SPECIFIC FEATURES OF THERMAL RUNAWAY OF LITHIUM–ION BATTERIES EQUIPPED WITH SAFETY VALVES

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Abstract: The article presents a comparative assessment of the safety for prismatic lithium–ion batteries (LIBs) subjected to thermal runaway (TR). Thermal runaway was a consequence of a series of uncontrolled exothermic reactions occurring inside the cells under controlled external heating to a critical temperature. The most common electrochemical systems (NMC (nickel manganese cobalt) / C, NMC/LTO (lithium titanate), and LFP (lithium ferrophosphate) / C) in soft polymer and rigid metal packages were studied. As a result of the test-batteries constant-speed heating, the influence of the safety valve (SV) available on LIBs with rigid cases on the process of TR was determined in comparison with batteries with soft polymer cases. It is shown that LIBs equipped with SV are characterized by TR in two stages. It has been experimentally found that the secondary TR was initiated by clogging of the SV and by throttling of the gas outflow from far from SV areas of the LIBs.

Keywords: lithium–ion batteries; thermal runaway; safety valve; rigid case; NMC; LFP

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Figure Captions

Figure 1 Schematic of the experimental setup: *1* — sampler; *2* — constant volume chamber; *3* — electric heater; *4* — copper plate of 20-millimeter inner diameter for thermal interface between heater and LIB; *5* — LIB; *6* — fiberglass fabric shell to cover LIB and heater; *7* — thermocouple inlet (red from the heaters and blue — from contact point between LIB and copper plate); and *8* — electric heater power line. Dimensions are in millimeters

Figure 2 Schematic of the gas system: *1* — sampler; *2* — pressure gauge; *3* — air compressor; *4* — vacuum pump; *5* — manometer; *6* — vacuum gauge; *7* — test chamber with LIB; and *8* — drainage valve

Figure 3 Time histories of temperature, voltage, and pressure in the test chamber in an experiment with LIB of A type (*a*), B (*b*), C (*c*), D (*d*), and E (*e*)

Figure 4 Lithium–ion battery in a rigid case before (*a*) and after (*b*) experiment. Clogging of the SV

Table Caption

Test objects

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