933 |
| Average value | 104565 | 108246 | 114916 | 116794 |
| Velocity value /  (μms) | Maximum value | 1.457 | 1.537 | 1.183 | 1.038 |
| Minimum value | 1.162 | 1.182 | 1.025 | 1.002 |
| Average value | 1.283 | 1.302 | 1.104 | 1.020 |