Design Modification of Components of Head Assembly of Syrup Filling Machine- A Review

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Abstract— This paper reviews Literature survey is carried out to find the methodology and various researches have been done so far in the topic. Here due to interference problem in head assembly of syrup filling machine. hence the rework is must to perform on the particular component that increases the total cost and manufacturing time. Generally interferences and clearances type design requirements are control by design tolerances and also on manufacturing process tolerances .hence tolerance play very important role in design of product. In which little investment gives significant manufacturing cost savings. the currently available tolerance allocation tools and identifies their shortcomings which are then used to create a better tool suitable for industrial applications. The objective is to examine the optimal tolerance allocation by considering both tolerance cost and quality loss so that the total assembly cost is minimized.

Key words: Tolerance Allocation, Cost-Tolerance Function, Quality Loss Function, Syrup Filling Machine

I. INTRODUCTION

Filling machines are used for packaging, mainly for food and beverage but for other products as well as pharmaceuticals products. These are used to fill either a pouch or a bottle, depending on the product the liquid filling machines discussed here are used throughout all industries including food, beverage, chemical, cosmetic and pharmaceutical but at lower speeds; usually less than 200 containers per minute. In actual, most of the market for liquid filling machines in terms of units sold is for semi-automatic equipment that operates at speeds not exceeding 20 containers per minute. There are various type of filling machine used in industries and pharmaceuticals according to there requirement for filling of specific liquids that means one particular filling machine cannot handle all liquids in the industries. For example, a machine that fills bottled water cannot fill cosmetic cold cream. Nor would chemical duty filler be used to fill pharmaceutical grade or dairy products. Although there are many different types of filling technologies, there are relatively few that are versatile, practical and cost effective to own and operate.

II. PROBLEM DESCRIPTION

There are difficulties found in the filling head assembly parts like shafts, side plates, flange, bearings etc. while we perform assembly, in which, parts are not fitted properly. Hence, there is a need of rework of such parts to assemble them properly, which leads to increase the assembly time as well as total production cost.

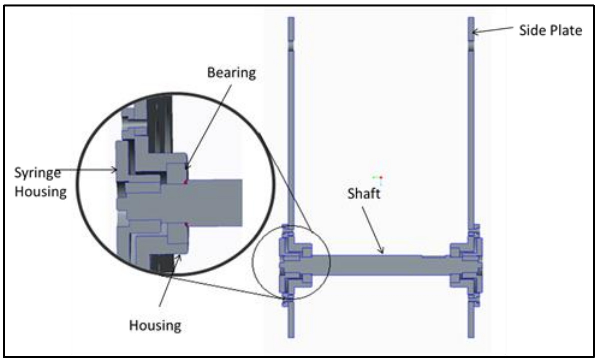

Fig. 1: Creo Model of Head Assembly of Syrup Filling Machine

As shown in fig.1 many components are their in head assembly of syrup filling machine here cross –section view represented.it is found that there should be interference between shaft and bearing .Hence for proper functioning ; interference should be eliminated. To avoid the interference; design of shaft is modified and tolerance allocation should be done according to functionality and its process capabilities.

III. LITERATURE REVIEW

M.n.islam[4] et al explained that the dimensioning and tolerancing is a multidisciplinary problem which requires the fulfilment of a large number of dimensional requirement. a strategy for separating D&T problem in to group the determination of an optimum solution order for coupled functional equation , a generic tolerance allocation strategy and strategies for solving different type of D&T problem .A number of commonly used cost minimization strategies, such as the use of standard parts, preferred sizes fits, preferred tolerance have incorporated into methodology. They also suggested about concurrent engineering[22] approach for tolerance allocation with considering process capability.

Tajulariffin bin abdullah [5] et al has discussed design improvement of product steam iron by using design for assembly (DFA) method. Components that have major influence on product assembly time are identified for elimination or combination and redesign purpose. Both data form current design and proposed design compared. The result show that the total part count are being reduced and ease installation can be done the new product development.

B.K. Ngoi et al [6] investigate that the GD&T are important engineering process in different phases of a product development cycle. Two main phase in cycle D&T are extensively imploded in Ares of product design and process planning Manual dimension and tolerance assignment is often tedious ,time consuming and require a considerable amount of skill and experience .which resulting in inconsistencies and errors. For minimizing of manufacturing as well as assembling cost GD&T gives minimum clearance or interference requirement.

A.k.sahani et al[7] suggested that Geometric dimensioning and Tolerance (GDT) constitutes the dominant approach for design and manufacture of mechanical parts that control inevitable dimensional and geometrical deviations within appropriate limits. The methodology for systematic solving stack up tolerance problem with use of generic capsule method. The generic capsule method is straightforward and easy to use for stack up of geometrical tolerances of components and their assembly using graphical approach.

R. Sampathkumar et al[8] suggests that tolerances have a significant impact on manufacturing cost and product quality. In the design of discrete part shapes, the specification of tolerance constraints can have major consequences for product quality and cost. The objective is to examine the optimal tolerance allocation by considering both tolerance cost and manufacturing cost so that the total assembly cost is minimized with pattern search method. This work is done on piston cylinder assembly and on that assembly the tolerance design is optimized by pattern search method.

Yi zhanget al[9] suggests that assembly tolerances reflect functional requirements of assembling, which can be used to control assembling qualities and production costs. A hierarchical structure tree model, namely, assembly structure tree AST, is established to express assembly structure and assembly sequence of product Assembly tolerance network design is determined by many factors, and these factors associate with each other. Therefore, the design is a multi-scale issue.

The problem addressed by r .s rinivasan et al[10] is the development of a physico-mathematical basis for mechanical tolerances. The lack of such a basis has fostered a decoupling of design (function) and manufacturing. A methodology for the overall design process comprises three stages: conceptual design, embodiment design and detail design .abstracting the error information in terms of minimum set of parameters, then used in the synthesis of realistic part models.

A. K. Sahani et al [11] suggests new approach for tolerance analysis. The stack up of tolerances and their redistribution without hampering the functionality is very important for cost optimization. It gives graphical approach over the conventional approach for tolerance stack-up. The method is known as generic-capsule.It can be verified with the design tolerance of the assembly. Based on the comparison, designer has to reassign the appropriate tolerances to fulfill the functionality if required. If the stacked tolerance is as per designer requirement, then reallocation of tolerances on individual components should be done.

Chase et al [12] established various tolerance model and give extensive research on tolerance CAD based model ,they suggest how tolerance allocation have been carried out through various method and their significant on product design .mostly tolerance allocation strategy is based on minimize of total cost .in this paper langrage multiplier method used to finding out optimal tolerances. They also gives new tolerance accumulation method which is known as estimated mean shift tolerance theory this method is very effective and it is formed to overcome the limitation which presents in traditional tolerance allocation methods (worst case method and statistical method)

There are various cost-tolerance model is suggest by different authors shown in Table I.

Cost Model	Function	Solution method	Reference
Linear	A – Bx	Linear programming	Edel and Auer[13]
Exponential	Be^{-mx}	Graphical	Peters[14]
Reciprocal squared	$A + B/x^2$	Lagrange multiplier	Spootts [15]
Reciprocal Power	$A + B/x^k$	Lagrange multiplier	Chase[12]
Empirical data	Discrete points	Lagrange multiplier	Chase et al[16]

Table 1: Various Costs –Tolerance Function

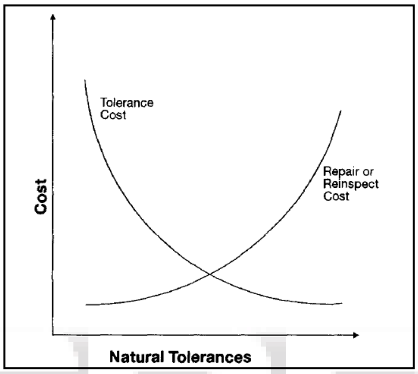

Fig. 2: Typical Cost-Tolerance Relation

After that some researcher found that if tolerance allocation is done only on minimum cost basis that would lead to quality loss of product. Hence they incorporating quality and minimum cost for tolerance design.

Jeang et al[17] represented various mathematical model for finding optimal tolerance which allocation done by combining minimum cost and quality loss.they suggested three model (i) nominal the best ,(ii)larger the better and (iii) smaller the better. for bilateral tolerance nominal the best model is always taken. low quality loss (better quality) implies high manufacturing cost (tight tolerance limits) and high quality loss (poor quality) indicates low manufacturing costs (loose tolerance limits), so adjusting the tolerances for an economic balance between quality loss and manufacturing cost for product design.

Taguchi [18] emphasized that level of quality did not meet the level of fraction nonconformities. the level indicated measure of societal losses that means 'quality losses must be defined as deviation from target value ,not conformance to arbitrarily specification.' It is observed that the product is well within its specification although the product has a quality loss if quality value is not at ideal or as target quality characteristics.

Cheng et al [19] incorporated taguchi's quality loss function for finding optimal tolerance for mechanical assembly in this paper a sensitivity analysis is also conducted to determine the effects of shifts in a component's variance and mean. That showed if a component's mean varies, only the quality loss associated with that component will be changed. If a component's variance shifts in assembly tolerance the optimal allowance, tolerance costs, and quality losses associated with each component will be affected.

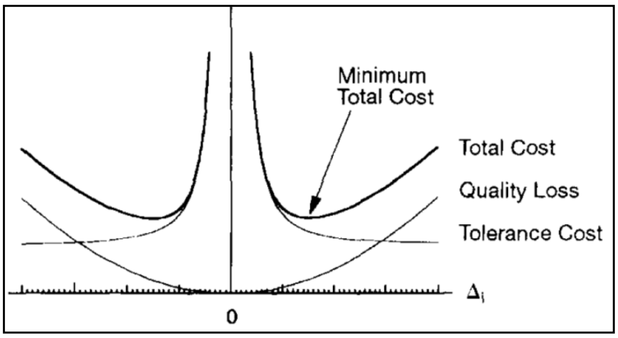

Fig. 3: Combination of Tolerance Cost and Quality Loss [21]

Huang et al [20] gives concurrent design environment and robustness as optimal method to determine design tolerance with respect to process sequences and their process tolerances .also established a nonlinear optimal model with incorporating taguchi's quality loss function .Nicely explained the methodology with taking example of wheel assembly.

Chou et al [21] further improve the method of tolerance allocation with incorporating new factors and that are time degradation and value of money. they also performed sensitivity analysis with two new parameters in the proposed model: the planning horizon (T) and the product user's discount rate (r) for finding true optimal tolerance.

IV. Conclusion

From the Literature review related to design issues in mechanical assembly , it can be concluded that:

Design requirements should be fulfilled for proper functioning of machine.Tolerance plays vital role in product design. in this area very little investment can results in significant cost savings. Various tolerance allocation strategies been proposed and cost reduction has been the focus of most of these strategies. The existing tolerance allocation strategies can be grouped into three categories: (i) strategies that lead to cost reduction, (ii) strategies that attempt minimize quality loss and (iii) strategies that attempt to minimize quality loss and/or productivity loss and cost tolerance both together .

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