

The detrimental effect of nonrenewable energy sources has increased the need for sustainable renewable energy. However, reliance on renewable energy sources also necessitates the existence of a feasible energy storage system, such as a battery energy storage system, which acts as a tool for storing, delivering, and distributing electrical energy. This kind of energy storage technology delivers great efficiency by enhancing the grid's resilience and dependability and reducing our reliance on fossil fuel-based energy sources.

This thesis will investigate the impact of flow batteries on fire safety, since battery storage systems have become an increasingly common method of energy storage. Literature review is conducted to comprehend the safety and fire concerns associated with flow batteries. Even though flow batteries are regarded to be intrinsically safer than typical lithium-ion batteries, there are various scenarios in which flow batteries might offer a substantial threat, and this thesis analyzes these discoveries.

In the review, a semi-systematic technique or a narrative review methodology was developed, and 110 publications were analyzed; these papers were screened based on a set of inclusion/exclusion criteria, with fire and safety concerns taking precedence. After evaluating the safety problems and fire threats connected with flow batteries, the hazards are compared to those of lithium-ion batteries, which are now the market leader in terms of battery storage system but are deficient in terms of fire and safety concerns.

Flow batteries have been proven to provide considerable advantages over lithium-ion batteries in terms of safety, scalability, and possibly a longer life cycle. However, the fact that it is safer than lithium-ion does not imply that it is entirely safer, since it has several disadvantages, such as electrolyte leakage and gas evolution owing to side reactions. Flow batteries employ a non-flammable electrolyte because the bulk of the electrolyte in flow batteries is water, while lithium-ion batteries use a flammable electrolyte. The second safety feature of flow batteries is that they employ pumps to circulate the electrolyte into the reaction region where current is produced. By reversing the flow of the pumps, the electrolyte may be drained from the reaction area, eliminating any current/voltage hazards or reduce any potentially arising hazard. Flow batteries can be dangerous because they need to store a large quantity of electrolytes to produce enough energy, and because they need a lot of complicated mechanical and electrical parts, like valves, pipes, pumps, and inverters, to work well together, there is always a chance that electrolyte will leak, or parts might fail. Even though the electrolytes used is not flammable, it is very acidic, which causes toxicity and corrosivity problems. Both vanadium flow batteries and zinc bromine flow batteries employ sulfuric acid and bromine as supporting electrolytes respectively, which are believed to be powerful oxidizers that promote the burning of other substances. Other hazards observed were the risk of gas evolution such as hydrogen during normal operations induced by cell imbalance inside the battery; without sufficient venting/safety procedures, hydrogen gas can quickly approach its flammable limits. If a secondary fire threatens the storage system, both lithium-ion batteries and flow batteries may represent a serious hazard to life and property, since explosion is a potential possibility.