Appendix A Search Strings for Scopus and Web of Science

Search results as of 26 March 2023:

1st Attempt

Scopus (n_{1a}=78):
(TITLE-ABS-KEY(lithium-ion) OR TITLE-ABS-KEY(li-ion)) AND TITLE-ABS-KEY(batter*) AND TITLE-ABS-KEY(fire) AND TITLE-ABS-KEY(suppression)

Web of Science (n_{1b}=67):
(TS=(lithium-ion) OR TS=(li-ion)) AND TS=(batter*) AND TS=(fire) AND TS=(suppression)

2nd Attempt

Scopus (n_{2a}=381):
(TITLE-ABS-KEY(lithium-ion) OR TITLE-ABS-KEY(li-ion) OR TITLE-ABS-KEY(lib)) AND TITLE-ABS-KEY(batter*) AND (TITLE-ABS-KEY(fire*) OR TITLE-ABS-KEY(flame*)) AND (TITLE-ABS-KEY(suppress*) OR TITLE-ABS-KEY(extinguish*) OR TITLE-ABS-KEY(mitigat*))

Web of Science (n_{2b}=403):
((TS=(lithium-ion) OR TS=(li-ion) OR TS=(lib)) AND TS=(batter*) AND (TS=(fire*) OR TS=(flame*)) AND (TS=(suppress*) OR TS=(extinguish*) OR TS=(mitigat*))

3rd Attempt

Scopus (n_{3a}=328)
((TITLE-ABS-KEY(lithium-ion) OR TITLE-ABS-KEY(li-ion) OR TITLE-ABS-KEY(lib)) AND TITLE-ABS-KEY(batter*) AND (TITLE-ABS-KEY(fire*) OR TITLE-ABS-KEY(flame*)) AND (TITLE-ABS-KEY(suppress*) OR TITLE-ABS-KEY(extinguish*) OR TITLE-ABS-KEY(mitigat*))) AND (EXCLUDE(EXACTKEYWORD, "Lithium Metal Battery"))

Web of Science (n_{3b}=325):
((TS=(lithium-ion) OR TS=(li-ion) OR TS=(lib)) AND TS=(batter*) AND (TS=(fire*) OR TS=(flame*)) AND (TS=(suppress*) OR TS=(extinguish*) OR TS=(mitigat*)) NOT TS=(metal))

Appendix B1 Selected Publications – Reviewed-Based

S/N	Reference		Article Title	Country
1	Conzen et al., 2023	[127]	*"Lithium ion battery energy storage systems (BESS) hazards"*	USA
2	Sebastian, 2022	[128]	*"A review of fire mitigation methods for li-ion battery energy storage system"*	USA
3	Zhang et al., 2022	[129]	*"A review of fire-extinguishing agents and fire suppression strategies for lithium-ion batteries fire"*	China
4	Zhang et al., 2022	[130]	*"A Review on Fire Research of Electric Power Grids of China: State-Of-The-Art and New Insights"*	China
5	Qiu & Jiang, 2022	[131]	*"A review on passive and active strategies of enhancing the safety of lithium-ion batteries"*	China
6	Snyder & Theis, 2022	[132]	*"Understanding and managing hazards of lithium-ion battery systems"*	USA
7	Yuan et al., 2021	[133]	*"A review of fire-extinguishing agent on suppressing lithium-ion batteries fire"*	China
8	Sun et al., 2021	[134]	*"Progress on the research of fire behavior and fire protection of lithium ion battery"*	China
9	Cui & Liu, 2021	[135]	*"Research progress of water mist fire extinguishing technology and its application in battery fires"*	China
10	Li et al., 2021	[136]	*"Research progress on fire protection technology of containerized Li-ion battery energy storage system"*	China
11	Sun et al., 2020	[137]	*"A review of battery fires in electric vehicles"*	China & Sweden
12	Ghiji et al., 2020	[35]	*"A review of lithium-ion battery fire suppression"*	Australia
13	Chombo & Laoonual, 2020	[138]	*"A review of safety strategies of a Li-ion battery"*	Thailand
14	Diaz et al., 2020	[139]	*"Meta-review of fire safety of lithium-ion batteries: Industry challenges and research contributions"*	UK
15	Wang et al., 2019	[140]	*"A review of lithium ion battery failure mechanisms and fire prevention strategies"*	China
16	Kong et al., 2018	[141]	*"Li-ion battery fire hazards and safety strategies"*	USA & China
17	Ingram, 2013	[142]	*"Lithium-ion batteries: A potential fire hazard"*	USA
Citation Search				
18	Hill, 2020	[143]	*"McMicken battery energy storage system event technical analysis and recommendations"*	USA
19	Wilkens et al., 2017	[144]	*"Assessment of existing fire protection strategies and recommendation for future work"*	Denmark
20	Warner, 2017	[145]	*"Overview of a year of battery fire testing by DNV GL"*	USA

Appendix B2

Appendix B2 Selected Publications – Experimental-Based

Note: 1. Unless otherwise stated, experiments with single-cell or multiple-cells bundled in the table below are directly exposed to the extinguishing agents. 2. Battery used for experiments are with 100% state-of-charge (SOC) unless otherwise stated. Comparison of the suppression efficacy of different SOCs is not discussed in the thesis.

S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
2023							
1	Li et al.	[100]	Cylindrical 3.5Ah NMC	Two cells bundled in an explosion-proof box	Aluminium ammonium sulfate dodecahydrate (AASD) composited ABC dry powder	China	AASD has high heat absorbing capacity (10 times higher than Novec1230). It can extinguish LIB fire and suppress thermal runaway propagation.
2	Zhang et al.	[68]	Cylindrical 4Ah NMC	Three cells bundled in an explosion-proof tank	Intermittent water spray	China	Duty cycles and spray time are proposed for the intermittent water spray, which can extinguish the fire, accelerate the cooling and prevent thermal runaway (TR) propagation.
3	Zhang et al.	[96]	Cylindrical 1.2Ah LFP	Single-cell in an accelerating rate calorimeter chamber	1. N_2(g); 2. Liquid N_2	USA	Both N_2(g) (slow cooling) and liquid N_2 (fast cooling) can mitigate TR by setting the activation temperature at 130°C. No visible flame is involved in the experiment.
4	Liang et al.	[103]	Prismatic 271Ah LFP	EV Pack-Level: A standard electric bus battery box containing 7 live cells and 26 dummy cells	$C_6F_{12}O$ gas discharge into the battery box	China	$C_6F_{12}O$ can extinguish the fire and prevent thermal runaway propagation. The temperature of the adjacent batteries does not exceed 90°C within 30mins after the fire is extinguished and no re-ignition is observed. $C_6F_{12}O$'s performance is affected by the extreme ambient temperatures at -40°C and 85°C. Details are also presented in Chapter 4.
5	Cao et al.	[92]	Cylindrical 3.5Ah NMC	Single-cell in an open space without an enclosure	Liquid N_2	China	Liquid N_2 exhibits a superior cooling effect, drastically reducing the surface temperature of a thermal runaway battery to -170°C. Thus, it can effectively extinguish the fire and inhibit the thermal runaway of LIBs.
6	Rothe et al. (White paper from citation search)	[117]	Prismatic 40Ah LMO and Cylindrical cells	BESS Rack-Level: Three live battery racks and 11 dummy racks in a 20' sea container	1. HPWM fixed firefighting system (FFS) 2. N_2(g) FFS 3. Aerosol FFS	Germany	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
				2022			
7	Yuan et al.	[75]	Cylindrical 15Ah LFP	Three cells bundled in a cuboid combustion chamber	1. WM with 3% F-500 additive 2. WM	China	WM can extinguish the fire but cannot stop TR propagation. WM with F-500 additive can both extinguish the fire and stop TR propagation. The cooling capacity of WM with F-500 additive is estimated 3 times of pure WM.
8	Han et al.	[104]	Prismatic 24Ah LFP	EV Pack-Level: A standard electric bus battery box contains 9 modules and 28 cells in each module, for a total of 252 cells.	FK-5-1-12 ($C_6F_{12}O$) gas discharge into the battery box	China	The cooling effect of $C_6F_{12}O$ gas increases with more $C_6F_{12}O$ gas being released into the battery box. $C_6F_{12}O$ gas can extinguish the fire but cannot completely inhibit the TR propagation in this experiment. Details are also presented in Chapter 4.
9	Zhang et al.	[146]	Cylindrical 4Ah NMC	Single-cell in an explosion-proof tank	Intermittent water spray	China	Intermittent water spray can extinguish the fire and has a higher water utilisation frequency and a better cooling effect than continuous spray. The paper compares the efficacy of short-pulse and long-pulse sprays but does not report if the intermittent water spray can effectively stop the TR.
10	Meng et al.	[69]	Cylindrical 14Ah LFP	Single-cell in an ISO9705 full-scale room	Intermittent $C_6F_{12}O$ gas spray	China	The intermittent $C_6F_{12}O$ spray extinguishes the fire successfully, lengthens the low-temperature duration and decreases the rate of temperature rise after the agent is exhausted. For the tested 14 Ah LFP battery, the optimal duty cycle of 55.4% for the intermittent spray is proposed to achieve the best suppression and cooling effect.
11	Sun et al.	[105]	Prismatic 117Ah NMC	EV Pack-Level: Two cells in an EV battery module box	1. $C_6F_{12}O$ gas 2. Water spray 3. HFC-227ea (not discussed in this thesis) Agents are discharged into the battery module box	China	$C_6F_{12}O$ gas cannot prevent TR propagation but prolong the TR propagation by decreasing the battery temperature and reducing the heat transfer. Water spray achieves a better cooling effect and prevents TR propagation. Details are also presented in Chapter 4.
12	Zhang et al.	[109]	Prismatic 273Ah LFP	BESS Rack-Level: A battery rack in	$C_6F_{12}O$ gas	China	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
				an energy storage container. The rack contains 1 live battery module and 20 dummy modules. The live battery module contains 12 live battery cells.			
13	Wang et al.	[93]	Cylindrical 3.5Ah NMC	1. Single-cell 2. Two cells bundled in a confined space	Liquid N_2	China	Liquid N_2 can extinguish the fire and effectively inhibit TR propagation in the confined space.
14	Zhou et al.	[76]	Cylindrical 3.5Ah NMC	Two cells bundled without an enclosure	Fine WM with additives containing urea (CH_4N_2O), AEO-9, FC4330 and DMMP	China	The low conductivity fine WM with additives containing the optimal concentration of 0.36% urea, 2% AEO-9, 0.25% FC-4330 and 3.5% DMMP is proposed to achieve efficient inhibition of TR and its propagation and reduce the risk of short-circuiting.
15	Huang et al.	[94]	Cylindrical 2.2Ah LCO	Five cells bundled in an explosion-proof chamber	Liquid N_2	China	Liquid N_2 has an excellent cooling capacity, which can prevent TR propagation when the activation of the agents starts before the batteries reach critical temperatures, as proposed in the paper.
16	Wang et al.	[77]	Prismatic 30Ah LFP	Single-cell in an explosion-proof box	WM with different combinations of additives containing SDBS, APG0810, K_2CO_3, Na_2CO_3, $C_{12}H_{26}O$, FC4330, EL90 and urea (CH_4N_2O)	China	The study finds that WM with SDBS-FC4430-Na_2CO_3 solution with a mass ratio of 1:2:1.5 has the highest fire-extinguishing efficiency, followed by EL90 as an additive. The TR propagation is not discussed in the paper.
17	Wang et al.	[78]	Cylindrical 2.6Ah NMC	Five cells bundled in a combustion chamber	Fine WM with additives containing $NaHCO_3$ and urea (CH_4N_2O)	China, UK & USA	Fine WM with additives is more effective in extinguishing fires than pure WM without additives. The additives improve heat absorption, cooling effect, oxygen depletion and breakage of the chemical reaction. The compound agent can also stop TR propagation.
18	Zhang et al.	[71]	Cylindrical 3.4Ah NCA	Single-cell in an enclosed combustion chamber	1. N_2-twin-fluid $C_6F_{12}O$ mist 2. N_2-twin-fluid H_2O mist	China	The N_2-twin-fluid liquid mist synergistic technology proposed in this paper can extinguish the fire and suppress TR. N_2-twin-

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
							fluid $C_6F_{12}O$ mist exhibits 51.2% higher extinguishing efficiency than applying N_2(g) alone, and N_2-twin-fluid H_2O mist increases the cooling rate by 20%.
19	Liu et al.	[87]	Prismatic 300Ah LFP	Single-cell in a combustion chamber scaled to ½ of ISO9705 room.	$C_6F_{12}O$ gas	China	Higher doses of $C_6F_{12}O$ gas achieve more efficient extinguishment. However, it increases the toxicity level. The study proposes the optimal doses of 2.9g/Wh under the experimental conditions for this battery cell. The thermal runaway cannot be wholly mitigated for such high-power LIB.
20	Yuan et al.	[79]	Cylindrical 3Ah NCA	Six cells bundled in an enclosed stainless steel tank	WM with 3% F-500 additive	China	WM with 3% F-500 additive could absorb the main explosive gases. It exhibits better cooling capacity and more water penetration than pure WM. The agent can also suppress LIB fires but cannot prevent TR propagation with 100% SOC.
21	Liu et al.	[80]	Cylindrical 1.5Ah LFP; 1.3Ah LCO; 1.5Ah NMC	Single-cell without an enclosure	WM with 5% NaCl additive	China	WM with 5% NaCl additive demonstrates better fire suppression efficiency and cooling effect than pure WM. Both WM with 5% NaCl additive and pure WM can extinguish the fire and inhibit TR for LFP. However, the inhibition effect of TR for LCO and NMC is unsatisfactory.
22	Xu et al. (Journal paper from citation search)	[123]	Cylindrical 2.5Ah NMC	1. Single-cell 2. Three cells bundled in an enclosed box	WM	China	The study demonstrates a good cooling efficiency of WM. The paper also quantifies the critical onset temperature of TR is increased by 36ºC due to WM, which prolongs the TR propagation and will ultimately suppress the TR propagation if the duration of WM release increases.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
2021							
23	Zhao et al.	[91]	Cylindrical 2.6Ah NMC	Four cells bundled in an experimental box	1. Water spray 2. ABC ultra-fine dry powder 3. BC ultra-fine dry powder 4. Novec1230 ($C_6F_{12}O$)	China	The study is based on 70% SOC for the fire suppression test. The results show that water spray exhibits the best cooling efficiency and prevents TR propagation. The other 3 agents cannot effectively prevent TR propagation.
24	Said & Stoliarov	[88]	Cylindrical 2.6Ah LCO	12 cells bundled in a bench-scale wind tunnel test	Novec1230 ($C_6F_{12}O$) with 8.5% and 15.2% design concentration	USA	8.5 vol% concentration of Novec1230 cannot extinguish the fire and fails to prevent TR propagation. With the increased %vol concentration, 15.2% of Novec1230 can prevent thermal runaway propagation in 4 out of 6 tests, with 57% of battery cells (out of a total of 72 cells in 6 tests) not suffering from the thermal runaway during the tests. The combustion efficiency is reduced to below 18% by Novec1230.
25	Said et al.	[147]	Cylindrical 2.6Ah LCO	12 cells bundled in a bench-scale wind tunnel test	WM	USA	WM at the flow rates of 1.0 and 1.6g/s prevent TR propagation in 40%-50% of all tests. WM also delays TR propagation. The combustion efficiency is reduced to below 50% by WM.
26	Zhang et al.	[125]	Cylindrical 4Ah NMC	1. Single-cell 2. Three cells bundled in an explosion-proof box	Water spray	China	Water spray can efficiently suppress the fire. However, insufficient volume and low contact efficiency cannot prevent TR propagation. This can be resolved by increasing the volume of water spray and higher contact efficiency.
27	Huang et al.	[95]	Cylindrical 2.2Ah LCO	Single-cell in an explosion-proof combustion chamber	Liquid N_2	China	Liquid N_2 exhibits excellent cooling efficiency, which can cool a TR battery from approximately 700°C to less than 100°C within 80s. The TR could be prevented if the agent is applied before the critical TR temperature of 170°C for this type of battery.
28	Zhou et al.	[106]	Prismatic 202Ah LFP	EV Pack-Level: Three cells bundled in a simulated battery box	$C_6F_{12}O$ gas discharge into the battery box	China	$C_6F_{12}O$ gas can quickly suppress the initial fire, and an extended spray of the agent is required to achieve a better cooling effect, thus preventing TR propagation. Details are also presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
29	Guo et al.	[73]	Cylindrical 4Ah NMC	Two cells bundled in a combustion chamber	1. Low-pressure twin-fluid WM (mixing water and air) 2. AVD	China	The twin-fluid WM can quickly extinguish the fire. At an optimal working pressure of 1.2MPa, it performs better than AVD in cooling surface and flame temperatures. In contrast, AVD has a better asphyxiant capability to prevent re-ignition.
30	Zhou et al.	[81]	Cylindrical 3.5Ah LCO	Single-cell in a semi-enclosed box	WM with additives containing urea (CH_4N_2O), KEOA, KCl and FC-4330.	China	The experiment finds that the WM with additives of the optimal concentration of 0.17% FC-4330, 0.2% TEOA, 0.32% urea and 2.5% KCl can fire extinguishing and cooling effects to overcome a jet fire from the battery.
31	Wang et al.	[82]	Pouch 20Ah LFP	Single-cell in a combustion chamber	1. WM with SDS additive 2. WM with carboamide additive 3. WM	China	Compared among the three agents, all of them can suppress the LIB fires. The order of fire suppression capability is WM with 1% SDS > WM with 1% carboamide > pure WM. The ability to prevent TR is not tested, but the experiments show that WM with additives has better heat absorption, potentially beneficial to TR mitigation.
32	Tian et al.	[74]	Cylindrical 6.5Ah NMC	Six cells bundled in an explosion-proof box	Novec1230($C_6F_{12}O$) + heptafluorocyclopentane mixed solution	China	The mixed solution improves the cooling effect of Novec1230, which can extinguish the fire and keep the batteries cool. However, TR propagation is not further investigated in the paper.
33	Zheng et al.	[83]	Shape not mentioned 12Ah LFP	Single-cell without an enclosure	WM with additives containing PFAB, APG0810, K_2CO_3, SDBS, $C_{12}H_{26}O$ and Na_2CO_3	China	The experiment finds that WM with PFAB-APG0810-K_2CO_3 additive has a better extinguishment effect for an incipient fire, and WM with SDBS- $C_{12}H_{26}O$-Na_2CO_3 additive exhibits a better cooling effect to bring a TR battery below 200^oC in a shorter time.
34	Wang et al.	[121]	1. Pouch 26Ah NMC 2. Pouch 20Ah LFP 3. Cylindrical 4.2Ah NMC	1. Individual cells for NMC and LFP 2. Three cells bundled for NMC in an explosion-proof chamber	1. AVD 2. Novec1230 ($C_6F_{12}O$) 3. 2-BTP	China	Compared AVD's cooling efficacy among the 3 types of batteries, the order is Pouch LFP(-220^oC/s) > Pouch NMC(-84^oC/s) > Cylindrical NMC(-23^oC/s). Compared the three agents' cooling efficacy on LCO's battery, AVD outweighs Novec1230 (-9^oC/s) and 2-BTP(-10^oC/s). TR propagation is

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
							not further investigated in the experiment.
35	Un & Aydin	[148]	Cylindrical 2Ah LCO	15 cells bundled in an outdoor environment	Boron-based suppression agent	Turkey	Boron-based suppression agent can extinguish the fire and provide a cooling effect. No investigation of TR is in the paper.
36	Bisschop et al. (Technical report from citation search)	[36]	1. Cylindrical 2.55Ah NMC 2. Prismatic 50Ah LFP	BESS Rack-Level: 1. 39 NMC cells form a battery module 2. Two LFP cells form a battery module A rack consists of 1 live module and 11 dummy modules. The test is conducted in a standard shipping container.	1. Total flooding WM with 3% F-500 additive 2. Sprinkler water with 3% F-500 additive 3. Direct spray water + AVD 4. Total flooding IG541 gas	Sweden	Details are presented in Chapter 4.
37	Siemens (White paper from citation search)	[50]	Prismatic Unknown capacity and chemistry	Module-Level: Three cells bundled in an original module housing	N_2 gas with a 45.2% extinguishing concentration	Switzer-land	Oxygen concentration is reduced to 11.3% to prevent TR propagation, provided that the activation of N_2 gas starts at the earliest possible time during LIB's off-gassing.
38	Barowy et al. (Technical report from citation search)	[116]	Cylindrical 3.2Ah NCA	BESS Rack-Level: In a standard shipping container, one TR initiating rack consists of nine modules, each loaded with 270 cells. Two adjacent target racks are loaded with 1/3 capacity of the TR initiating rack.	1. Novec1230 ($C_6F_{12}O$) 2. Sprinkler	USA	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
2020							
39	Xu et al.	[120]	Prismatic 94Ah NMC	Single-cell in an explosion-proof chamber	1. CO_2 2. WM 3. FM200 (not discussed in this thesis)	China	WM exhibits a better cooling effect than CO_2 in the experiment. WM can effectively suppress LIB fires. However, CO_2 cannot completely suppress the fire. However, the experiment does not further investigate the efficacy of the agents for TR mitigation.
40	Liu et al.	[72]	Prismatic 38Ah NMC	Single-cell in a battery module box	1. $C_6F_{12}O$ gas 2. WM 3. $C_6F_{12}O$ gas + WM 4. WM with $KHCO_3$ & $K_2C_2O_4$-H_2O additives Discharge directly into the module box	China	The experiment shows that the cooling effect of the combined agents of $C_6F_{12}O$ gas and WM outweighs $C_6F_{12}O$ gas alone or WM alone. Early activation of agents also brings better cooling efficiency. WM at higher working pressure provides better cooling efficiency. Lastly, WM with additives exhibits better cooling and suppression effects.
41	Meng et al.	[97]	Prismatic 22Ah LFP	Single-cell in full-scale ISO9705 room	ABC dry powder	China	ABC dry powder can suppress LIB fire under appropriate conditions but with a limited cooling effect which cannot prevent TR of the LIB.
42	Zhang et al.	[70]	Prismatic 243Ah LFP	Single-cell in a combustion chamber	1. $C_6F_{12}O$ gas 2. WM 3. $C_6F_{12}O$ gas + WM 4. CO_2 + WM 5. HFC-227ea + WM (not discussed in this thesis)	China	$C_6F_{12}O$ gas alone can suppress the fire quickly but has a limited cooling effect. WM alone takes a long time to suppress the fire but eventually cools the battery and prolongs the TR. The combination of $C_6F_{12}O$ gas + WM exhibits the best performance, which can quickly suppress the fire and cool the battery temperature more significantly. The overall effect of $C_6F_{12}O$ gas + WM is better than CO_2 + WM.
43	Bisschop et al.	[108]	Prismatic 28Ah NMC	EV Pack-Level: An enclosed EV battery pack cabinet contains two live and six dummy modules. Each live module contains 12 cells.	1. WM with less than 5% foam additives (Internal only) 2. Water spray with less than 5% foam additives (Internal and External) Discharge internally into the battery box and externally onto the battery box	Sweden	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
44	Liu et al. (Journal paper from citation search)	[124]	Cylindrical 2.6Ah NMC	Five cells bundled in a combustion chamber	WM	China	WM can extinguish the fire and exhibit an excellent cooling effect to prevent TR propagation. However, an insufficient amount of WM could not stop the TR of the initiating cell effectively.
2019							
45	Liu et al.	[149]	Cylindrical NMC 2.6Ah	Single-cell in a combustion chamber	WM	China	WM can prevent TR before the battery reaches the critical TR temperature. Although it cools the battery surface, it still cannot stop TR beyond the critical TR temperature.
46	Yu et al.	[107]	Prismatic 20Ah LFP	EV Pack-Level: A standard electric bus battery pack case contains one live and eight dummy modules. The live module contains 12 cells.	$C_6F_{12}O$ gas discharge directly into the battery case. The battery cells in the live module are exposed to the gaseous agent.	China	$C_6F_{12}O$ gas can extinguish the fire and has a certain cooling effect to block TR propagation with continuous injection. Details are also presented in Chapter 4.
47	Long & Misera (Technical report from citation search)	[113]	1. Prismatic 20Ah LFP 2. Prismatic 32.5Ah NMC	BESS Rack-Level: A rack contains 16 live battery modules. Each LFP live module contains 78 cells, and each NMC live module contains 64 cells.	Sprinkler system in a testing facility	USA	Details are presented in Chapter 4.
48	Ditch & Zeng (Technical report from citation search)	[112]					
49	Gully et al. (Technical report from citation search)	[110]	Pouch Unknown cell capacity NMC	BESS Rack-Level: A rack contains 1 live and 17 dummy modules in a testing facility.	1. Sprinkler 2. HPWM 3. Novec1230 ($C_6F_{12}O$) 4. Direct injection of FIFI4Marine CAFS 5. Direct injection of water	Norway	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
2018							
50	Russo et al.	[122]	Pouch 20Ah LNO	Single-cell in an open outdoor space	1. CO_2; 2. Foam; 3. dry powder; 4. Water; and 5. WM	Italy	The experiment briefly investigates the extinguishing effect of each agent on the single cell. The order of extinguishing efficiency is water>foam>WM>CO2>Dry Powder. TR mitigation is not investigated.
51	Si et al.	[150]	Prismatic NMC	Single-cell in an explosion-proof tank	1. CO_2 2. HFC-227ea (not discussed in the thesis)	China	CO_2 can extinguish the fire and has a certain cooling effect on the battery. TR is not investigated in this paper.
52	Zhuang et al.	[89]	Pouch 30Ah LFP	Single-cell in a combustion chamber	1. N2 2. CO_2	China	CO_2 has better heat absorption capability than N_2 and exhibits a better cooling effect. However, both agents cannot prevent TR.
53	Liu et al.	[90]	Prismatic 38Ah NMC	Single-cell in an explosion-proof box	$C_6F_{12}O$ gas	China	$C_6F_{12}O$ gas can quickly extinguish the fire within 2-3s. However, it cannot effectively cool the battery below the TR temperature from the evidence that the vent gas continues releasing from the battery after the fire is extinguished.
54	Li et al.	[84]	Pouch 30Ah LFP	Single-cell in an enclosure	WM with additives containing SDS and EL-20	China	The experiment investigates the fire extinguishment capability of WM and WM with additives. The extinguishment efficiency is in the order of WM with SDS+EL-20 additives > WM with SDS additive > WM with EL-20 additive > pure WM. TR mitigation is not further investigated.
55	Wang et al.	[119]	Cylindrical 50Ah NMC	Single-cell in an enclosed cupboard with three layers of shelf	1. $C_6F_{12}O$ gas 2. CO_2	China & UK	$C_6F_{12}O$ gas can extinguish the battery fire within 30s. Whereas, CO_2 cannot entirely suppress the fire. TR mitigation is not investigated in this paper.
56	Andersson et al. (Technical report from citation search)	[102]	Pouch 20Ah LFP	Module-Level: one live cell, one dummy cell and four perforated metal sheets (mimicking densely packed battery cells) are placed in a battery module box.	Total compartment test: 1. LPWM 2. HPWM 3. Water spray Direct spray test over the module box: 4. Water spray 5. Class A foam 6. Class F foam 7. CAFS 8. N_2 9. AVD	Sweden	Details are presented in Chapter 4.

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S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
57	Zhu et al. (Journal paper from citation search)	[85]	Unknown shape 20Ah LFP	Module-Level: Four cells bundled in a battery module box	LPWM with not more than 5% additives containing FMEE-APG-SDS-AEC-MAEPK	China	WM mist with the proposed additives can effectively and quickly extinguish the fire. TR mitigation is not investigated in this paper. Details are also presented in Chapter 4
58	Luo et al. (Journal paper from citation search)	[86]	Cylindrical 20Ah LFP 50% SOC	Module-Level: Four cells bundled in a battery module box	1. WM with 5% F500 2. WM with 5% self-made solution 3. Pure water	China	WM with additives exhibits more rapid suppression and excellent cooling effect than pure water. The overall performance of WM with the self-made solution is slightly better than WM with F500. Details are also presented in Chapter 4
2017							
59	Ditch	[118]	Pouch 20Ah LFP	Warehouse Storage: 20 cells packed in a single-wall corrugated carton box. Plastic dividers separate the cells. A maximum of 42 carton boxes contain a total of 840 cells. 50% SOC	Sprinkler system	USA	Details are presented in Chapter 4.
60	Hill et al.	[101]	1. NMC 2. LFP 3. LTO Ranged from 1.2 to 200 Ah	1. Cell test in an enclosed chamber 2. Module-Level test in a partially enclosed outdoor burn facility (metal container) 90% SOC	1. Water 2. Pyrocool 3. F-500 4. FireIce 5. Aerosol (Star-X)	USA	Details are presented in Chapter 4
61	Hill & Warner (Technical report from citation search)	[99]					
2015							
62	Rao et al.	[98]	Prismatic 100Ah LFP	Single-cell in an enclosed chamber	1. CO_2 2. Superfine powder 3. Heptafluoropropane (FM200) (not discussed in this thesis)	China	The experiment shows that CO_2 and superfine powder can suppress the fire but cannot stop TR.

Appendix B2

S/N	Reference		Battery Type	Test Method	Extinguishant / Suppression Method	Country	Key Finding
				2014			
63	Maloney (Technical report from citation search)	[67]	Cylindrical 2.6Ah (50% SOC) Unknown chemistry	Five cells bundled in an enclosed test chamber	Water-based agents: 1. Water 2. AF-21 3. AF-31 4. Aqueous A-B-D Gas-based agents: 5. Novec1230 ($C_6F_{12}O$) 6. Dupont FE36 7. CO_2 8. FM200 (not discussed in the thesis) 9. Halon (not discussed in the thesis) Dry chemical agent: 10. Purple-K	USA	Water-based agents are more effective in cooling than non-water-based agents. Water, AF21, AF31, Aqueous A-B-D and Novec1230 can extinguish the fire and stop the TR propagation. Whereas all the rest of the agents cannot prevent the TR propagation.
				2013			
64	Juarez et al.	[64]	Cylindrical 4Ah Unknown Chemistry unknown	Module-Level: Two battery modules with four cells in each module. No enclosure is used.	1. Fine WM extinguisher 2. CO2 extinguisher Discharge over the surface of two battery modules.	USA	Details are presented in Chapter 4.
65	Ditch & Vries (Technical report from citation search)	[65]	Cylindrical Unknown capability and chemistry	Warehouse Storage: Carton boxes containing packed cells are arranged in a three-tier-high open-frame rack-storage (up to 4.6m) in a Large Burn Laboratory. 50% SOC	Sprinkler system	USA	Under the test storage environment, the ceiling sprinkler cannot extinguish the fires beyond the predicted experimental duration.

Appendix B2

Filtered articles based on the exclusion criteria in Step 4

S/N	Reference		Article Title	Reason of Exclusion
1	Han et al., 2023	[151]	*"Study on the minimum extinguishing concentration of $C_6F_{12}O$ for extinguishing synthesis gas flame of lithium-ion battery"*	The experiment uses extractive lithium-ion vent gases.
2	Wang et al., 2022	[152]	*"Fire and explosion characteristics of vent gas from lithium-ion batteries after thermal runaway: A comparative study"*	The experiment uses extractive lithium-ion vent gases.
3	Strum et al., 2022	[153]	*"Fire tests with lithium-ion battery electric vehicles in road tunnels"*	The experiment uses direct injection of water via a firefighting lance for fire services
4	Cui et al., 2022	[154]	*"Full-scale experimental study on suppressing lithium-ion battery pack fires from electric vehicles"*	The experiment uses direct injection of compressed air foam for fire services.
5	McKinnon et al., 2022	[155]	*"Full-scale walk-in containerized lithium-ion battery energy storage system fire test data"*	The paper only provides the proposed experimental settings without any results.
6	Fan et al., 2022	[156]	*"Numerical analysis on the combustion characteristic of lithium-ion battery vent gases and the suppression effect"*	The experiment uses extractive lithium-ion vent gases.
7	Liu et al., 2021	[157]	*"Experimental study on active control of refrigerant emergency spray cooling of thermal abnormal power battery"*	The experiment uses dummy battery cells to investigate the active control of the battery thermal management system, which is not directly related to fire suppression.
8	Egelhaaf et al., 2021	[158]	*"Firefighting of Li-Ion Traction Batteries - An Update"*	The experiment uses direct injection of water/CO_2/F-500 via a firefighting lance for fire services
9	Barelli et al., 2021	[159]	*"Oxygen reduction approaches for fire protection to increase grid Li-ion BESS safety"*	The paper discusses the conceptual study using the flammability limit of vent gases from LIBs. No experiment is carried out.
10	Un et al., 2021	[160]	*"Experimental study of fire suppression for Li-ion electric batteries with H_2O"*	The experiment uses direct injection of water for fire services.
11	Li et al., 2020	[161]	*"Full-scale experimental study on the combustion behavior of lithium ion battery pack used for electric vehicle"*	The experiment uses direct injection of water for fire services.
12	Liu et al., 2019	[162]	*"The inhibition/promotion effect of $C_6F_{12}O$ added to a lithium-ion cell syngas premixed flame"*	The experiment uses extractive lithium-ion vent gases.
13	Ghiji et al., 2019	[163]	*"Lithium-ion battery fire suppression using water mist systems"*	The experiment uses extractive lithium-ion electrolyte
14	Wang et al., 2016	[164]	*"The efficiency of heptafluoropropane fire extinguishing agent on suppressing the lithium titanate battery fire"*	The experiment uses FM200 for the fire suppression test.
15	Blum & Long, 2015	[165]	*"Full-scale fire tests of electric drive vehicle batteries"*	The experiment uses direct injection of water for fire service.
16	Hu et al., 2013	[166]	*"Effectiveness of heat insulation and heat dissipation for mitigating thermal runaway propagation in lithium-ion battery module"*	The paper discusses passive fire protection using a heat insulation approach. No experiment has been conducted on active fire protection methods.
17	Egelhaaf et al., 2013	[66]	*"Fire fighting of li-ion traction batteries"*	The experiment uses direct injection of water for fire service.