INTISARI

Saat ini, baterai *lithium-ion* sebagai sumber energi dari berbagai alat elektronik dan kendaraan listrik terus meningkat intensitas pemakaiannya. Peningkatan jumlah baterai tersebut berdampak pada peningkatan limbah baterai secara progresif. Bertambahnya jumlah limbah baterai di Indonesia lambat laun dapat memicu penumpukan limbah. Mendaur ulang limbah baterai tersebut dapat menjadi solusi yang efektif, namun usaha itu harus dilaksanakan dengan hati-hati berdasarkan langkah *pretreatment* tertentu. Kominusi merupakan salah satu langkah yang harus dilalui dalam proses daur ulang baterai dan jenis limbah elektronik lainnya. Maka dari itu, mesin kominusi harus dirancang sebaik mungkin agar mampu melakukan proses kominusi baterai secara efektif.

Penelitian ini bertujuan untuk merancang dan menyimulasikan model ruang kominusi untuk *prototype* mesin *shredder* baterai *lithium-ion* 18650. Parameter rancangan komponen *driveshaft*, *countershaft*, 6 model pisau, dan 3 model ruang kominusi diperoleh dengan memanfaatkan metode analitik. Variasi model pisau dan ruang kominusi dikelompokkan menjadi 3 jenis, yaitu model Tipe A, B, dan C. Varian model Tipe A memiliki pisau dengan jumlah *blade* 2 buah. Sementara varian model Tipe B dan C, masing-masing memiliki pisau dengan *blade* berjumlah 3 dan 4 buah. Setiap model yang telah dirancang kemudian disimulasikan dengan perangkat lunak Abaqus CAE. Simulasi *static stress* dilakukan pada komponen *driveshaft*, *countershaft*, dan 6 model pisau. Simulasi *explicit dynamic* dilakukan pada 3 model ruang kominusi.

Hasil simulasi pada model *driveshaft*, *countershaft*, dan 6 model pisau menunjukkan bahwa semua model sudah aman, serta pantas untuk dimanufaktur. Simulasi *explicit dynamic* pada model ruang kominusi menunjukkan bahwa model ruang kominusi dengan konfigurasi pisau Tipe A mampu menghancurkan baterai dengan baik. Ukuran puing hasil kominusi, respon dinamis elemen, dan kapasitas ruang kominusi juga dievaluasi. Sementara model Tipe B dan C tidak mampu menghancurkan baterai. Oleh karena itu, parameter model ruang kominusi Tipe A digunakan sebagai referensi untuk merancang *prototype* mesin *shredder* baterai *lithium-ion* tipe 18650.

Kata kunci: Baterai *lithium-ion*, Daur ulang, Kominusi, Respon dinamis, Simulasi *static stress*, Simulasi *explicit dynamic*

ABSTRACT

Lithium-ion batteries are currently being used more frequently as an energy source for different electronic products and electric cars. As the quantity of batteries increases, so does the amount of battery waste. The growing amount of battery waste in Indonesia may eventually lead to e-waste accumulation. Recycling these spent batteries can be an efficient option, but it must be done with caution and in accordance with specific pretreatment methods. Comminution is one of the procedures required in the recycling of batteries and other types of electrical waste. As a result, in order to carry out the battery comminution process properly, the comminution device must be designed properly.

The purpose of this research is to design and simulate several comminution chamber models for a lithium-ion battery shredder machine. Analytical methods were used to determine the design parameters for the driveshaft, countershaft, 6 knife models, and 3 comminution chamber models. Knife models and comminution chambers are categorized based on the number of blades on the knife. The Type A model has knives with 2 blades. The Type B and C model variants have knives with 3 and 4 blades, respectively. Each developed model is then simulated using the Abaqus CAE software. The driveshaft, countershaft, and 6 knife models were subjected to static stress simulations. Three models of comminution chamber were subjected to explicit dynamic simulations.

The simulation results for the driveshaft, countershaft, and 6 knife models reveal that all of them are safe and suitable for manufacturing. Explicit dynamic simulation of the comminution chamber models reveals that the comminution chamber model with Type A blade configuration can effectively destroy the battery. The size of the comminuted shards, the dynamic response of the battery element, and the capacity of the comminution chamber were also evaluated. The Type B and C models, on the other hand, were not capable of destroying the battery. As a result, the Type A comminution chamber model parameters were used as a basis for designing the lithium-ion battery shredder prototype.

Keywords: Comminution, Dynamic response, Explicit dynamic simulations, Lithium-ion battery, Recycling, Static stress simulations