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Research Article

Statistical analysis, machine learning modeling, and text analytics of aggregation attachment efficiency: Mono and binary particle systems

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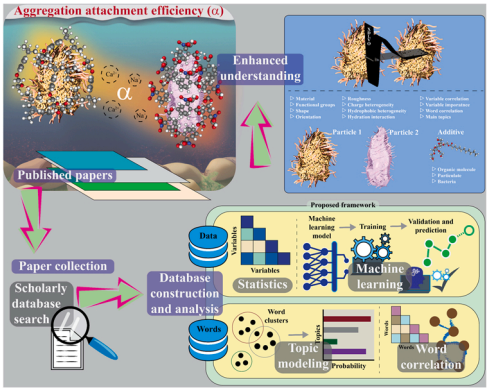
HIGHLIGHTS

- Databases on aggregation in mono and binary particle systems were analyzed.
- Statistics, machine learning, and text analytics were used for analyses.
- Variable correlations and importance were identified.
- Random forest and neural network were used after missing data imputation.
- Topic modeling and word correlations were performed on the literature.

GRAPHICAL ABSTRACT



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ABSTRACT

The aggregation attachment efficiency (α) is the fraction of particle–particle collisions resulting in aggregation. Despite significant research, α predictions have not accounted for the full complexity of systems due to constraints imposed by particle types, dispersed matter, water chemistry, quantification methods, and modeling. Experimental α values are often case–specific, and simplified systems are used to rule out complexity. To address these challenges, statistical analysis was performed on α databases to identify gaps in current knowledge, and machine learning (ML) was used to predict α under various particle types and conditions. Moreover, text analytics was employed to support knowledge from statistics and ML, as well as gain insight into the ideas communicated by current literature. Most studies investigated α in mono–particle systems, but binary or higher systems require more investigation. Furthermore, our work highlights that numerous variables, interactions, and mechanisms influence α behavior, making its investigation complex and difficult for both experiments and modeling. Consequently, future research should incorporate more particle types, shapes, coatings, and surface heterogeneities, and aim to address overlooked variables and conditions. Therefore, building a comprehensive α database can enable the development of more accurate empirical models for prediction.

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