Supplementary Materials: Measurement-Based Modelling of Material Moisture and Particle Classification for Control of Copper Ore Dry Grinding Process

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1. Screw Feeder Throughput During Experiments

Table S1. Throughput of the screw feeder (as percentage of nominal throughput) during experiments.

Throughput [%]	Experiment no.
50	2, 3, 5, 7, 9, 12, 14, 15, 17, 19, 22
100	1, 4, 6, 8, 10, 11, 13, 16, 18, 20, 21

2. Measurement Data: Material Weights

Table S2. Weights of subsequent granularity classes (particles retained on the sieves) measured after each experiment – lower classification product.

Experiment	Mass [g] of particles sized:					Total
no.	*0–0.12 mm*	*0.12–0.25 mm*	*0.25–0.49 mm*	*0.49–0.75 mm*	*0.75–1.25 mm*	**mass [g]**
1	9	19	34	32	18	**112**
2	12.5	23	30	23	15	**103.5**
3	11	21	31	23	15	**101**
4	10	19	31	26	14	**100**
5	13	23	32	24	13	**105**
6	13	25	36	25	13	**112**
7	12	22	33	28	12	**107**
8	17	25	33	25	10	**110**
9	14	23	33	24	14	**108**
10	16	27	36	26	11	**116**
11	15	25	32	23	9	**104**
12	13	24	35	28	12	**112**
13	13	24	34	25	10	**106**
14	18	26	32	22	10	**108**
15	20	29	34	21	13	**117**
16	21	30	35	22	15	**123**
17	24	32	35	18	13	**122**
18	22	28	36	25	11	**122**
19	21	29	36	23	13	**122**
20	18	34	49	35	25	**161**
21	17	26	36	30	14	**123**
22	19	29	33	24	17	**122**

Table S3. Weights of subsequent granularity classes (particles retained on the sieves) measured after each experiment – upper classification product.

Experiment no.	**Mass [g] of particles sized:** *0–0.12 mm*	*0.12–0.25 mm*	*0.25–0.49 mm*	*0.49–0.75 mm*	*0.75–1.25 mm*	**Total mass [g]**
1	50	8	3	1	1	**63**
2	63	13	5	3	2	**86**
3	57	11	3	1	1	**73**
4	61	12	4	2	1	**80**
5	61	12	4	2	1	**80**
6	63	14	4	1	1	**83**
7	64	12	4	2	1	**83**
8	63	14	4	2	1	**84**
9	64	13	4	2	1	**84**
10	63	13	4	1.5	1	**82.5**
11	64	14	4	2	1	**85**
12	65	12	3	1	1	**82**
13	63	12	4	1.5	1	**81.5**
14	78	14	4	1	1	**98**
15	65	14	4	2	1	**86**
16	68	13	4	2	1	**88**
17	63	13	3	1	1	**81**
18	59	18	6	2	1	**86**
19	63	13	4	1	1	**82**
20	68	12	4	2	1	**87**
21	64	13	4	2	1	**84**
22	64	13	4	1	1	**83**

Note: Weights of subsequent granularity classes for the *input* material used in *i*-th experiment were calculated as sums of corresponding weights for the upper and lower product.

3. Measurement Data: Material Moisture

3.1. Input Material

Table S4. Measurements needed to calculate the moisture of input material – screw feeder running at 50% of nominal throughput. Entries sorted by increasing average moisture.

Experiment no. (a)	Sample no. (b)	Mass [g] of wet sample (c)	Mass [g] of dried sample (d)	Mass [g] of water $(e) = (c)–(d)$	Moisture [%] $(f) = (e)/(c) \cdot 100\%$	Average moisture [%] $(g) = \frac{1}{3}\sum(f)$
	1	8.442	8.393	0.049	0.58	
14	**2**	8.606	8.555	0.051	0.59	0.58
	3	8.070	8.024	0.046	0.57	
	1	8.219	8.149	0.070	0.85	
2	**2**	8.307	8.222	0.085	1.02	0.94
	3	8.224	8.147	0.077	0.94	
	1	8.488	8.406	0.082	0.97	
3	**2**	8.525	8.444	0.081	0.95	0.96
	3	8.361	8.281	0.080	0.96	
	1	9.180	9.050	0.130	1.42	
5	**2**	8.805	8.678	0.127	1.44	1.45
	3	8.575	8.446	0.129	1.50	
	1	8.848	8.680	0.168	1.90	
7	**2**	8.109	7.952	0.157	1.94	1.92
	3	8.583	8.418	0.165	1.92	
	1	9.979	9.720	0.259	2.60	
9	**2**	7.026	6.846	0.180	2.56	2.58
	3	9.904	9.649	0.255	2.57	
	1	11.021	10.701	0.320	2.90	
12	**2**	6.670	6.475	0.195	2.92	2.87
	3	11.957	11.626	0.331	2.77	
	1	8.073	7.802	0.271	3.36	
19	**2**	10.938	10.577	0.361	3.30	3.32
	3	7.390	7.147	0.243	3.29	
	1	7.043	6.776	0.267	3.79	
15	**2**	8.046	7.750	0.296	3.68	3.73
	3	8.657	8.336	0.321	3.71	
	1	7.960	7.630	0.330	4.15	
22	**2**	8.694	8.322	0.372	4.28	4.23
	3	9.760	9.345	0.415	4.25	
	1	10.444	9.941	0.503	4.82	
17	**2**	7.250	6.905	0.345	4.76	4.75
	3	8.557	8.158	0.399	4.66	

Table S5. Measurements needed to calculate the moisture of input material – screw feeder running at 100% of nominal throughput. Entries sorted by increasing average moisture.

Experiment no. (a)	Sample no. (b)	Mass [g] of wet sample (c)	Mass [g] of dried sample (d)	Mass [g] of water $(e) = (c)–(d)$	Moisture [%] $(f) = (e)/(c) \cdot 100\%$	Average moisture [%] $(g) = \frac{1}{3}\sum(f)$
	1	8.377	8.326	0.051	0.61	
1	**2**	8.173	8.123	0.050	0.61	0.61
	3	8.243	8.192	0.051	0.62	
	1	8.361	8.279	0.082	0.98	
4	**2**	8.437	8.364	0.073	0.87	0.92
	3	8.376	8.300	0.076	0.91	
	1	8.483	8.364	0.119	1.40	
6	**2**	8.294	8.175	0.119	1.43	1.42
	3	8.345	8.227	0.118	1.41	
	1	6.532	6.407	0.125	1.91	
8	**2**	6.390	6.265	0.125	1.96	1.94
	3	7.495	7.349	0.146	1.95	
	1	8.383	8.196	0.187	2.23	
10	**2**	8.847	8.654	0.193	2.18	2.21
	3	8.576	8.387	0.189	2.20	
	1	6.120	5.967	0.153	2.50	
11	**2**	8.580	8.371	0.209	2.44	2.47
	3	8.215	8.012	0.203	2.47	
	1	9.677	9.392	0.285	2.95	
13	**2**	7.960	7.729	0.231	2.90	2.92
	3	9.697	9.416	0.281	2.90	
	1	6.417	6.189	0.228	3.55	
20	**2**	8.927	8.614	0.313	3.51	3.50
	3	9.287	8.967	0.320	3.45	
	1	9.680	9.304	0.376	3.88	
21	**2**	10.275	9.878	0.397	3.86	3.87
	3	9.503	9.135	0.368	3.87	
	1	9.785	9.358	0.427	4.36	
16	**2**	8.647	8.292	0.355	4.11	4.25
	3	8.306	7.950	0.356	4.29	
	1	7.855	7.487	0.368	4.68	
18	**2**	7.430	7.081	0.349	4.70	4.70
	3	8.101	7.719	0.382	4.72	

3.2. Lower Classification Product

Table S6. Measurements needed to calculate the moisture of lower product of classification – screw feeder running at 50% of nominal throughput. Entries ordered the same as in Table S4.

Experiment no. (a)	**Sample no.** (b)	**Mass [g] of wet sample** (c)	**Mass [g] of dried sample** (d)	**Mass [g] of water** $(e) = (c){-}(d)$	**Moisture [%]** $(f) = (e)/(c) \cdot 100\%$	**Average moisture [%]** $(g) = \frac{1}{3}\sum(f)$
	1	8.490	8.440	0.050	0.59	
14	**2**	8.912	8.860	0.052	0.58	0.57
	3	8.115	8.071	0.044	0.54	
	1	8.396	8.330	0.066	0.79	
2	**2**	8.517	8.451	0.066	0.77	0.77
	3	8.482	8.418	0.064	0.75	
	1	8.334	8.272	0.062	0.74	
3	**2**	8.270	8.206	0.064	0.77	0.76
	3	8.484	8.420	0.064	0.75	
	1	8.381	8.305	0.076	0.91	
5	**2**	8.238	8.163	0.075	0.91	0.91
	3	8.490	8.413	0.077	0.91	
	1	8.488	8.404	0.084	0.99	
7	**2**	6.494	6.424	0.070	1.08	1.02
	3	6.716	6.649	0.067	1.00	
	1	6.404	6.323	0.081	1.26	
9	**2**	7.866	7.766	0.100	1.27	1.23
	3	8.354	8.258	0.096	1.15	
	1	8.477	8.362	0.115	1.36	
12	**2**	8.017	7.906	0.111	1.38	1.37
	3	8.425	8.310	0.115	1.37	
	1	7.486	7.370	0.116	1.55	
19	**2**	6.566	6.461	0.105	1.60	1.53
	3	6.623	6.527	0.096	1.45	
	1	5.673	5.582	0.091	1.60	
15	**2**	5.469	5.383	0.086	1.57	1.60
	3	5.692	5.600	0.092	1.62	
	1	9.404	9.198	0.206	2.19	
22	**2**	8.453	8.276	0.177	2.09	2.15
	3	6.898	6.749	0.149	2.16	
	1	8.251	8.075	0.176	2.13	
17	**2**	7.446	7.289	0.157	2.11	2.13
	3	7.729	7.563	0.166	2.15	

Table S7. Measurements needed to calculate the moisture of lower product of classification – screw feeder running at 100% of nominal throughput. Entries ordered the same as in Table S5.

Experiment no. (a)	**Sample no.** (b)	**Mass [g] of wet sample** (c)	**Mass [g] of dried sample** (d)	**Mass [g] of water** $(e) = (c) - (d)$	**Moisture [%]** $(f) = (e)/(c) \cdot 100\%$	**Average moisture [%]** $(g) = \frac{1}{3}\sum(f)$
1	**1**	8.425	8.381	0.044	0.52	0.51
	2	8.693	8.647	0.046	0.53	
	3	8.077	8.038	0.039	0.48	
4	**1**	8.495	8.432	0.063	0.74	0.72
	2	8.364	8.305	0.059	0.71	
	3	8.443	8.383	0.060	0.71	
6	**1**	8.376	8.295	0.081	0.97	0.96
	2	8.530	8.449	0.081	0.95	
	3	8.394	8.314	0.080	0.95	
8	**1**	8.728	8.626	0.102	1.17	1.18
	2	8.475	8.374	0.101	1.19	
	3	8.867	8.763	0.104	1.17	
10	**1**	8.263	8.156	0.107	1.29	1.28
	2	8.207	8.104	0.103	1.26	
	3	8.591	8.479	0.112	1.30	
11	**1**	8.458	8.336	0.122	1.44	1.36
	2	8.827	8.701	0.126	1.43	
	3	8.478	8.376	0.102	1.20	
13	**1**	7.974	7.849	0.125	1.57	1.60
	2	8.191	8.060	0.131	1.60	
	3	9.690	9.532	0.158	1.63	
20	**1**	9.748	9.552	0.196	2.01	1.96
	2	8.260	8.100	0.160	1.94	
	3	8.705	8.537	0.168	1.93	
21	**1**	9.484	9.277	0.207	2.18	2.10
	2	7.331	7.186	0.145	1.98	
	3	7.660	7.495	0.165	2.15	
16	**1**	8.493	8.280	0.213	2.51	2.36
	2	8.175	7.990	0.185	2.26	
	3	8.894	8.688	0.206	2.32	
18	**1**	9.206	8.966	0.240	2.61	2.59
	2	9.865	9.609	0.256	2.60	
	3	8.547	8.327	0.220	2.57	

3.3. Upper Classification Product

Table S8. Measurements needed to calculate the moisture of upper product of classification – screw feeder running at 50% of nominal throughput. Entries ordered the same as in Table S4.

Experiment no. (a)	**Sample no.** (b)	**Mass [g] of wet sample** (c)	**Mass [g] of dried sample** (d)	**Mass [g] of water** $(e) = (c) - (d)$	**Moisture [%]** $(f) = (e)/(c) \cdot 100\%$	**Average moisture [%]** $(g) = \frac{1}{3}\sum(f)$
	1	8.882	8.807	0.075	0.84	
14	**2**	9.018	8.940	0.078	0.86	0.85
	3	8.835	8.762	0.073	0.83	
	1	8.603	8.522	0.081	0.94	
2	**2**	7.194	7.134	0.060	0.83	0.88
	3	8.469	8.397	0.072	0.85	
	1	8.136	8.067	0.069	0.85	
3	**2**	8.173	8.102	0.071	0.87	0.89
	3	8.427	8.347	0.080	0.95	
	1	8.437	8.352	0.085	1.01	
5	**2**	8.395	8.310	0.085	1.01	1.01
	3	8.399	8.314	0.085	1.01	
	1	6.566	6.491	0.075	1.14	
7	**2**	6.070	6.005	0.065	1.07	1.12
	3	6.253	6.181	0.072	1.15	
	1	7.309	7.211	0.098	1.34	
9	**2**	5.473	5.400	0.073	1.33	1.32
	3	5.158	5.091	0.067	1.30	
	1	8.508	8.387	0.121	1.42	
12	**2**	8.370	8.251	0.119	1.42	1.40
	3	8.405	8.291	0.114	1.36	
	1	7.248	7.147	0.101	1.39	
19	**2**	7.363	7.267	0.096	1.30	1.38
	3	8.007	7.891	0.116	1.45	
	1	6.676	6.555	0.121	1.81	
15	**2**	5.435	5.339	0.096	1.77	1.69
	3	5.540	5.458	0.082	1.48	
	1	6.322	6.223	0.099	1.57	
22	**2**	7.740	7.619	0.121	1.56	1.57
	3	6.206	6.108	0.098	1.58	
	1	8.359	8.232	0.127	1.52	
17	**2**	6.980	6.870	0.110	1.58	1.53
	3	7.451	7.340	0.111	1.49	

Table S9. Measurements needed to calculate the moisture of upper product of classification – screw feeder running at 100% of nominal throughput. Entries ordered the same as in Table S5.

Experiment no. (a)	**Sample no.** (b)	**Mass [g] of wet sample** (c)	**Mass [g] of dried sample** (d)	**Mass [g] of water** $(e) = (c)–(d)$	**Moisture [%]** $(f) = (e)/(c) \cdot 100\%$	**Average moisture [%]** $(g) = \frac{1}{3}\sum(f)$
	1	8.393	8.326	0.067	0.80	
1	**2**	8.265	8.206	0.059	0.71	0.75
	3	8.210	8.149	0.061	0.74	
	1	8.475	8.411	0.064	0.76	
4	**2**	8.425	8.352	0.073	0.87	0.77
	3	8.501	8.442	0.059	0.69	
	1	8.378	8.293	0.085	1.01	
6	**2**	8.350	8.262	0.088	1.05	1.04
	3	8.505	8.416	0.089	1.05	
	1	8.587	8.479	0.108	1.26	
8	**2**	8.352	8.260	0.092	1.10	1.22
	3	8.301	8.194	0.107	1.29	
	1	8.472	8.352	0.120	1.42	
10	**2**	8.288	8.178	0.110	1.33	1.43
	3	8.327	8.199	0.128	1.54	
	1	8.314	8.189	0.125	1.50	
11	**2**	8.216	8.097	0.119	1.45	1.48
	3	8.682	8.553	0.129	1.49	
	1	8.856	8.699	0.157	1.77	
13	**2**	8.987	8.833	0.154	1.71	1.74
	3	9.121	8.963	0.158	1.73	
	1	6.685	6.573	0.112	1.68	
20	**2**	7.866	7.739	0.127	1.61	1.62
	3	10.332	10.170	0.162	1.57	
	1	6.985	6.882	0.103	1.47	
21	**2**	7.674	7.559	0.115	1.50	1.56
	3	10.636	10.455	0.181	1.70	
	1	7.814	7.677	0.137	1.75	
16	**2**	7.691	7.562	0.129	1.68	1.73
	3	7.970	7.830	0.140	1.76	
	1	7.710	7.575	0.135	1.75	
18	**2**	6.804	6.688	0.116	1.70	1.71
	3	6.605	6.495	0.110	1.67	