

SUPPLEMENTARY MATERIALS: Search Strategy and Study Selection

Parameter-Based Selection of Acid Mine Drainage and Coal Mine Wastewater Treatment: Evidence and Operational Constraints

1. Search framework

The literature search used a structured, cluster-based strategy. The formal database retrieval was conducted in ScienceDirect Advanced Search using the Title, abstract or author-specified keywords field, restricted to publications from 2014 through 2026 and sorted by relevance. The search covered neutralization and precipitation, adsorption, passive and wetland treatment, sulfate-reducing processes, electrocoagulation, manganese and sulfate control, residual management, membrane separation, resource recovery, hybrid treatment, cost and energy, and field operation.

Google Scholar was used as a concordance check rather than as a second independently pooled formal database. Additional source-sensitive searches were used to capture terminology variants, non-Elsevier evidence, and Indonesia-specific coal-mine evidence. These supplementary searches retained separate provenance.

2. Formal ScienceDirect search strings

Interface: ScienceDirect Advanced Search. **Search field:** Title, abstract or author-specified keywords. **Publication years:** 2014-2026. **Sorting:** Relevance. **Formal search sets:** 24. **Canonical retrieval occurrences:** 4,546.

Search ID	Thematic cluster	Exact search string	Raw hits
SD01A	Neutralization	"acid mine drainage" AND (neutralization OR neutralisation OR "alkaline treatment" OR "chemical precipitation" OR "limestone treatment" OR "lime treatment")	367
SD01B1	Neutralization	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining water" OR "coal mining wastewater") AND (neutralization OR neutralisation OR "alkaline treatment"))	45
SD01B2	Neutralization	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining water" OR "coal mining wastewater") AND ("chemical precipitation" OR "limestone treatment" OR "lime treatment"))	5
SD02A	Adsorption	"acid mine drainage" AND (adsorption OR adsorbent OR sorption OR "activated carbon" OR zeolite OR biochar OR "fly ash")	536
SD02B1	Adsorption	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining water" OR "coal mining wastewater") AND (adsorption OR adsorbent OR sorption))	63
SD02B2	Adsorption	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater") AND ("activated carbon" OR zeolite OR biochar OR "fly ash"))	38
SD03A	Passive / wetland / SRB	"acid mine drainage" AND ("constructed wetland" OR "passive treatment" OR wetland OR bioreactor OR "sulfate-reducing bacteria" OR SRB)	313
SD03B1	Passive / wetland / SRB	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater" OR "coalfield acid mine drainage") AND ("constructed wetland" OR "passive treatment" OR wetland))	20
SD03B2	Passive / wetland / SRB	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater" OR "coalfield acid mine drainage") AND (bioreactor OR "sulfate-reducing bacteria" OR SRB))	18
SD04A	Electrocoagulation	"acid mine drainage" AND (electrocoagulation OR "electro-coagulation" OR "electrochemical coagulation")	10
SD04B	Electrocoagulation	((("coal" AND "acid mine drainage") OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater" OR "coalfield acid mine drainage") AND electrocoagulation)	1

Search ID	Thematic cluster	Exact search string	Raw hits
SD05A	Manganese control	"acid mine drainage" AND (manganese OR Mn) AND (treatment OR removal OR oxidation OR adsorption)	333
SD05B1	Manganese control	("coal mine drainage" OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater") AND manganese AND (treatment OR removal)	4
SD05B2	Manganese control	"acid mine drainage" AND "coal mining" AND manganese AND (treatment OR removal)	0
SD05C	Sulfate control	"acid mine drainage" AND sulfate AND (treatment OR removal OR reduction OR "sulfate-reducing bacteria")	460
SD05D1	Sulfate control	("coal mine drainage" OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater") AND sulfate AND (treatment OR removal OR reduction)	18
SD05D2	Sulfate control	("coal mine drainage" OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater") AND ("sulfate-reducing bacteria" OR "sulfate reduction")	5
SD06A	Residual / sludge management	"acid mine drainage" AND ("treatment sludge" OR sludge OR "spent media" OR leaching OR stabilization OR disposal OR dewatering)	498
SD06B	Residual / sludge management	("coal mine drainage" OR "coal mine water" OR "coal mine wastewater" OR "coal mining wastewater") AND ("treatment sludge" OR "sludge management" OR "spent media" OR dewatering)	1
SD07A	Membrane / advanced separation	"acid mine drainage" AND (membrane OR nanofiltration OR "reverse osmosis" OR ultrafiltration OR electrodialysis)	128
SD07B	Resource recovery / valorization	"acid mine drainage" AND ("resource recovery" OR valorization OR valorisation OR recovery OR "metal recovery")	360
SD07C	Hybrid / combined treatment	"acid mine drainage" AND (hybrid OR combined OR integrated OR "treatment train" OR "sequential treatment")	340
SD07D1	Cost / energy / techno-economic	"acid mine drainage" AND (cost OR "operating cost" OR "operational cost" OR energy OR "energy consumption" OR economics OR "techno-economic")	453
SD07D2	Field operation / maintenance / scale-up	"acid mine drainage" AND (maintenance OR scalability OR "scale-up" OR "full-scale" OR "long-term" OR continuous OR pilot)	530

SD05B2 returned zero records and remains part of the documented search set. Raw counts refer to retrieval occurrences before record-level deduplication.

3. Google Scholar concordance search

Exact query: "acid mine drainage" treatment "coal mine". Google Scholar applies implicit AND logic between unconnected terms. The search was restricted to 2014-2026, sorted by relevance, and the first 50 results were screened. Patents and citation-only records were excluded. No new unique record was identified after comparison with the ScienceDirect evidence base.

Search ID	Exact query	Years	Sort	Screening rule	Search date	New unique records
GS-C1	"acid mine drainage" treatment "coal mine"	2014-2026	Relevance	First 50 results; patents and citation-only records excluded	28 Aug 2026	0

4. Supplementary sensitivity searches

Supplementary searches were used to address terminology sensitivity, coal-specific evidence, treatment residuals, passive and biological systems, electrocoagulation, resource recovery, and Indonesian coal-mine evidence. These searches were not added to the formal ScienceDirect raw-hit denominator.

Search ID	Exact query	Source constraint	Years	Sort	Cutoff	Relevant records logged
OS01	"acid mine water" treatment sulfate manganese precipitation electrocoagulation	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	0
OS02	"coal mine drainage" treatment passive wetland iron manganese sulfate	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	1
OS03	"acid mine drainage" neutralization limestone sludge precipitation	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	3
OS04	"acid mine drainage" adsorption sorption biochar	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	0
OS05	"acid mine drainage" constructed wetland sulfate reducing bioreactor	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	7
OS06	"acid mine drainage" electrocoagulation treatment energy	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	2
OS07	"acid mine drainage" resource recovery rare earth techno-economic	Springer, MDPI, RSC	2014-2026	Relevance	First 10 scholarly results	4
OS08	Indonesia "coal mine" "acid mine drainage" treatment	Open scholarly web, Indonesia-focused	2014-2026	Relevance	First 10 scholarly results	8

Search date for OS01-OS08: 26 August 2026.

5. Deduplication procedure

Duplicate RIS exports and misassigned duplicate files were removed before record-level deduplication so that each formal search contributed only its canonical retrieval records.

DOIs were normalized by converting to lowercase and removing DOI URL/prefix variants. Exact normalized DOI matching was the primary record-level deduplication rule.

Normalized title matching was used as a safeguard by applying Unicode normalization, lowercasing, punctuation removal, and whitespace collapse. Fuzzy-title matching was not used.

The 4,546 canonical ScienceDirect retrieval occurrences were reduced to 1,691 unique records. Search-query and source-file provenance were retained for each unique record.

6. Title/abstract screening

Title/abstract screening retained records that directly addressed acid mine drainage, coal-mine drainage or wastewater, mine water, or mining-influenced water and provided potentially usable evidence on treatment performance, operating conditions, residual management, cost or energy, treatment trains, or directly relevant resource recovery.

Stage	Count	Disposition
Initial ScienceDirect unique records	1,691	Records entering title/abstract screening
Initial title/abstract include	537	Advanced to evidence review
Initial title/abstract exclude	1,154	Excluded for wrong context, non-treatment focus, peripheral treatment evidence, or non-independent publication
Secondary title/abstract verification subset	112	Records initially excluded under E2/E3 selected for secondary verification
Records reinstated after secondary verification	84	Eligibility for evidence review confirmed
Additional eligibility verification	1	Treatment relevance confirmed after source verification
ScienceDirect evidence-review pool	622	537 + 84 + 1

Title/abstract exclusion categories: E1, wrong wastewater or context; E2, wrong topic or outside treatment scope; E3, treatment evidence not sufficiently central to the study objective; E4, comment, corrigendum, discussion, or comparable non-independent publication.

7. Combined evidence-review pool and full-text disposition

Stage	Count	Definition
ScienceDirect evidence-review pool	622	After title/abstract screening and documented secondary verification
External or legacy records logged	37	Separate provenance from formal ScienceDirect retrieval
New external main-window records	31	2014-2026 records added to evidence review
External duplicates to ScienceDirect	2	Not counted twice
External exclusions	2	Not advanced
Legacy/supportive records	2	Outside the main 2014-2026 count
Combined main-window evidence-review pool	653	622 ScienceDirect + 31 new external records
Evidence-priority set	67	Selected for intensive full-text extraction and coverage of technology, water context, scale, operational evidence, residuals, cost/energy, and resource recovery
Retained full texts	64	Final study-level evidence database
Excluded full texts	2	Excluded after full-text assessment
Not retrieved	1	Reported separately from scientific exclusion

The evidence-priority set contained 67 records. Full-text disposition resulted in 64 retained studies, 2 exclusions, and 1 record not retrieved. The 64 retained full texts constitute the final study-level evidence database reported in Supplementary File S2.

8. Reproducibility statement

Search identifiers, exact search strings, raw counts, DOI/title deduplication, screening decisions, secondary screening verification, source provenance, evidence-priority selection, retrieval outcomes, and final full-text disposition are documented in the supplementary records. Reported counts correspond to the recorded stages of the study-selection process.