Optimal Sample Size Allocation for Accelerated Degradation Test

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Accelerated Degradation tests (ADTs) are widely used to assess the lifetime information of highly reliable products possessing quality characteristics that both degrade over time and can be related to reliability. Hence, how to design an efficient ADT plan for assessing product's lifetime information at normal-use stress (especially for the optimal sample-size allocation to higher test-stress levels) turns out to be a challenging issue for reliability analysts. In the literature, several papers had addressed this decision problem. However, the results are only based on a specific degradation model (such as Wiener, Gamma, inverse Gaussian models, etc.) and it lacks of a uniform approach for a general degradation model. To overcome this difficulty, we first propose an exponential dispersion (ED) degradation model which covers all mentioned above degradation models. Next, by using V-optimality, D-optimality, and A-optimality criterion, we derive the analytical expression of the optimal sample-size allocation for a 2-stress ADT when the underlying degradation model follows an ED degradation model. The results demonstrate that the V-optimal and A-optimal allocations are the functions of unknown parameters and life-stress function, while D-optimal allocation turns out to be an equal sample-size allocation. Furthermore, we also discuss the relative efficiency of the D-optimal and A-optimal allocations with respect to V-optimal allocation and it demonstrates that the relative efficiency of D-optimal and A-optimal allocations with respect to V-optimal allocation are around 85% and 83%, respectively.

Key Words: Exponential dispersion model, V-optimality, D-optimality, A-optimality.