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Material Screw Testing ON Tail Rotor Drive Using 'D' Penetrant Testing Method

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ABSTRACT

Non Destructive Testing is a method of inspection that used in aircraft maintenance. Penetrant test is one type of Non Destructive Test (NDT) which is applied to screw tail rotor drive material. The purpose of this study was to determine the presence of defects, cracks, or other discontinuities without damaging the object being tested or inspected. The design research of applying the penetrant test to screw tail rotor drive material containing ferrous (fe) used the 'D' method, which is by dipping the material into the penetrant liquid with a waiting time of 20 minutes, then cleaning it using water and an emulsifier and drying using an oven. Before the inspection is carried out, the material is sprayed with a developer with a waiting time of 10 minutes, then the material is checked for defects or not. The test results showed that there was no defect in the form of a crack, but found an indication that is included in the non-relevant indication, which is an indication of the shape or design of the material found in the screw section.

Keywords: Non destructive Test, PENETRANT Test, Tail Rotor Drive

INTRODUCTION

In the aviation industry equipment with solid good material automatically uses machines and those that still use human power, cannot be separated from the problem of physical defects or damage that has occurred inside the product. Physical defects that occurs on a large and deep scale maintenance activities will have an impact on financial losses even create a danger to the safety of workers or users of product. The physical defect that resides in solid matter is of course not can be known from direct sight so it is necessary do an inspection of an object to see whether there is or whether or not defects that occur in solid objects. The inspection carried out in the industrialized world without destroying the solid objects that are regularly inspected called the Non-Destructive Test.

Non-Destructive Test (NDT) is defined as a physical evaluation of a solid object under test. NDT is used mainly in industry to detect defects, cracks and voids in materials used in various structures with different materials its kind. In NDT there are four basic NDT methods with name: (1) magnetic particle inspection (MT); dye penetrant inspection (PT); radiographic inspection (RT); and (4) ultrasonic inspection. Type of NDT methods have advantages and disadvantages of each. For example, the advantages of Penetrant Testing (PT) are: simple to use, inexpensive, quick results, can be used on any non-porrous material, portability, low operator skill required.

The disadvantages of PT are: surface breaking defect only, little indication of depths, penetrant may contaminate component, surface preparation critical, post cleaning required, potentially hazardous chemicals, can't test unlimited times, temperature dependent. The advantages of magnetic particle testing (MT) are: simple to use, inexpensive, rapid result, and little surface preparation required, possible to inspect through thin coatings. The disadvantages of MT are: surface or slight sub-surface detection only, magnetic materials only, no indication of defects depths, only suitable for linear defects, detection is required in two directions.

The advantages of ultrasonic testing (UT) are: rapid results, both surface and sub-surface detection, safe, capable of measuring the depth of defects, may be battery powered, portable. The disadvantages of UT are: trained and skilled operator required, requires high operator skill, good surface finish required, defect identification, couplant may contaminate, no permanent record, calibration required, ferrite material (mostly).

The advantages of radiographic testing (RT) are: permanent record, little surface preparation, defect identification, no material limitation, not so reliant upon operator skill, thin materials. The disadvantages of RT are: expensive consumables, bulky equipment,

harmful radiation, defect require significant depth in relation to the radiation beam (not good for planar defects), slow results, very little indication of depths, access to both sides required [1]. The most widely NDT method that used in aerospace industry is penetrant test [2]. Various practical testing of penetrant is used for airplane parts are conducted for local inspection, which results in testing of temperature and oil infiltration jams [3]. It's used widely because the ability to easily and cheaply inspect large complex geometries. It can also be used on a wide variety of materials provided the surface is not too rough or porous [4].

The penetrant testing on the surface is more popularly used because the test is considered safe for use on various types of material objects. This test is the most sensitive way to determine subtle defects on a surface, such as cracks, smooth surface holes or leaks. The aim of the research is to know the defect in material screw testing on tail rotor drive without destructive the object tested. To ensure the quality of material's surface effectively we can use penetrant test [2].

Penetrant test is a method with using color dye to see surface cracks. The technique is based on capillarity action with the ability of a liquid to be drawn into a 'clean' surface breaking flaw [5]. Penetrant is also applied to the check part by dipping, spraying or brushing [6]. Penetrant test used to verify open discontinuities at the surface of inspected [7], [8]. Penetrant test also detect individual parts, combine surface, material is easy to filter into the inside, and that can't be cleaning [9]. The spray can't be used to detect cracks for a local test in the critical part [10].

Excess penetration is eliminated by water washing (A method), emulsification hydrophilic (B Method), lipophilic emulsification (C Method), or solvent cleaner (D Method). The penetrant must remove from the surface without removing from the inside discontinuity. The optimal number of washes must be obtained. Too slight washing will cause a penetrant background redundant and the indication will not be indistinguishable from the part surface. If too much is removed from the discontinuity, the indication is weak or no indication will be formed.

The process of 'D' Penetrant testing method is similar to B method water based emulsifier uses detergent action to removes penetrant on the surface. This is possible perfectly cleanses the surface and enhances contrast for inspection. The optimum emulsification time must be determined experimentally for specific application. The emulsifier concentration for the spray method is limited up to 5%.

The concentration level of the immersion method can vary from 5% up to 35% depending on the manufacturer. Emulsion waiting time should not be more than 2 minutes. After application of the hydrophilic emulsion, the components will be checked should be rinsed with water. In case of over-

removal, part must be cleaned and reprocessed [11].

RESEARCH METHOD

The research used experiment method and was conducted for two months, starting from May 2020 to July 2020 in PT. Dirgantara Indonesia. The material testing is screw on tail rotor drive shift super puma aircraft with part number 332A34 - 1104 - 22. The test method used the D method emulsifiable, hydrophilic penetrant testing. Sensitivity level 4 – Ultrahigh with developers form D - Nonaqueous for type I fluorescent penetrant.

Figure 1. Screw tail rotor drive

The tools and materials those use in experiment can be seen in the following table.

Table 1. Tools and materials

No	Tools	Materials
1.	UV Lamp MR 4012K	Methyl Ethyl Ketone (MEK)
2.	Oven	Penetrant
3.	Tampanel	Developer
4.	Hanger	Emulsifier
5.	Light Meter	Water
6.	Refractometer	Lint free cloth

The steps of D Penetrant test is as follows:

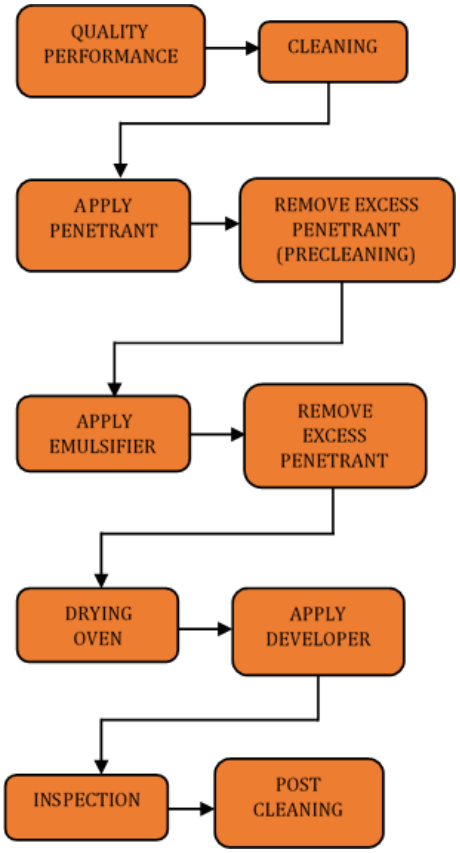

Figure 2. The steps of D penetrant test

RESULT AND DISCUSSION

The process of this research are:

1. Collecting data by observation and study of literature.
2. Making the work steps of D penetrant test.
3. Preparing the tools and material that used in D penetrant test.
4. Doing D penetrant test.
5. Making the report of D penetrant test.
6. Giving conclusion and recommendation according to D penetrant test.

The steps of D penetrant test are:

1. Quality Performance

   This step for controlling to ensure that materials and equipment which are used in penetrant system is acceptable. For facilities that operate less frequently, check frequency daily and weekly can be reduced, but must be done before inspection. Other checks must be carried out at the same frequency like for full time inspection [11].

2. Cleaning

   Before the test, the procedure that must be done is the cleaning process material manually using Methyl Ethyl Ketone (MEK), the purpose of cleaning this material is to remove dirt or oil that is on the surface of the material which can affect indication of the test to be performed.

Figure 3. Cleaning process

3. Apply Penetrant

   The penetrant must cover the entire of surface test. Some sections can be used for large surface material. Some method that used to coverage as needed are by spraying, dyeing, brushing, or other methods. Component, penetrant, and the room temperature will all range from 40° to 125°F (4°C to 52°C) unless otherwise specified [12].

Figure 4. Apply penetrant

4. Remove Excess Penetrant

   Remove excess penetrant using water with a pressure of 25 psi, spray angle of 45° with a distance of 30 cm below the UV light with an intensity of 23 actual light 110 mW/cm^2. In the early step of removing excess is useful to remove excess penetrant adhering to the surface material. In this process, pay close attention to the material so as not to over-wash occurs, if over-wash occurs then the material must be cleaned clean again and reprocess again.

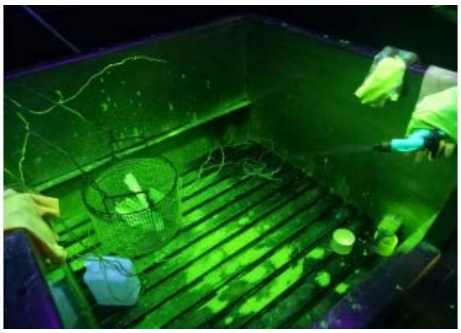

Figure 5. Remove excess penetrant

5. Apply Emulsifier

   The emulsion used is the Ardrox 9881 type. Application carried out by the

process of immersing the material into a tank containing the emulsion with an actual time of 1 minute and a maximum time of 2 minutes. It is very necessary to pay attention to the immersion time so that over-wash does not occur which can help eliminate any indication that will surface. In the event of an over-wash, the material must be cleaned and processed reset.

Figure 6. Apply emulsifier

6. Remove Excess Emulsifier

This process use water with a pressure of 25 psi, spray angle of 45° with spacing 30 cm under UV light with actual light intensity of 110 mW/cm^2. In this second stage, remove excess is useful for removing the emulsion excess adhering to the surface of the material. In this process pay attention to the material carefully so that there is no over-wash, if over-wash, the indication that will be checked will be wasted and make the material have to be cleaned again and on process reset.

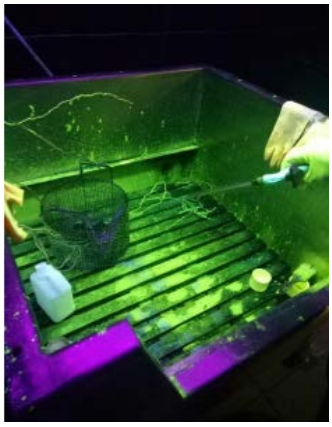

Figure 7. Remove excess emulsifier

7. Drying Oven

The process is in oven with automated system, where the part is drained by heat radiation and forced air, the system speed must be in such a way as to prevent over-drying of parts. Temperature must be controlled with a device that is calibrated to maintain temperature oven at 615 ° F from the set temperature. The oven should not exceed 160° F (71°C).

Figure 8. Drying oven

8. Apply Developer

Before apply the developer components or areas must be dry. No aqueous developers must applied by

spraying. For type I penetrants with low sensitivity, developer should be applied as a thin on all layer of the surface to be checked. For Type II penetrants with moderate sensitivity, the developer must be applied throughout surface to form a white layer to give color contrast suitable for penetrant indication. The thickness uniformity of the developer layer is important for both types of penetrant systems. If the thickness of the developer layer is too thick for a Type I system so that the metal surface is completely covered, the component must be cleaned and reprocessed. Unless otherwise specified, time minimum and maximum development for no aqueous developers is 10 minutes and 1 hour respectively.

Figure 9. Apply developer

9. Inspection

The inspection process can be carried out under UV light with actual intensity 3300 mW/cm^2 and actual light leakage with 0 fc maximum value of 2 fc. The whole inspection is carried out in a manner observation section by section including critical areas. Critical area on the screw includes the load-bearing parts, holes and threads.

Figure 10. Inspection

10. Post Cleaning

The Components must be cleaned after inspection to remove developer and other inspection material residues would be detrimental the next operation or function of that component. The residue from the penetrant process can be harmful to the parts experience a buildup of remaining layers of operation. It can also be annoying future penetration inspections. The remaining penetration in the can affect coating, anodizing and welding operations. Leftover oil components of the liquid oxygen system can cause an explosion. Penetrant remaining in the discontinuity can dry out or irritate penetration mechanism in later inspections. Most of the developer can be removed with water and wiping or by rubbing [12].

Figure 11. Post cleaning process

The result from the test on the screw tail rotor drive is there is no crack indication, there is only a non-relevant indication or an indication caused by the design of the object itself which is a thread.

Figure 12. Inspection result

CONCLUSION

The penetrant test is based on the ability of the liquid to soak into in the cavity surface and remains in the cavity when the fluids are excess is removed. The remaining fluid in the cavity is then withdrawn out to form a much more visible indication than that of its cavity. The penetrant test is used to detect discontinuities solid material surface. It is used on forgings, cast metals and metals alloys, plastics, ceramics and glass. From the results of the research on the screw tail rotor material, there is no indication of crack, it's just that a non-relevant indication or an indication that is caused by the design of the object itself, namely in the form of a thread.

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