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Design and Analysis of Fuel Tube Fixture for Sleeve Heating Process in Automobile

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Abstract: Introduction of sleeve heating fixture for heat shrinking oven in order to eliminate temporary mismatch of the fixture to hold the sleeve on peeling area of the fuel supply pipe and to ensure the specified limit of the fixture using heat shrinking process by adopting vital design modification of fixture. To ensure the specification limit of the fuel tube fixture for the heat shrinking process. Conventionally in the manufacture the fixture is not used so that the manufacturing process becomes so tedious and a slower process but now we are designed a fixture which would help the process to get automated and makes the heat shrinking process simpler and efficient. And the heat shrinked tubes are tested by using dye penetrant test and leak test and those results depicted that the accuracy improvement in the heat shrinked tubes. The improvement in the accuracy of the heat shrinked tubes simultaneously increases the production rate and thus the overall economic improvement in the manufacture occurs.

Keywords: Fixture; Design modification; production rate; peeling area

I. Introduction

Over the past century, manufacturing has made considerable progress. New machine tools, high performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. Although work holding methods have also advanced considerably, the basic principles of clamping and locating are still the same.

The fixtures must satisfy the following conditions

- ☐ Reduction of ideal time
- ☐ Cleanliness
- ☐ Provision for coolant
- ☐ Safety

II. Literature Survey

A brief review of contemporary research supporting this paper is presented below.

The study of Dr. Yu Zheng presents a method for finding form-closure locations with enhanced immobilization capability. Fixtures are used in many manufacturing processes to hold objects. Fixture layout design is to arrange fixturing elements on the object surface such that the object can be held in form-closure and totally immobilized.

The research of closure locations was determined experimentally by Kartik as it focused on the kinematics, stiffness, repeatability of a moving groove and dual-purpose positioned fixture. A dual-purpose positioned fixture is an alignment device that may be operated in a fixture mode or a six-axis nano-positioning mode.

In contrast to concentration of six axis nano positioning method Dr.Patrick J. Golden tested a unique dovetail fretting fatigue fixture was designed and evaluated for testing turbine engine materials at room or elevated temperatures. Initial test results revealed interesting variability in the behavior of the nickel based super alloy specimens at elevated temperature.

Mervyn addresses the development of an Internet-enabled interactive fixture design system. A fixture design system should be able to transfer information with the various other systems to bring about a seamless product design and manufacturing environment.

The general situation of research on agile fixture design is summarized and the achievements and deficiencies in the field of case-based fixture design are pointed out. There are no correlative case bases and matching mechanisms during the period from establishing the fixture planning to design the fixture in currently used case-based fixture design systems. Thus a great amount of experience of fixture design is wasted and can't be re-used, which reduces design efficiency and violates the original intention of case-based reasoning methods. In order to realize agility of fixture design, including re-configurability, re-scalability and re-usability.

Wassanai Wattanutchariya's paper investigates the allowable tolerance limits in fixtures in order to minimize fin buckling while attaining precise alignment. A high-temperature buckling model is developed to predict the onset of fin buckling within a fixture. The results of the model are validated empirically. The post-buckled beam shows the soften-and-hardening characteristics of restoring force. In order to clarify chaotic behavior of thin walled beams, detailed experimental results carried by Nagai are presented on chaotic vibrations of a post-buckled beam subjected to periodic lateral acceleration. The principal component analysis predicts that the contribution of the lowest mode of vibration to the chaos is dominant among other contributions of multiple vibration modes.

K.C. Aw paper concentrates on electronic equipment used for maritime application. Simulation using ANSYS workbench software was performed to comprehend the effect of various parameters of accelerated testing performed on these waterproof enclosures. Experiments were performed to examine the correlation with simulation results.

The above mentioned strategy was applied to reduce the buckling in a part of fixture design assembly. But our main objective of the project is to increase the productivity with required accuracy.

III. Objectives

- Mismatching of sleeve on peeling during the heat shrinking process due to fixture design
- Due to mismatching of sleeve on peeling it cause damage to the fuel tube

IV. Methodology

- Study of the fuel tube component and the existing fixture in use.
- Study of the process planning: Estimation of the process for achieving the final dimensions of the components, selection of tools, tool holders, insert grades, cutting parameters and arriving at the cycle time of the component.
- Fixturing concept: As per the fixture plate dimensions the vertical machining center is selected and conceptualized design is done by using creo software
- Detailed design: Part drawing of the fixture using CREO modeling software.
- Analysis of critical components: The transient temperature analysis By using ANSYS software.

V. Fixture design

Fixture planning is to conceptualize a basic fixture configuration through analyzing all the available information regarding the material and geometry of the work piece, operations required, processing equipment for the operations and the operator.

VI. Design features

1. Heat shrink Sleeve length
2. Peeled area length
3. Heat shrink Sleeve position
4. Lock pin

6.1 Cycle time estimation

The design of fixtures should be such that the process of loading and unloading the components takes the minimum possible time and enables on easy loading.

Table 1: Cycle time estimation

Total cycle time	3 mins
Load and unload time	1 mins
Total time	4 mins
No. of tubes / hour	150 nos.

Hence, the production rate of fuel tube component is one fifty components per hour.

6.2 Fixture planning

Certain things to be remembered while designing a fixture

- Application of the fixture (manufacturing/repair/inspection)
- Number of parts for which the fixture will be used
- Level of accuracy required
- Replace ability, reusability and discard ability of the fixture
- Standardization of fixtures

6.3 Fuel Tube component

1. A fuel tube for a gasoline engine, the fuel tube comprising: an outer polymer layer; an inner polymer layer; and an intermediate layer of ethylene vinyl alcohol copolymer (EVOH), wherein the intermediate layer is a permeation barrier layer having an ethylene content of approximately 24 to 29 mol percent and a thickness between approximately 0.02mm and 0.07mm.
2. The fuel tube for a gasoline engine of claim 1, wherein the outer polymer layer is constructed of polyamide.
3. The fuel tube for a gasoline engine of claim 1, wherein the outer polymer layer is constructed of a polyamide selected from a group consisting of polyamide 12, polyamide 11, polyamide 10-10, polyamide 6-10, polyamide 6-12,polyamide12-12andcombinationsthereof.
4. The fuel tube for a gasoline engine of claim 6, wherein the inner polymer layer is constructed of a low oligomer polyamide selected from a group consisting of polyamide 6-10, polyamide 6-12, polyamide 10-10 and combination therof.
5. The fuel tube for a gasoline engine of claim 1, wherein the outer polymer layer is constructed of a polyamide selected from a first group consisting of polyamide 12, polyamide 11, polyamide 10-10, polyamide 6-10, polyamide 6-12, polyamide 12-12 and combinations thereof and the inner polymer layer is constructed of a polyamide selected from a second group consisting of polyamide 6-10, polyamide 6-12, polyamide 10-10 and combinations thereof.
6. The fuel tube for a gasoline engine of claim 1, wherein the fuel tube is three-layer, co-extruded tube.
7. The fuel tube for a gasoline engine of claim 1, wherein the fuel tube is a liquid fuel tube for transferring a liquid fuel.
8. The fuel tube for a gasoline engine of claim 1, wherein the fuel tube is a fuel vapor tube for transferring a fuel vapor.
9. The fuel tube for a gasoline engine of claim 1, wherein the inner layer is a conductive layer or a static dissipative layer.
10. The fuel tube for a gasoline engine of claim 1, wherein the inner layer is a non-conductive layer.
11. The fuel tube for a gasoline engine of claim 1, wherein the inner layer is a low oligomer polyamide layer.
12. The fuel tube for a gasoline engine of claim 1, further comprising a first adhesive layer between the inner layer and the intermediate layer and a second adhesive layer between the outer layer and the intermediate layer.

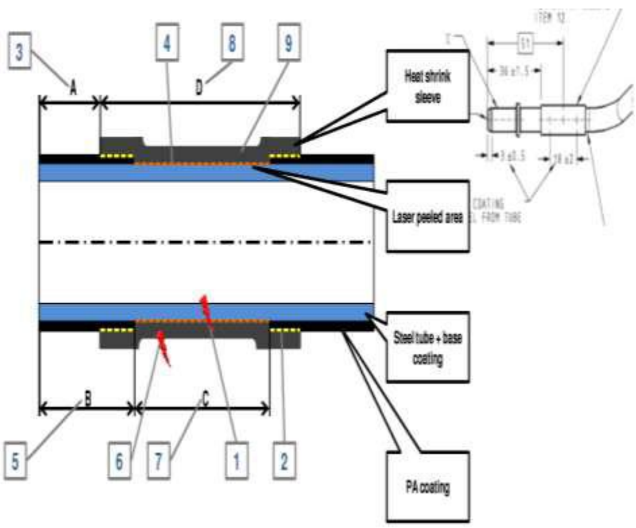

Figure No :1 sleeve connection in fuel tube

7. Part Drawing of Heat Shrinking fixture

This fixture designed with in specification limits and it satisfy the specification limits of 36±1.5 and 3±0.5 The fixture which is required for the IR-oven is design and analyzed as follow

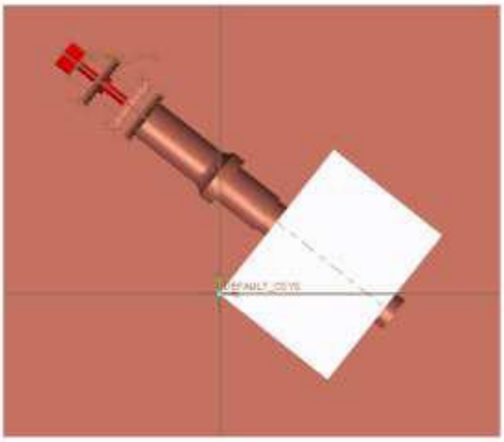

Figure No: 2 Top View of Fixture

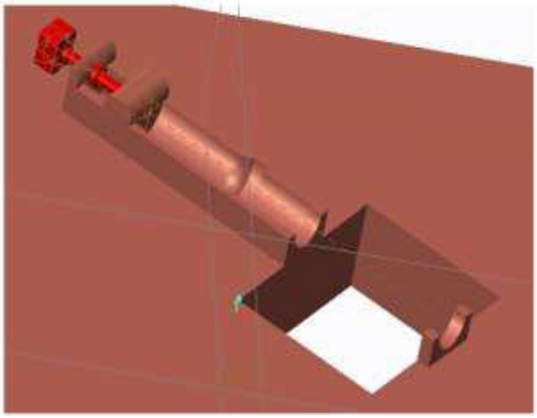

Figure No: 3 Isometric View of Fixture

In fixture one part will be zoomed the figure no 2,3 shows the top and isometric view of the fixture.

- This fixture to improve the production rate and reducing the overall production time. Hence, it is easy to operate for the operator. Replacement of the newly designed fixture improves the production rate.
- Reduces the complications in the production process.
- Improves the accuracy in the manufacture of fuel tube .
- The introduction of the new fixture reduces production time comparatively and thus increases the production quantity.

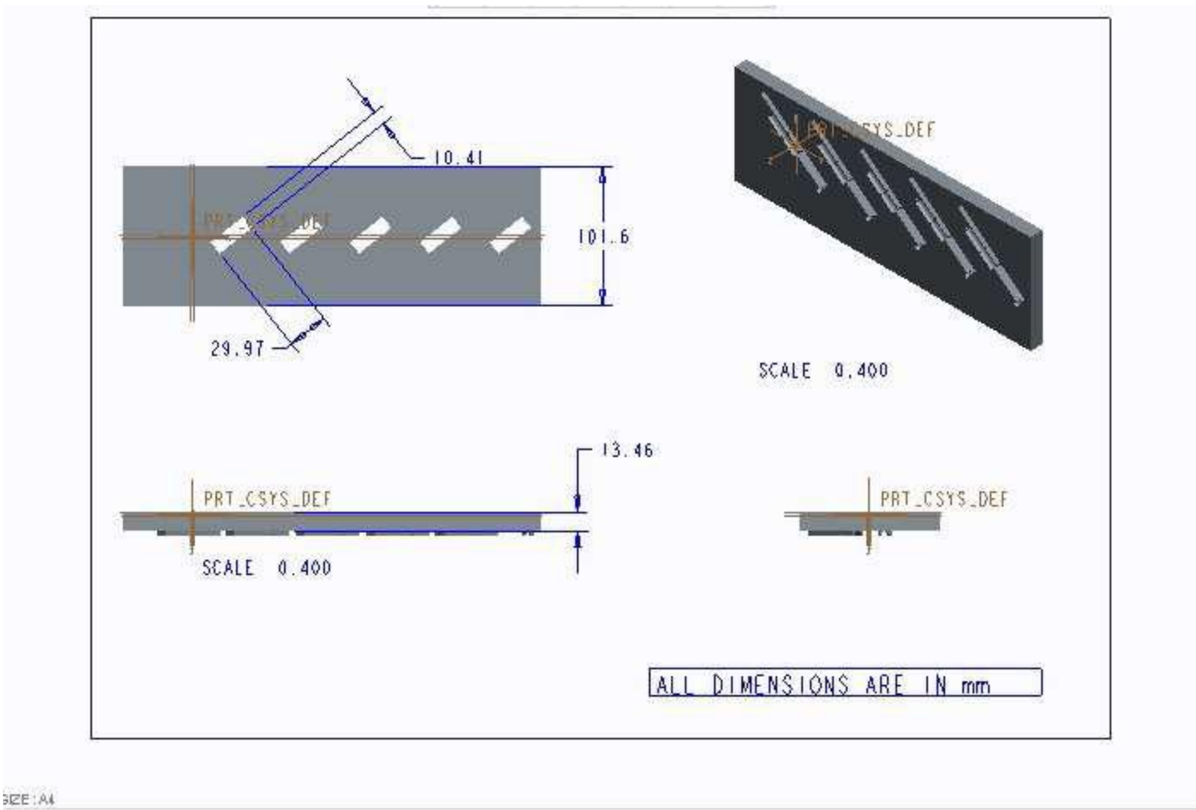

Figure No:4 Detailed view of fixture

VII. Introduction t o finite element method

The finite element method is numerical technique, well suited to digital computers, which can be applied to solve problems in solid mechanics, fluid mechanics, heat transfer and vibrations. The procedure to solve problems in each of these fields is similar in all finite element models of the domain (the solid in solid mechanics problems) is divided into a finite number of elements.

8.1 Basic steps of finite element method

- Discretization of the continuum
- Selection of key points
- Choose proper field variables
- Generating the system of equations
- Globalizing the system equations
- Solution to the system equations to obtain the unknown field variables
- Computation of element variable or secondary field variables

8.2 Introduction to ANSYS

ANSYS is finite element analysis software that enables engineers to perform the following tasks.

- Build computer models or transfer CAD models of structures, products, components, or systems.
- Apply operating loads or other design performance conditions.
- Study physical responses, such as stress levels, temperature distributions or electromagnetic fields.
- Optimize a design early in the development process to reduce production costs.

VIII. Thermal analysis

The procedure for a static analysis consists of these tasks:

1. Set the analysis title
2. Preferences
3. Preprocessor
    - Element type
    - Real constant
    - Material properties
    - Model generation
    - ☐ Applying boundary conditions
4. Review of result

The detailed steps in performing static deflection of support pin through finite element approach are as follows:

a. Set the analysis title: "thermal transient temperature of fixture"

b. Preferences: Structural, Discipline: h method

c. Preprocessor:

- **Element type:** The elements chosen for the present work is SOLID-45.
- **Material properties:**

Aluminum melting temperature = 660°c

Aluminum thermal conductivity = 205w/mk (0.50 Cal/Sec)

- **Model generation:**

The model is imported from CREO and the meshing has been carried out using Ansys-mesh tool.

Figure

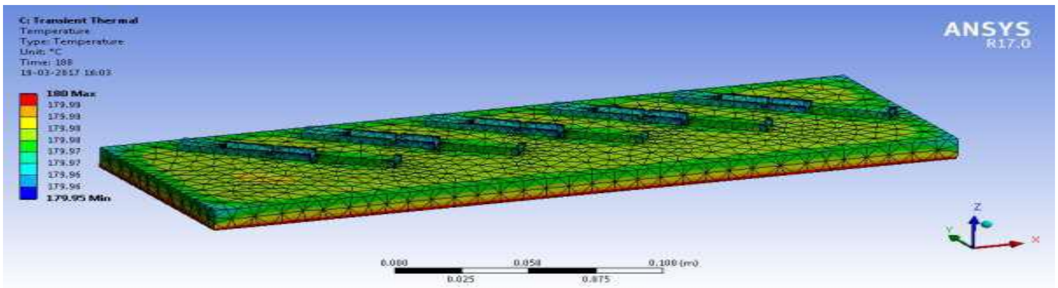

Figure No:5 Thermal Transient Temperature Analysis of Fixture

The temperature used in this method 180˚c. The maximum temperature to be distribute in the bottom surface of the fixture. The minimum temperature to maintained 179.95˚c in the fixture. The temperature varies in the range of 0.01˚c.The temperature analysis to be done in 3 minutes (180 seconds).

Table No:1 Transient Thermal Temperature

Time [s]	Minimum [°C]	Maximum [°C]
1.8	92.719	180
2.4	118.39	
2.8173	133.87	
3.2346	146.13	
3.716	156.42	
4.1978	163.73	
4.6798	168.81	
5.1628	172.33	
5.6466	174.77	
6.1304	176.43	
6.6143	177.57	
7.099	178.34	
7.5843	178.86	
8.0702	179.22	
8.5567	179.46	
9.0438	179.63	
9.5315	179.74	
10.02	179.81	
11.484	179.9	
15.878	179.95	
29.059		
47.059		
65.059		
83.059		
101.06		
119.06		
137.06		
155.06		
173.06		
180.		

The temperature distribution with respect to time to be above mentioned the table.

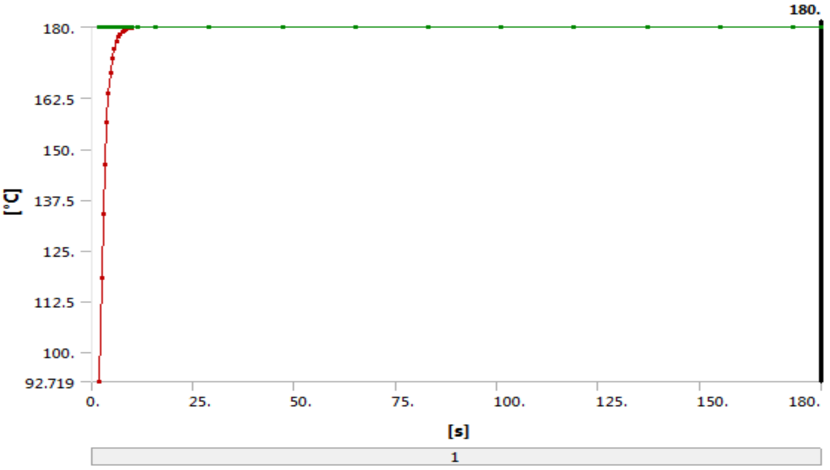

Figure No: 6 Transient temperature solution

The transient temperature distribution with respect to time to be shows the figure no 6 in the graphical method. The temperature variation in the fixture to be gradual increased. The heat shrinking process start after 1.8 seconds the fixture to be heated and time, temperature to be increased.

IX. Conclusions

1. In the current work, the following conclusion is outlined.

- The fixture for heat shrinking process in fuel tube component as per the specific limits requirements has been attempted successfully, in order to increase the productivity.

2. The thermal analysis of the important basic component of the designed fixture carried out by thermal transient convection method using ANSYS software is summarized as follows.

- Maximum and maximum temperature employed for the analysis are 179.99°C and 179.95°C respectively

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