Conditional Monitoring of Electronic Passive Component Techniques: A Review

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Abstract

Fast and continuous change of technology in field of electronic devices in field of low cost, better performance the devices are getting more complex and also getting easy for portability. In the current era cost, performance is key features to attract customers. So as the integration of components on a single chip is increasing, devices are getting more and more complex and also due to this the chances of fault and failure is increasing.

Keywords: RUL(Remaining Useful Life), rate of failure, Capacitor, Prediction of failure

1. Introduction

The instrument or electronic component manufacturers around the globe are trying to improve the reliability of their exciting components. The struggle is going to increase the performance of the components by keeping a normal cost and also less time to market. High performance and low cost is no more attraction to customers. Many a times there is a recall of sold components because of low quality or a faulty system causing a big loss to even device giants. This is generally because of ignoring the need of reliability calculation and failure analysis or due to using traditional approach of calculating the RUL i.e. remaining useful life. The automobile industry is also not safe and big automobile giants need to call back their cars.

SO a prediction method to find failure in component is required so as to reduce the rework cost. There are multiple approaches to find the same. In this paper a review has been done related to multiple existing techniques of calculating the failure and reliability of components.

FAILURE and RELIABILITY PREDICTION

Reliability is used to find that how reliable any component is used in electronic devices. It is used to prevent the failure in components or devices. Reliability plays a vital role to measure rate of failure. Reliability defines the chance of occurrence of these failures in the system along with preference. Few of the major reasons of failures are as follows:

1) Using the component beyond prescribed limit of stresses.
2) Inherent weakness or bad quality product itself.
3) Deterioration of component because of its age and regular usage.
4) Failure of one component may result to bad performances of other components as well.

Bath-tub curve which is used to analyze failures in the electronic devices

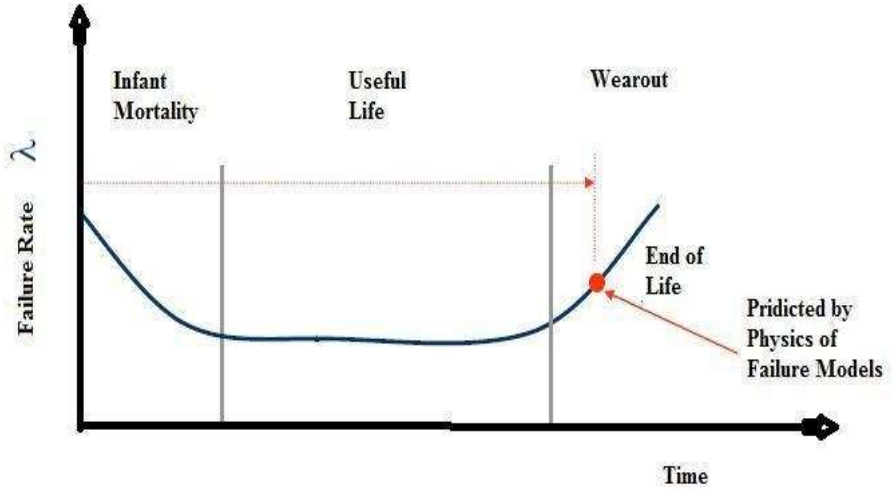

Figure 1. Bath Tub Curve

The defects that turn up during manufacturing process or in the very beginning of component usage are termed as early life failures represented in infant mortality section. With increasing age this error gradually decreases.

The second stage represents a constant failure rate which is due to random occurring evening. The fine stage is wear out stage which is due to exposure of component to environmental stress or overloaded electrical parameters. The chances of failure in this section increase gradually because as age of component increases, chances of failure also increase.

2. Literature Review

1) **Zhao, Shuai, et al. [9]**, a health assessment method for electronic components subject to condition monitoring (CM) is presented, which can be used to estimate the conditional reliability characteristics given the current operational age and the corresponding degradation state. The degradation process is characterized by a continuous-time Markov chain, which is incorporated into a Cox's proportional hazard model to describe the hazard rate of the time to failure. The two main challenges encountered in the health assessment of electronic components subject to CM and hard failure, i.e., the large number of degradation states and the general deteriorating transition mechanism, can be properly addressed by the proposed method.

2) **Vasan, Arvind Sai Sarathi, and Michael G. Pecht [10]** When ever there is any change or deviation in electrical parameter of electronic component from their basic initial value, the component starts to degrade. This results to lower performance of circuit in which these components are used. This parametric failure also results to failure of component or device. The current approach is to find the component level errors in the system by finding deviation in individual parameter. To solve this issue, a prognostics method that exploits features extracted from responses of circuit-comprising components exhibiting parametric faults is discussed

3) **Bhargava, C., Banga, V. K., & Singh, Y. (2018[15]** The paper focuses on another major parameter which is reason of failure of capacitor. The factor is thermal stress or high temperature. Under effect of high temperature, VALUE of ESR and C changes rapidly because electrolyte inside capacitor starts to evaporate due to which size of capacitor reduces. Due to this charging and discharging cycle of capacitor also varies and results to degradation in life of capacitor. In the paper humidity factor is also considered which enhances the degradation cycle of capacitor. Considering this the accuracy in predicting life of capacitor was enhanced to 90% which was only 55% in earlier cases.

4) **Yao, K., Cao, C., & Yang, S. (2017). [14**] As electrolytic capacitors are majorly responsible for failure of power electronic devices, hence a online noninvasive monitoring system was suggested to check reliability and life of Electrolytic capacitors. The monitoring system is capable to find output of electrolytic capacitor by continuous analysis of Equivalent series resistance (ESR) and capacitance. An extra trigger was used to amplify the output and to detect the switching in output voltages by continuously monitoring capacitors. The monitoring discussed is of three types- offline monitoring, Quasi online and

online monitoring. The major drawback of offline monitoring was device is required to be switched off before analyzing and was overcome by online monitoring and quasi online monitoring.

5) **Chigurupati A et.al. [16]** With advancement in machine learning, to predict the failure of component, the past behavior is used to learn and analyze and there after predict the future behavior. This helps in predicting behavior of individual component until failure occurs. Use of past life makes the prediction more accurate. In the paper the ability of machine learning to predict the past behavior were explored to improve the prediction of component before the failure happens. Once failure is predicted the problem of complete machine failure can be saved.

6) **Bhargava, C., Banga, V. K., & Singh, Y. (2014, March). [**13] Capacitor is used mostly in all the electronic circuits basically to store charge. Electrolytic capacitors are those capacitors which are most widely used because of less prize and higher capacitance. The biggest problem is failure of these components because of millions of components integrating over a single chip. Generally, life or reliability of all the components depends majorly on electrolytic capacitors. As the environmental stress and other parameters like electrical enhances there is degrading in the electrolytic capacitor performance. Due to this degradation the reliability of electronic component reduces. The paper emphasizes over different parameters which affect the performances of electrolytic capacitors.

Electrolytic capacitors are mostly used with power electronic circuits. Due to this they are under effect of high temperature as huge amount of power is dissipated under influence of ripple current and high voltages.

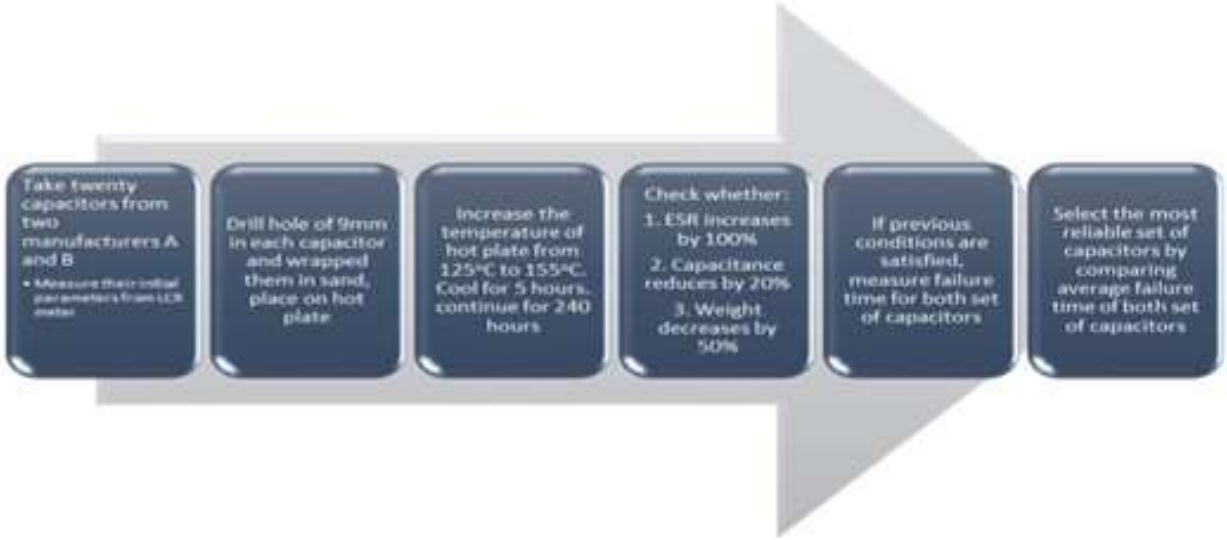

Figure 5: experimental method used to find reliability of electrolytic capacitors [13].

7) **Challa, V., Rundle, P., & Pecht, M. (2013)** [11] In this modern era of developing and emerging electronics, it is very much important to find if a component is able to meet the specific requirements or not. VLSI companies are trying and spending huge amount of money on developing high performance components. It is required to find the reliability of the component under adverse physical conditions by the help of qualification. Qualification means showing if a component is meeting all the specified requirements under different physical conditions. For all the components it is very much important to undergo qualification before the yielding starts else any failure might result to cost penalties or higher rework and costly redesigning of components. This will also increase time to market of electronic component. Qualification may start from simulation only and after any small change in component specification requalification is mandatory so as to find if component is reliable to be launched in market. For better and optimum results of qualification it is required that the process is done at all the different stages like contract manufactures followed by component manufactures, assembly companies and computer manufactures. After all these tests, it is also not mandatory that the actual life of component is same as that predicted by qualification.

8) **Chauhan, P et.al. [12]** Whenever and electronic device is functional the important and critical role is played by solder interconnects. The connect plays an important role in assembling so to predict the failure of components, monitoring of solder connects is important. This monitoring of solders also helps to find rate of failure in the devices. The paper [12] shows how temperature can be used as an health assessment model to monitor the health of these devices. With increase in temperature, the degradation of solder connect is analyzed by increasing the temp and keeping a constant current of 5 Ampere. The analysis shows that the rise in temperature is directly proportional to damage in the device. Hence temperature plays an important role in predicting RUL of solders.

Table 1: Reliability of Solder Connects

Solder type	**Sample size**	**Thermal cycles**			
SN100C	3	750	1500	3000	4500
SnPb	3	750	1500	3000	4500

Conclusions

This paper reviews different observations on reliability and life prediction of components by different researchers. In different research articles different parameters were considered to find the faulty component. Even though basic techniques are also used but with emerging technology chances of fault is also increasing.

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