NON-DESTRUCTIVE SURFACE CRACK DETECTION USING FLUORESCENT DYE AND BABY POWDER AS AN IMPROVISED DYE PENETRANT TEST

A Mini Research Project
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ABSTRACT

This mini-research project addresses the cost and accessibility of commercial dye penetrant testing products by developing and improvising an alternative penetrant testing product using household materials. The objective of this study was to create an effective and cost-friendly dye penetrant for early surface flaw detection. The experiments were conducted using a visual inspection method, by preparing three metal samples, each subjected to five trials to evaluate surface flaw through dye visibility and UV fluorescence. An aerosol spray was used to evenly apply the penetrant to the metal surface, followed by a 15-minute dwell time, surface cleaning, and application of baby powder as a developer. Visibility of surface flaws was then evaluated under both natural and UV light conditions. Results showed that all samples have high visibility rating, specially to a flat surface alloy, with detailed flaws highlighted by both dye visibility and UV fluorescence. The study concludes that the improvised penetrant is effective, particularly on flat and smoother surfaces, and indicates potential as a low-cost, available method for non-destructive surface flaw detection in engineering applications.

Keywords: *Dye penetrant, surface flaw, household materials, non-destructive testing, dwell time*

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LIST OF ABBREVIATIONS AND SYMBOLS

NDT	Non-Destructive Testing
DPT	Dye Penetrant Testing
LPI	Low Power Imaging
ASNDT	American Society for Non- destructive Testing
FPI	Fluorescent Penetrant Inspection
UV	Ultraviolet

CHAPTER 1

INTRODUCTION

This chapter of the paper presents the problem and its setting. It includes the background of the study, the statement of the problem, significance of the study, and scope and limitation of the study.

1.1 Background of the Study

Non-destructive testing (NDT) is an essential technique in material evaluation that enables the inspection of components without causing damage. This method is widely used in various industries, including aerospace, automotive, and energy, to ensure the structural integrity, reliability, and safety of materials in service. One of the most accessible and widely used NDT methods is Dye Penetrant Testing (DPT), which was developed in the 1920s. DPT is particularly effective for detecting surface-level defects such as cracks, porosity, laps, and fractures. It operates on the principle of capillary action, where a visible or fluorescent dye penetrant is applied to the surface of a material. After a dwell time, excess penetrant is removed and a developer is applied, which draws out the dye from any flaws, making them visible to the naked eye (Meola et al., 2017).

This method is highly valued for its simplicity, cost-effectiveness, and versatility. Unlike other NDT methods that require specialized equipment or are limited to specific material types, dye penetrant testing can be used on a wide variety of materials, including metals, ceramics, plastics, and composites. It is also applicable to materials of different shapes and sizes, making it especially useful in fieldwork and preventive maintenance programs.

Despite its advantages, standard commercial dye penetrant materials can be expensive and difficult to obtain, especially in educational settings, small workshops, or remote industrial facilities with limited resources. These constraints pose a challenge for routine inspections and early detection of material defects, particularly in developing regions or low-budget operations.

To address this limitation, this research explores the development of an improvised dye penetrant testing method using commonly available household materials as a low-cost alternative. The goal is to replicate the essential properties of conventional penetrant and developer products—such as fluidity, contrast, and capillarity—using accessible resources. This approach aims to offer a practical and economical solution for early surface defect detection in materials.

The study will particularly focus on materials commonly used in geothermal systems, where reliable inspection methods are crucial for maintaining safety and preventing equipment failure. By evaluating the effectiveness of this improvised technique, the research aims to contribute to preventive maintenance practices and promote a more accessible approach to non-destructive testing. Ultimately, the development of a cost-effective alternative supports improved operational safety and sustainability in geothermal and other industrial systems where resource limitations may hinder regular inspection routines.

1.2 Statement of the Problem

Commercial dye penetrant testing equipment can be expensive and are often not readily available, especially in school laboratories or remote areas. This limits the ability of students to perform early crack detection on materials to be tested. This study aims to address the need for a low-cost and improvised dye penetrant testing method using household materials. Specifically, it seeks to determine whether these alternatives can effectively detect surface cracks on different materials. The research also explores the potential of this method to serve as a simple and practical tool for early crack detection in both academic and field settings.

This study aims to answer the following questions:

1. How effective are household materials as substitutes for commercial dye penetrant agents in the detection of surface cracks?
2. What are the limitations and safety concerns when using household dye penetrant testing in academic settings?

1.3 Objectives of the Study

1. *General objectives:*
   To develop and evaluate an improvised dye penetrant testing method using household materials as a low-cost alternative for detecting surface cracks in materials used in geothermal systems.

2. *Specific objectives:*

   - To identify and select suitable household materials that can act as a penetrant and developer.
   - To apply the improvised dye penetrant testing procedure on different geothermal-related materials such as steel pipes.
   - To assess the visibility and effectiveness of the improvised method in detecting surface cracks.
   - To determine the limitations and potential applications of the improvised method in educational and field settings.
   - To promote a cost-effective and accessible NDT approach for early crack detection.

1.4 Scope and Limitations of the Study

This study focuses on testing an improvised dye penetrant testing (DPT) method using commonly available household materials such as food colouring, alcohol, highlighter and powder. This method will be applied to detect surface cracks on selected materials. The research includes the preparation of test samples with defects, application of the improvised DPT, and evaluation of its effectiveness based on its visibility and accuracy.

This study is limited to the detection of surface flaws of the material. The alternative materials used may not provide the same level of sensitivity and reliability on standard DPT products. Testing will be conducted under controlled conditions. Factors such as temperature, lighting, or surface finish may affect the visibility and effectiveness of the results. The improvised method may not be applicable to all defects found on the material tested. The evaluation of the results will rely on visual and qualitative analysis.

1.5 Significance of the Study

The results of this study will be significant and beneficial to the following sectors:

1. *For Students and Schools:*
   Provides an affordable alternative to practice non-destructive testing, especially in schools with limited laboratory resources.
2. *For the Geothermal Industry:*
   Supports preventive maintenance by providing an accessible testing method for components exposed to harsh geothermal environments.
3. *For Researchers and Innovators:*
   Encourages the development of alternative testing solutions using locally available materials, promoting creativity and resourcefulness.
4. *For the Aerospace Industry:*
   The study offers a low-cost method for early surface defect detection, which can be useful in preliminary inspections or educational training in aerospace, where precision and safety are critical. It provides an accessible alternative when conventional NDT tools are unavailable, supporting maintenance in remote or budget-limited operations.
5. *For the Automotive Industry:*
   The improvised dye penetrant method enables cost-effective surface crack detection in automotive components, making it useful for routine inspections, especially in small workshops or during prototyping. It supports early flaw detection, which helps prevent failures and ensures product reliability and safety.

CHAPTER 2

LITERATURE REVIEW

This chapter presents the related literature and studies after the thorough and in-depth search done by the researchers. It includes previous research, relevant theories, and identified research gaps that inform the direction of the present study.

2.1 Related Literature

Development of the Method

Dye penetrant testing has already been used back to early ages. The materials involved in this method is a crushed chalk mix with alcohol or water. This mixture then is applied to the hot surface of the material. But first, the surface is thoroughly cleaned by treating it with petroleum. Then, the mixture is then coated to the surface of the material. When the suspension medium has evaporated, the dry chalk would reveal surface flaws as dark lines due to the petroleum left. This method is then developed into a standard dye penetrant examination, which replaces petroleum with a capillary-active coloring agent and the chalk/alcohol mix with a developer. Also, the existence of aerosol as a container for penetrants and developers had improved its accessibility and convenience. Despite its simplicity and low equipment requirements, the method still needs proper execution for more accurate results ("Dye Penetrant Examination: (Penetrant Flaw Detection)," 1989).

Penetrants

The use of penetrating materials is subject to specific physical properties, such as toxicity, flash point, and corrosiveness, which are dictated by industry and military regulations. Other requirements include those for storage and contamination. The materials' performance or sensitivity are largely determined by other properties, including their flash point, surface wetting ability, viscosity, color, brightness, ultraviolet stability, thermal stability (overnight), and water tolerance. (Nondestructive Evaluation (NDE) Education Resource Center. Penetrants: Quality control, 2020).

The color of a material penetrant is important in visible dye penetrant inspections because it provides greater contrast with the part being examined. Typically, red is the most popular color, but it can have other hues for specific purposes. Fluorescent materials, including those produced by Low Power Imaging (LPI), emit luminous emission due to the absorption of electromagnetic radiation over a specific wavelength. The return of energy occurs as a result of changes in the electronic configuration of molecules. The absorption of energy leads to the reproduction of photos at a longer wavelength in visible light. (Nondestructive Evaluation (NDE) Education Resource Center. Penetrants: Quality control, 2020).

Exposure to intense ultraviolet light and elevated temperatures can have a negative effect on fluorescent penetrant indications. One study measured the intensity of fluorescent penetrant indications on a sample that was subjected to multiple UV exposure cycles. After eight exposure cycles, the brightness of the indications were less than one half their original values. (Nondestructive Evaluation (NDE) Education Resource Center. Penetrants: Quality control, 2020).

Non-Destructive Evaluation: Liquid Penetrant Testing

The effectiveness of liquid penetrant testing mostly depends on the condition of your material surface and the environment factors. There are also factors on the material tested, such as surface finish, defect parameters and the type of material that may affect the results. To maximize accuracy, the material surfaces must be thoroughly cleaned to eliminate contaminants that may affect the function of the penetrant on the surface flaws, creating false indications. Cleaning the material after testing is very critical to avoid unnecessary issues due to chemical reactions from penetrant residue, affecting the material's reliability. Visible dye penetrants, usually red, require a sufficient white light for inspection, while fluorescent dyes need ultraviolet light to reveal bright yellow-green indications against dark conditions. (Meola et al., 2016)

Even with its basic use and versatility, liquid penetrant testing should have thorough examination in terms of chemical composition before using the tested material to avoid damage from chemical reactions. Industries such as aerospace, automotive, petrochemical, structural steel, and power generation utilize this method across different product types, including castings, welds, and forgings. However, special attention is required for detecting small cracks, which may absorb penetrant yet restrict its movement due to the size of the crack, resulting in inaccurate indications. (Meola et al., 2016)

The Dye Penetration Test (DPT) is a most commonly used non-destructive testing (NDT) technique that is based on the philosophy of capillary action principle. This principle allows a low surface tension liquid to infiltrate on surface flaws of dry materials. The effectiveness of this method is highly dependent on the period during which the penetrant remains on the surface to allow the infiltration of the liquid to the flaws and defects of the material surface, also known as the *dwell time* (OnestopNDT, 2024).

The American Society for Non- destructive Testing (ASNDT), Liquid Penetrant Testing is commonly used for non-destructive testing to detect surface cracking/breaking/defects in non-porous materials. It is effectively useful to identify flaws like cracks, porous materials, defects on many materials such as metals, ceramics, some other plastics and hard materials. The liquid penetrant testing involves many steps; surface cleaning, visible or fluorescent/phosphorescent dye penetrant, takes time to allow the penetrant to penetrate the surface flaws, next is remove the excess penetrant, apply the developer and inspect. It helps the developer to draw the penetrant out and make it visible to the inspector. These test/ methods have highly sensitive to a small discontinuity and valued for simplicity and cost effectiveness for the equipment. (Industrial inspection and analysis, 2025)

There are three types of penetrants, which are water washable, post emulsifiable and solvent removable. Each of the penetrants have a specific application and the materials to be used. One of the most used is the solvent removable for its versatility and easy to use for the field. The used for liquid penetrant testing have limits. It only detects the surface flaws/defects, and it is not also suitable on dirty and porous surfaces, which can interfere with the result's accuracy. And the penetrant largely depends on the skills and technique of the operator. The American Society for Non – Destructive Testing plays a crucial role for proper training and certification to ensure accurate and consistent evaluations. Therefore, it continues to be an important valuable method in various industries and companies for inspections and maintenance for quality control. (Industrial inspection and analysis, 2025)

The Non-destructive test method protects the integrity of the structure and also the item's outcome under test, it is effectively implicit for determining the flaws of the surface fracture, including the fatigue cracks, quench cracks, porosity, laps, pin holes in welds ideal for material testing particularly in metals, plastics, ceramics, and non-porous surfaces with a vast of sensitivity levels to find a problem that does not seen in a naked eye, It is useful on intricate geometries. Lower cost than the other test method of non-destructive testing also it is fast and effective on an area's big inspection and can be portable and conducted on site. (Industrial inspection and analysis, 2025)

Fluorescent Penetrant Inspection

By using a fluorescent dye, Fluorescent Penetrant Inspection (FPI) can detect defects on non-porous materials without causing harm. Many industries use this simple method because it is sensitive to smaller imperfections. Ultraviolet radiation emitted by the dye produces a bright yellow color that contrasts with the dark background, making it easy to detect even the slightest imperfections. The use of FPI is particularly advantageous for metals with smooth surfaces and small pores, where imperfections are often caused by shaping processes. The FPI process is not destructive, ensuring that the test process does not harm any part. The correct dye and process should be chosen to prevent any damage or staining (*Dye Penetrant Testing | Fluorescent Penetrant Inspection (FPI)*, 2024).

Dye Penetrant Inspection

Dye Penetrant Inspection is a widely used, cost-effective method for detecting surface-breaking defects in smooth surface materials. The process involves applying a low surface tension liquid penetrant to the surface of the material by dipping, spraying, or brushing. The penetrant seeps into any surface flaws through capillary action, after its dwell time, the excess penetrant is then removed and a developer is applied to draw the penetrant out of the defects, making them visible for inspection. (Vera, 2024).

Dye Penetrant Inspection is useful for identifying cracks, porosity, and fatigue-related damage in components like castings, piping, and welds. It is very versatile since it is suitable for both ferrous and non-ferrous materials. The method is highly appreciated for its ease of use, low cost, and high sensitivity (Vera, 2024).

Dye Penetrant Inspection, however, has some limitations. It can only detect defects that are on the surface and requires a clean, smooth, and non-porous surface. Testing on rough or dirty surfaces will lead to false results, and this method can't be used on porous materials. Direct physical access to the test area is necessary, which may prove to be difficult in certain situations. (ND Technologies, n.d.).

The chemicals used in Dye Penetrant Inspection may cause skin irritations and produce hazardous fumes, so it is a must for proper handling, ventilation, and disposal protocols to be followed. Additionally, because the process of Dye Penetrant Inspection involves multiple steps, errors at any stage can affect the accuracy of the results. Despite these limitations, Dye Penetrant Inspection remains a reliable and accessible inspection method across various industries. (ND Technologies, n.d.).

Dye Penetrant Inspection (DPI) is a widely adopted non-destructive testing (NDT) method that provides a cost-effective approach to detecting surface discontinuities in non-porous materials such as metals, plastics, and ceramics. It is extensively utilized across various industries—including aerospace, automotive, and petroleum—to identify surface-level imperfections such as cracks, fractures, porosity, and leaks in castings, forgings, and welds (Dye Penetrant Examination, 1989). DPI is especially useful for identifying flaws that open to the surface, including fatigue cracks, quench cracks, grinding cracks, and pinholes in welds (Industrial-ia.com, n.d.). Because the method does not penetrate below the surface, it is limited in its ability to detect subsurface or internal defects and is unsuitable for use on porous materials, which absorb the dye and interfere with results (ND Technologies, n.d.).

Despite its limitations, DPI remains an essential tool in quality control due to its portability, low cost, and fast processing time, even over large inspection areas or volumes. Its ability to accommodate a range of surface geometries and sensitivity levels makes it highly adaptable to various inspection needs (Industrial-ia.com, n.d.). For optimal effectiveness, however, the process must be conducted by trained personnel following a careful and standardized procedure to ensure reliable and accurate results (Industrial-ia.com, n.d.). The method maintains the structural integrity of the tested object, making it an ideal preliminary testing solution where internal structural preservation is crucial (ASNT, n.d.).

Dye penetrant inspection (DPI) is a low-cost testing procedure for detecting the imperfections of the surface in non-porous materials like plastics and ceramics. It has a wide reach in various fields such as in automotive, petroleum and aerospace to spot the flaws like cracks, fractures, and leaks. It helps to assist the flaws of surface detection such as the hairline cracks, and fractures in forging, welding, etc. The Dye penetrant inspection on porous materials is not credible to be efficient, as it absorbs the penetrant and can obstruct the procedure. The Dye penetrant inspection spots only the surface flaws and does not disclose the internal flaws. In addition, The Dye penetrant Testing is an efficiently effective technique if it is properly carried out perfectly. It must have a need for proper care, attention and needs to be well managed by the trained personnel to give the actual results. (Industrial inspection and analysis, 2025)

UV Blacklight

Industries increasingly rely on effective quality control to prevent defects that cost time, money, and customer's trust. UV light fluorescent inspection is becoming a widely adopted method for improving quality control because of its accuracy and effectiveness. Ultraviolet light, a part of the electromagnetic spectrum, is divided into three types, namely UV-A, UV-B, and UV-C. UV-A, also known as blacklight, has the longest wavelength and is most used in inspection due to its ability to excite fluorescent materials without being harmful (UVlight, 2025).

When UV light excites certain molecules, it causes them to emit visible light. This is called fluorescence. This property is widely used in various quality control applications.

Non-destructive testing is one of the most common uses, particularly for detecting cracks and fluid leaks. The UV fluorescent dyes used in crack detection provide high contrast under blacklight, making defects more visible and inspections more effective (Uvlight, 2025).

In fluid leak detection, UV-sensitive dyes are added to systems like automotive engines, HVAC units, and industrial machinery, which makes leaks become visible as bright fluorescent glows under UV-A light. In a similar way, UV inspection is also used to validate the even distribution of clear protective coatings on circuit boards and metals, ensuring proper application (Uvlight, 2025).

To sum it all up, UV fluorescent inspection processes offer highly sensitive, quick, and reliable methods for quality control, making them essential tools in various industries like electronics, aerospace, and automotive (Uvlight, 2025).

2.2 Related Studies

According to the study entitled "Current Trends in Integration of Nondestructive Testing Methods for Engineered Materials Testing" by Ramesh Kumpati, Wojciech Skarka, and Sunith Kumar Ontipuli (2021) stated that material failure can occur due to stress, temperature, and load conditions. Engineered materials often combine various materials, creating multilayered structures that can fail. Mechanical testing is essential for design and fabrication, while destructive tests can damage the material's structure. Nondestructive testing methods evaluate component quality without damaging the sample integrity. This review outlines advanced nondestructive techniques, including experimental developments, data acquisition systems, and technologically upgraded accessory components. These techniques provide fast, precise, and repeatable systems with high accuracy, and are considered for industrial implementation.

According to the study entitled "Review of conventional and advanced non-destructive testing techniques for detection and characterization of small-scale defects" by Maria Inês Silva, Evgenii Malitckii, Telmo G. Santos, and Pedro Vilaca (2023) stated that inspection reliability of small-scale defects is crucial for structural safety in high-value applications. Early defects can be repaired, contributing to the circular economy and sustainability. Non-Destructive Testing (NDT) techniques detect and reliably characterize these defects, with methods like computed tomography, scanning thermal microscopy, Raman spectroscopy, machine learning, and advanced post-processing signal algorithms providing high detection accuracy. Other promising techniques include time-of-flight diffraction, thermoreflectance thermal imaging, and advanced probes.

According to the study entitled "An Investigation into Non-Destructive Testing Techniques: A Specific Case Study" by Harshal Ashok Aglawe and Pradeep Kumar Soni (2015) that this study compares non-destructive testing techniques like magnetic particle inspection, gamma rays radiographic, and conventional ultrasonic testing for defect detection in Low Pressure Heater manufacturing at a company in India. It suggests that ultrasonic phased array technique can significantly reduce maintenance scheduling and operational costs.

According to the study entitled “Reliability of Dye Penetrant Inspection Method to Detect Weld Discontinuities” by J. Vera, L. Caballero, and M. Taboada (2024) a study that aimed to evaluate the reliability of dye penetrant inspection in detecting weld surface discontinuities based on their size. Six tests were conducted by three inspectors using both visible and fluorescent dyes on 20 welded joints with 63 known discontinuities. Results showed that fluorescent dyes, due to higher sensitivity, were more effective in detecting smaller defects. Probability of detection (POD) estimates indicated greater reliability with fluorescent penetrants, and detection rates increased with discontinuity size.

According to the study entitled “Non-Destructive Test Dye Penetrant and Ultrasonic on Welding SMAW Butt Joint with Acceptance Criteria ASME Standard” by T Endramawan and A Sifa (2018) stated that this study aims to identify the types of discontinuities in SMAW welds and evaluate them using ASME standards. Mild steel specimens were welded using specific electrodes and parameters. Non-destructive testing methods dye penetrant (PT) for surface flaws and ultrasonic testing (UT) for internal defects were used for analysis. The results revealed surface porosity and internal inclusions. Discontinuities that did not meet ASME acceptance criteria required removal by gouging and re-welding.

According to the study entitled “Advances in applications of Non-Destructive Testing (NDT)” by Mridul Gupta, Muhsin Ahmad Khan, Ravi Butola, and Ranganath M. Singari (2021) that this research explores various manufacturing processes and emphasizes the importance of precision to avoid defects. It focuses on Non-Destructive Testing (NDT) as a long-standing method used to detect anomalies in manufactured products without causing damage. The paper reviews several NDT techniques—including Visual Testing, Magnetic Particle Inspection, Penetrant Testing, Ultrasonic Testing, Radiographic Testing, Acoustic Emission, and Eddy Current Testing and highlights how advancements have expanded NDT's use beyond manufacturing. Despite these improvements, the paper notes that NDT still relies heavily on the skill and experience of inspectors, leading to potential human error. It also addresses current challenges and future directions for the field.

According to the study entitled “Modification of dye/fluorescent penetrant testing in accordance with Industry 4.0” by Nitish Kumar, Banshidhara Mallik, and Rahul Ramesh Kulkarni (2025), discusses dye/liquid fluorescent penetrant testing, a non-destructive method used to detect surface discontinuities in engineering components. The process relies on a chemical liquid penetrating surface flaws and revealing their location and size visually. It can detect defects such as cracks, porosity, seams, and laps with high reliability. The article also highlights the integration of automation and Industry 4.0 technologies, such as automated cameras and magnification systems, to enhance detection and monitoring during the inspection process.

CHAPTER 3

METHODOLOGY

This chapter discusses the methodology used in this study. The section of this chapter describes the research design, materials used (hardware/software), and experimental procedures.

3.1 Research Design

The researchers use the experimental approach design on the study. This approach is more appropriate as it focuses more on investigating the effectiveness of an improvised dye penetrant testing by observing, comparing, and evaluating the visual result of the tested material with and without artificial surface cracks, making the design suitable for the study.

3.2 Materials/Equipment Used (Hardware)

The following is a list of hardware materials that will be used in the study:

Figure 1. Red Dye

Red dye serves as a visible indicator that seeps into surface cracks or defects on a material. Its bright color makes flaws easily noticeable during inspection, enhancing detection without specialized equipment.(Dukowitz, 2025)

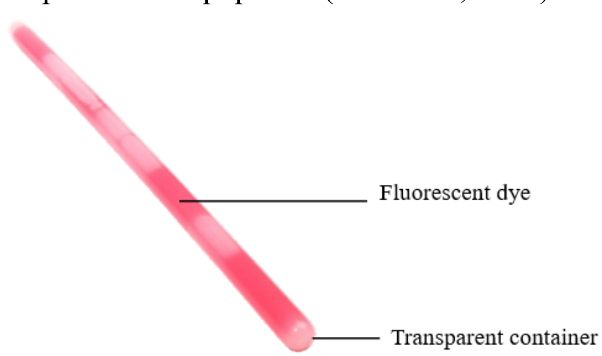

Figure 2. Fluorescent Dye

Fluorescent dye is used to reveal surface cracks under ultraviolet (UV) light. It glows brightly when exposed to UV, making even fine or hard-to-see defects more visible in low-light conditions.(Dukowitz, 2025)

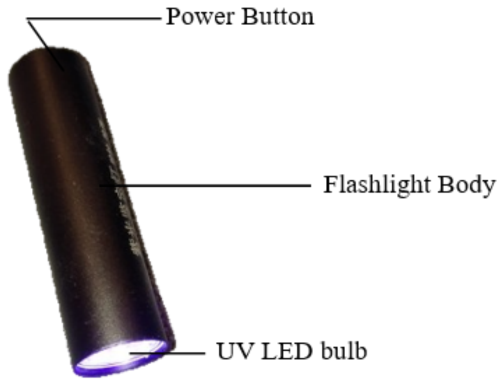

Figure 3. UV light

UV light is used to enhance the visibility of fluorescent dyes applied to the test surface. When exposed to UV light, the dye glows brightly, making even fine surface cracks easier to detect in low-light conditions.(Trockel, 2025)

Parts of the UV light:

- Power Button - Turns the UV flashlight on and off.
- Flashlight Body - Main housing that contains the internal components like wiring and batteries; also provides grip.
- UV LED Bulb - Emits ultraviolet (UV) light for detection purposes. (example: flute dye).

Figure 4. Ethyl Alcohol

Ethyl alcohol acts as a solvent that dilutes the dye, allowing it to spread evenly and penetrate fine surface cracks. With its low surface tension, it helps the dye maintain fluidity and enhances its ability to seep into defects for clearer visibility. It also acts as a cleaning agent to remove dirt and excess dye from the test surface. It ensures accurate inspection by providing a clean background that highlights any dye that remains in surface flaws.(IAEA, 2019)

Figure 5. Baby Powder

Baby powder is used as a developer to draw out the red dye from surface flaws through capillary action. It creates a contrasting white background, making any penetrant indications more visible.(*Liquid Penetrant Inspection | Stainless Foundry & Engineering*, 2024)

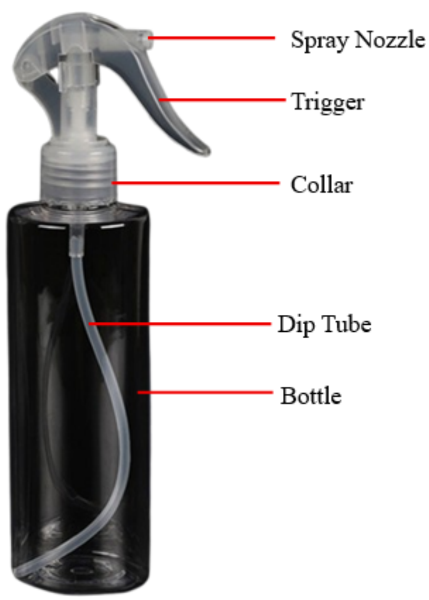

Figure 6. Spray Bottle

Spray bottles are used to evenly apply the penetrant on the test surface. They ensure consistent coverage and controlled application, improving the accuracy of flaw detection.(Dukowitz, 2025)

Parts of the spray bottle:

- Cap - a small cover placed over the spray nozzle to prevent dirt, dust, or accidental spraying.
- Spray Nozzle - Controls the spray pattern and releases the liquid when triggered.
- Trigger - When squeezed, it activates the pump mechanism to draw and expel the liquid.
- Collar - Secures the pump mechanism to the bottle and prevents leakage.
- Dip tube - A long tube inside the bottle that extends to the bottom, allowing liquid to be drawn up to the pump.
- Bottle - Holds the liquid that will be sprayed.

Figure 7. Metal Tube

Figure 8. Curved Surface Metal

Figure 9. Flat Surface Alloy

Metal samples are the test materials used to evaluate the effectiveness of the improvised penetrant testing method. They provide a surface for detecting visible cracks or defects when the red dye is applied and inspected.(Mr.Burns, 2024)

Figure 10. Microfiber Cloth

A microfiber cloth is a soft, lint-free fabric made of fine synthetic fibers. In improvised penetrant testing, it is used to gently clean the surface and remove excess dye without wiping away the penetrant from defects.(Homer, 2023)

Table 1. *Materials and Its Costs.*

MATERIALS	QUANTITY (by piece)	COST (PHP)
Red food coloring	2	Free (found at home)
Fluorescent dye	1	49.00
Ethyl alcohol	1	Free (found at home)
Baby powder	1	Free (found at home)
UV light	1	Free (found at home)
Spray bottle	2	Free (recycle)
Gloves	2	10.00
Laboratory Goggles	1	100.00
Metal samples	2	Free (found at home)
		Total Cost = 159.00

The project utilized various readily available materials to make a low-cost, household dye penetrant testing (DPT) solution. with a total cost of 159 pesos. These included red food coloring, fluorescent dye, isopropyl alcohol, baby powder, tap water, and basic application tools such as spray bottles and microfiber cloths. All materials were repurposed from common household supplies. The total expenditure for these items amounted to only **₱159**, making the approach highly accessible and budget-friendly for educational, experimental, or field-based use. This cost-effective setup demonstrates that basic non-destructive testing techniques can be simulated without the need for expensive, commercial kits thereby promoting learning and innovation using minimal resources.

3.3 Experimental Procedure

To begin the test, surface preparation is essential. The metal samples should be thoroughly cleaned using alcohol and a microfiber cloth. This step ensures that all dirt, oil, or contaminants are removed, allowing the dye to penetrate surface cracks effectively.

For the penetrant preparation, a mixture is made by combining red dye and the fluorescent dye into ethyl alcohol. This solution is then transferred into a spray bottle for application. The penetrant is sprayed onto both metal strips and allowed to sit for **10–15 minutes** to give it sufficient time to seep into any existing surface cracks.

Next, the **excess penetrant is removed** by gently wiping the tested surface using a microfiber cloth dampened with alcohol. Care must be taken during this step to avoid over-wiping, which may remove the penetrant trapped in the cracks.

The developer is prepared and applied using the following steps:

- Lightly dust baby powder over the area where the penetrant was applied.
- Let it sit for 10–15 minutes to allow the powder to draw out the dye from the cracks.
- Spray a fine mist of water on the surface to help reveal any defects more clearly.

Finally, a visual inspection is conducted. The surface is first examined under normal lighting to identify any visible red dye indications. Then, the lights are turned off and a UV light is used to illuminate the surface. Any defects present will glow due to the fluorescent properties of the highlighter ink in the penetrant, allowing for clearer identification of cracks. After evaluating the results, thoroughly clean the sample and repeat the procedure of every sample by five trials.

3.4 Data Collection Methods

This project requires a hands-on approach to test how effective the improvised dye penetrant testing is.

After conducting the testing, the data gathered from the improvised dye penetrant testing will be gathered based on materials labeled as the visibility of red coloring and under UV light inspection. These data will be tabulated based on the number of trials and the type of materials used, with the same processes and dwell time. The indication of defects will be evaluated based on how visible the indications are, to determine the relationship between the two variables mentioned. Additionally, the testing is necessary to determine whether the indicators of defects achieved the desired results.

CHAPTER 4

DESIGN AND IMPLEMENTATION

This chapter presents the overall design and implementation process of the improvised dye penetrant testing (DPT) system using household materials. The procedure mimics standard DPT processes, enabling early surface crack detection on metal specimens without using costly commercial kits. The research emphasizes affordability, accessibility, and practical application.

4.1 Detailed Description of the System Design

This study aims to develop an improvised dye penetrant testing method using commonly available household materials to detect early surface cracks in metallic components. Traditional dye penetrant testing relies on commercial penetrant dyes and developers, which can be expensive and inaccessible in low-resource environments. To address this, the study explores an alternative to commercial dye penetrant testing kits, especially in resource-limited environments or educational settings.

The core design of the system closely follows the traditional dye penetrant testing process, which is cleaning, penetrant application, removal of excess penetrant, developer application, and visual inspection. However, the materials used in each stage are improvised from commonly available items:

- **Cleaning agent:** 70% isopropyl alcohol was used to remove contaminants from the surface.
- **Penetrant:** A homemade mixture consisting of red food coloring and fluorescent dye diluted in isopropyl alcohol, stored in a spray bottle for easy and uniform application.
- **Developer:** Baby powder was used to draw the dye back to the surface through capillary action, enhancing crack visibility.
- **Optional enhancer:** A fine mist of water was sprayed onto the developer layer to better reveal crack patterns.
- **Inspection:** Visual inspection was performed in both normal lighting (for red dye detection) and under UV light (for fluorescent dye detection).

The system was tested using three sets of metal samples with three different surfaces.This setup allowed for controlled visual inspection between the red dye and the fluorescent dye.

The total cost of the materials used was approximately ₱159, with most items repurposed from common household supplies. This design demonstrates that basic non-destructive testing principles can be successfully applied using inexpensive alternatives, promoting innovation and accessibility in testing applications.

4.2 Simulation

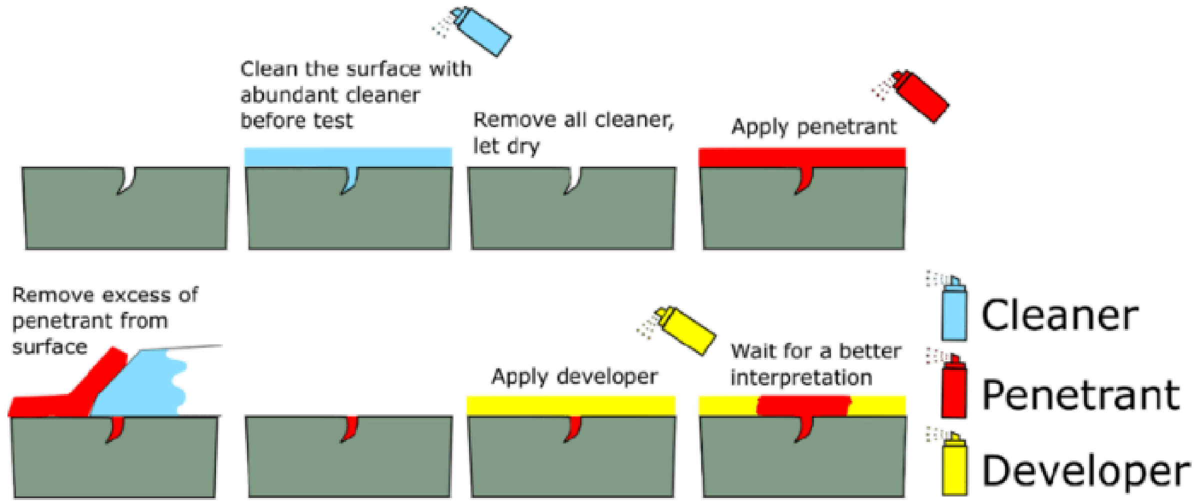

Figure 11. 2D Simulation of Dye Penetrant Testing (Muhsen, 2021)

4.3 Implementation Steps

The implementation of the improvised dye penetrant testing method involved the following steps:

Step 1: Surface Preparation

- Each metal sample was cleaned using a microfiber cloth and isopropyl alcohol to remove dirt, grease, and contaminants.
- The surface was left to dry completely to ensure dye penetration in later steps.

Step 2: Penetrant Preparation and Application

- The penetrant solution was prepared by mixing red food coloring and ink from a highlighter into a small amount of isopropyl alcohol.
- The mixture was transferred into an aerosol spray bottle to ensure even application.
- The penetrant was sprayed onto the metal samples and allowed to dwell for 10–15 minutes to seep into any surface defects.

Step 3: Removal of Excess Penetrant

- After dwell time, the surface was gently wiped using a microfiber cloth slightly dampened with alcohol.
- Care was taken to avoid over-wiping, which could remove dye from inside the cracks.

Step 4: Developer Application

- A fine layer of baby powder was dusted over the test surface using a strainer or brush.
- The developer was allowed to sit undisturbed for 10–15 minutes to pull dye from the cracks to the surface.
- A light mist of tap water was sprayed over the area to further enhance the visibility of dye markings.

Step 5: Visual Inspection

- The samples were first inspected under normal lighting to detect red dye indications.
- Lights were then turned off and UV light was used to observe the fluorescent reaction from the highlighter ink.
- Cracks or defects glowed under the UV light, confirming successful dye penetration.

Step 6: Data Recording and Evaluation

- Observations were recorded for each sample.
- A total of 3 specimens were tested, 5 trials each.
- The presence or absence of visible indications was logged.

This process allowed the researchers to assess the effectiveness of the improvised DPT method under realistic and repeatable conditions. The visual contrast between cracked and uncracked samples, particularly under UV light, provided a clear basis for evaluation. The simplicity, affordability, and effectiveness of the method support its potential as a practical NDT tool in resource-constrained settings.

CHAPTER 5
RESULTS AND DISCUSSION

5.1 Results

This chapter presents the results obtained from the application of the improvised dye penetrant testing (DPT) method. The study aimed to evaluate the effectiveness of a penetrant mixture made from red dye and fluorescent dye (e.g., highlighter ink), combined with a household developer (e.g., baby powder), for detecting surface cracks on various metal surfaces. The method was assessed based on crack visibility under both normal and ultraviolet (UV) lighting conditions.

Visibility Rating Scale used for evaluating penetrant test results:

RATING	**DESCRIPTION**
1 – Very Poor	No visible indication or extremely faint, unclear marks; difficult to distinguish.
2 – Poor	Very weak indication; barely visible, may require effort or specific lighting to notice.
3 – Fair	Clear but light indication; crack is visible but lacks strong contrast.
4 – Good	Distinct and well-defined indication; crack is easily noticeable and identifiable.
5 – Excellent	Very clear, sharp, and high-contrast indication; flaw stands out with no ambiguity.

5.1.1 Round Pipe Surface

Table 2: *Round Pipe Visibility Ratings*

Trial No. 1	Dye Visibility (1-5 Scale)	UV Visibility (1-5 Scale)
1	3/5	3/5
2	3/5	4/5
3	4/5	4/5
4	4/5	5/5
5	3/5	4/5

Table 5.1 shows the visibility ratings of surface cracks on a round metal pipe using the improvised dye penetrant method. Each trial was assessed under normal lighting (to observe the red dye) and under UV lighting (to observe the fluorescent response from the same penetrant mixture).

- **Normal light scores** ranged from 3 to 4, indicating moderate to high effectiveness of the red dye component in highlighting flaws. Some variations in score may have resulted from inconsistencies in penetrant application, surface cleanliness, or developer coverage.

- **UV light scores** were slightly higher, ranging from 3 to 5. The UV light revealed stronger contrast and better-defined indications, particularly in Trial 4, which scored a perfect 5. This suggests that the fluorescent component enhanced flaw visibility, especially for finer cracks.

In Trials 3 and 4, both lighting conditions yielded high scores, indicating that the combined penetrant mixture performed best when applied carefully and consistently. Trial 5 showed a slight drop in normal light visibility, despite maintaining a strong UV score—suggesting that while red dye provides some contrast, UV lighting significantly improves detection clarity.

5.1.2 Curved Metal Surface

Table 3: *Curved Surface Metal Visibility Ratings*

Trial No. 2	Dye Visibility (1-5 Scale)	UV Visibility (1-5 Scale)
1	4/5	4/5
2	5/5	5/5
3	5/5	5/5
4	5/5	5/5
5	4/5	5/5

Table 5.2 presents visibility scores for curved metallic surfaces. The results indicated consistently strong performance.

- **Normal light scores** ranged from 4 to 5, with clear red indications observed in most trials. Trials 2, 3, and 4 all received the maximum score.
- **UV light scores** were equally high, with nearly all trials receiving a perfect 5. The UV inspection revealed even small surface flaws that were slightly less distinct under regular lighting.

The curvature of the test surface did not hinder the performance of the improvised mixture. In fact, it demonstrated excellent adhesion and spread—likely aided by isopropyl alcohol during surface preparation—resulting in consistent and sharp flaw indications.

5.1.3 Flat Metal Surface

Table 4: *Flat surface Metal Visibility Ratings*

Trial No. 3	Dye Visibility (1-5 Scale)	UV Visibility (1-5 Scale)
1	5	5/5
2	4	5/5
3	5	5/5
4	5	5/5
5	5	5/5

Table 5.3 presents results for flat metal surfaces. The mixture performed excellently in this setup, with consistently high ratings under both normal and UV lighting.

- **Natural light** scores ranged from 4 to 5. The red dye produced clear indications in all trials, with four out of five receiving a perfect score.

- **UV light** scores were consistently rated 5/5, confirming that the fluorescent dye component contributed significantly to enhanced flaw detection.

The flat and smooth surface allowed for even distribution of the penetrant and developer, improving dye seepage into surface cracks and resulting in highly visible indications under both lighting conditions.

5.2 Discussion

This section discusses the implications of the results and evaluates the performance of the improvised dye penetrant testing method using household materials. Two key considerations are addressed: the effectiveness of these substitutes for commercial products, and the limitations and safety concerns when applying the method in academic settings.

1. *How effective are household materials as substitutes for commercial dye penetrant agents in the detection of surface cracks?*

   The results of this study indicate that household materials, specifically the improvised mixture of red dye and fluorescent highlighter ink as a penetrant, and baby powder as a developer, can effectively serve as substitutes for commercial dye penetrant testing products.

   Across all three surface types tested (flat, curved, and round metal surfaces), the improvised method produced consistently high visibility scores under both normal and UV light, with the fluorescent component significantly enhancing crack detection under ultraviolet exposure. On flat surfaces, both red and UV indications achieved near-perfect scores (4–5), confirming excellent flaw detection in ideal conditions. Similarly, on curved and round surfaces, the method remained effective, though slight variation in red dye visibility was noted, likely due to application angle and developer spread.

   The combined red and fluorescent dye penetrant allowed surface flaws as small as 0.2–0.3 mm to be detected visually. This level of sensitivity, especially when reinforced by UV inspection, demonstrates that improvised household materials can reliably detect visible surface cracks, particularly when proper surface cleaning and technique are applied. While not a replacement for high-precision commercial systems in critical applications (like aerospace or nuclear), the results support the use of the improvised method for basic maintenance inspections, educational demonstrations, and low-budget field applications.

2. *What are the limitations and safety concerns when using household dye penetrant testing in academic settings?*

   Despite its effectiveness, the improvised dye penetrant method has some limitations and safety considerations:

   - **Inconsistent Application**: The lack of standardized formulation and professional-grade equipment can lead to variation in results. Factors such as surface preparation, dye mixture ratio, dwell time, and lighting conditions can significantly impact flaw visibility.

   - **Limited Sensitivity**: While effective for visible surface cracks, the improvised method may not detect micro-cracks or subsurface flaws, which are often identified by higher-grade commercial penetrants and equipment.

   - **Surface Dependency**: Rough or porous surfaces can absorb the dye unevenly, leading to reduced contrast and inaccurate results.

   - **Shorter Penetrant Lifespan**: Household dyes and highlighter ink may degrade more quickly or lose effectiveness over time compared to specialized chemicals used in commercial kits.

   - **Safety Concerns**: Although household items are generally low-risk, prolonged exposure to certain substances (e.g., isopropyl alcohol, highlighter ink) may still pose health risks, especially in poorly ventilated areas. UV lights, if not handled correctly, can also cause eye strain or damage with direct exposure. Proper use of gloves, masks, and eye protection is recommended to ensure safe practice during testing.

   - **Educational Oversight Needed**: In academic settings, it is essential that students receive guidance on proper handling, application techniques, and disposal of used chemicals to prevent misuse or health hazards.

5.3 Conclusion of the Discussion

The improvised dye penetrant testing method using household materials demonstrated reliable crack detection across multiple surface geometries, validating its potential as a low-cost alternative for non-critical applications. With proper technique and adherence to safety guidelines, it offers valuable educational and practical benefits in settings where commercial products are inaccessible or too costly.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

This section presents the conclusions derived from the findings of the improvised dye penetrant testing (DPT) experiment and provides informed recommendations based on the observed results.

6.1 Conclusion

The conclusions drawn from this study highlight the significant findings and outcomes obtained through the testing and evaluation of an improvised dye penetrant testing (DPT) method using household materials. These conclusions are based on the analysis of experimental data, trial observations, and the fulfillment of research objectives. The key conclusions of the study are as follows:

1. Effectiveness of the Improvised Dye Penetrant Testing Method

   The study confirmed that household-based dye penetrant testing is a viable and cost-effective method for detecting surface cracks on metallic materials. Using readily available items such as red food coloring, fluorescent dye, baby powder, isopropyl alcohol, and basic cleaning tools, the improvised DPT method replicated the essential functions of commercial penetrant tests. Trials conducted on metal surfaces showed that even with these non-industrial materials, surface flaws such as hairline cracks could be successfully revealed. This suggests the method's potential as a functional alternative in situations where access to standard DPT kits is limited.
2. Superior Performance of the Fluorescent Penetrant under UV Light

   The improvised dye penetrant testing method utilized highlighter ink as a fluorescent penetrant, which was viewed under UV light to reveal surface cracks. This approach consistently demonstrated high effectiveness, with visibility scores reaching 5/5 in multiple trials, particularly on flat and curved metal surfaces. The use of a black light significantly enhanced the contrast between the flaw indications and the surrounding surface, allowing for clearer and more accurate detection of fine discontinuities. Even subtle cracks that might be difficult to observe under natural lighting were made visible with the UV-enhanced method. These results confirm that fluorescent penetrant inspection under UV light is a highly sensitive and reliable approach for surface flaw detection using improvised materials.
3. Influence of Surface Geometry on Crack Detection

   The results also highlighted how surface geometry impacts the effectiveness of penetrant testing. Flat and curved metal surfaces yielded clearer and more consistent results compared to round surfaces. This is likely due to the ease of applying the dye evenly and the developer settling smoothly on flat areas. In contrast, the curvature of round surfaces may cause uneven coverage, resulting in slightly lower visibility scores. Therefore, while the method is adaptable, it performs best on surfaces where the penetrant and developer can remain stable and undisturbed during testing.
4. Importance of Surface Preparation in Achieving Accurate Results

   Proper surface preparation was identified as a critical factor influencing the clarity of indications. Trials showed that cleaning the metal with isopropyl alcohol and drying it thoroughly before applying the dye greatly improved test outcomes. In cases where cleaning was insufficient or where moisture remained on the surface, the dye did not penetrate flaws as effectively, resulting in reduced visibility scores. These findings emphasize that even in improvised setups, surface preparation must follow established standards to ensure reliable and accurate results.

5. Applicability for Educational Use and Low-Resource Environments

   The low-cost nature and simplicity of the method make it highly suitable for educational purposes and use in low-resource settings. Students in engineering or vocational programs can benefit from hands-on practice with non-destructive testing techniques using affordable and safe materials. The method requires no specialized equipment aside from a black light, making it accessible to schools, training centers, and technical communities that may lack the budget for industrial NDT equipment. As such, it provides a practical introduction to flaw detection methods and material inspection.

6. Potential to Enhance Awareness and Technical Skills in Non-Destructive Testing

   Implementing this method in academic settings not only supports theoretical understanding but also improves practical skills in visual inspection, defect detection, and basic safety procedures. By engaging in active testing, learners develop a deeper appreciation for the principles of non-destructive evaluation and the role of visual indicators in quality control. This experience is particularly valuable in developing countries, underserved areas, or institutions aiming to strengthen technical education with limited resources.

7. Overall Reliability and Value of the Improvised Testing Approach

   Taking all findings into account, the improvised dye penetrant testing method demonstrated high reliability in identifying surface-level flaws when procedures were followed correctly. The fluorescent approach under UV light was particularly effective, offering results comparable to basic commercial testing. Although not intended for industrial certification or deep flaw analysis, the method stands out as a dependable and educationally valuable technique. It bridges the gap between theoretical learning and practical application, making surface flaw detection more accessible to a broader range of users.

6.2 Recommendation

Based on the findings and outcomes of the study, the following recommendations are proposed to improve the use, reliability, and future application of the improvised dye penetrant testing (DPT) method using household materials:

1. Prioritize the use of UV-based (fluorescent) penetrant for surface crack detection, particularly on curved or irregular surfaces.

   Basis: The study found that using fluorescent dye viewed under UV light produced consistently high visibility scores—often 5/5—on both curved and flat metal surfaces. The enhanced sensitivity and contrast provided by UV illumination allowed for the clear identification of surface flaws, including small or faint cracks that would likely go unnoticed under regular lighting. This indicates that the fluorescent approach offers a more reliable and effective solution for detecting discontinuities, especially on complex geometries where lighting angles and dye spread can affect results.

2. Ensure thorough surface preparation through cleaning and drying prior to dye application.

   Basis: Surface preparation plays a critical role in the success of dye penetrant testing. The experiment demonstrated that cracks were most visible when the metal was properly cleaned with isopropyl alcohol and fully dried before applying the penetrant. In contrast, trials with poorly cleaned or slightly wet surfaces resulted in blurred or weak indications. Any presence of oil, dust, or moisture can block dye penetration or cause uneven developer spread, significantly affecting the accuracy of results. Therefore, consistent and rigorous cleaning protocols should be followed to ensure data integrity.

3. Apply dye, developer, and cleaner evenly and consistently to ensure reliable visibility of flaw indications.

   Basis: The clarity and contrast of visible crack indications depend heavily on how uniformly the materials are applied. During the trials, uneven spraying or premature wiping of the dye or developer led to spotty or faded results. Conversely, when the dye and developer were applied in thin, even layers and allowed adequate drying time, the visibility of flaws greatly improved. This suggests that careful, repeatable application techniques are essential for accurate flaw detection, especially when using improvised materials with no standardized delivery method.

4. Encourage repetition of trials in experimental or classroom settings to improve user familiarity and minimize error.

   Basis: The accuracy and consistency of results improved in later trials, likely due to increased familiarity with the testing process. Repeating the procedure multiple times allowed users to refine their technique, recognize common mistakes, and build confidence. In educational contexts, repetition reinforces concepts such as surface preparation, application timing, and interpretation of results—skills that are crucial in both basic and advanced non-destructive testing (NDT) practices.

5. Limit the use of the improvised DPT method to educational, training, and non-critical field applications.

   Basis: Although the study confirms that household materials can effectively detect surface cracks, the improvised method lacks the certification, sensitivity, and repeatability required in industrial or safety-critical environments. As such, it should not be used as a substitute for certified NDT in fields like aerospace, pressure vessel inspection, or infrastructure safety. Instead, the method is best suited for academic demonstrations, laboratory activities, and preliminary assessments in low-risk settings.

6. Conduct additional testing on different metals, surface finishes, flaw types, and crack depths to assess broader applicability.

   Basis: The current study focused primarily on standard metal strips with surface-level flaws. To determine the full capabilities and limitations of the improvised method, future research should involve a variety of materials (e.g., aluminum, stainless steel, ceramics), surface textures (e.g., rough, polished), and defect sizes. This will help establish performance benchmarks and identify conditions under which the method may be less reliable or may require modification.

7. Promote the use of personal protective equipment (PPE) and proper laboratory safety practices.

   Basis: Even though the materials used are generally safe, handling chemicals such as isopropyl alcohol, fluorescent ink, and baby powder in spray form poses minor health risks, especially with prolonged exposure. To ensure safe practice, users should wear gloves and goggles and conduct tests in well-ventilated areas. This is especially important in educational settings, where proper lab conduct forms part of student training and safety culture.

8. Explore the use of alternative low-cost developers or carrier solutions to optimize performance.

   Basis: Baby powder served effectively as a developer in this study, but other household powders (e.g., cornstarch, talcum powder) or liquids might offer better adhesion, contrast, or drying characteristics. Similarly, different solvent bases could enhance dye spread or reduce drying time. Experimenting with alternative materials could lead to improvements in visibility, consistency, and ease of use—further increasing the value of the method for teaching and field use.

9. Integrate the improvised DPT method into vocational and engineering training programs.

   Basis: The method provides a valuable opportunity for hands-on learning at minimal cost. Including it in laboratory courses, technical workshops, or NDT modules allows students to engage directly with surface inspection techniques, building foundational skills in flaw detection, critical observation, and inspection protocol. In resource-limited institutions or regions without access to industrial-grade testing equipment, this method can significantly enhance the practical component of engineering and technical education.

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APPENDICES

Appendix A

Trial of Samples

Figure 12. Trial 1: Natural Light Evaluation

Figure 13. Trial 1: UV Light Evaluation

Figure 14. Trial 2: Natural Light Evaluation

Figure 15. Trial 2: UV Light Evaluation

Figure 16: Trial 3: Natural Light Evaluation

Figure 17: Trial 3:UV Light Evaluation

Figure 18. Trial 4: Natural Light Evaluation

Figure 19. Trial 4: UV Light Evaluation

Figure 20. Trial 5: Natural Light Evaluation

Figure 21. Trial 5: UV Light Evaluation

Figure 22. Trial 1: Natural Light Evaluation

Figure 23. Test 1: UV Light Evaluation

Figure 24. Trial 2: Natural Light Evaluation

Figure 25. Trial 2: UV Light Evaluation

Figure 26. Trial 3: Natural Light Evaluation

Figure 27. Trial 3: UV Light Evaluation

Figure 28. Trial 4: Natural Light Evaluation

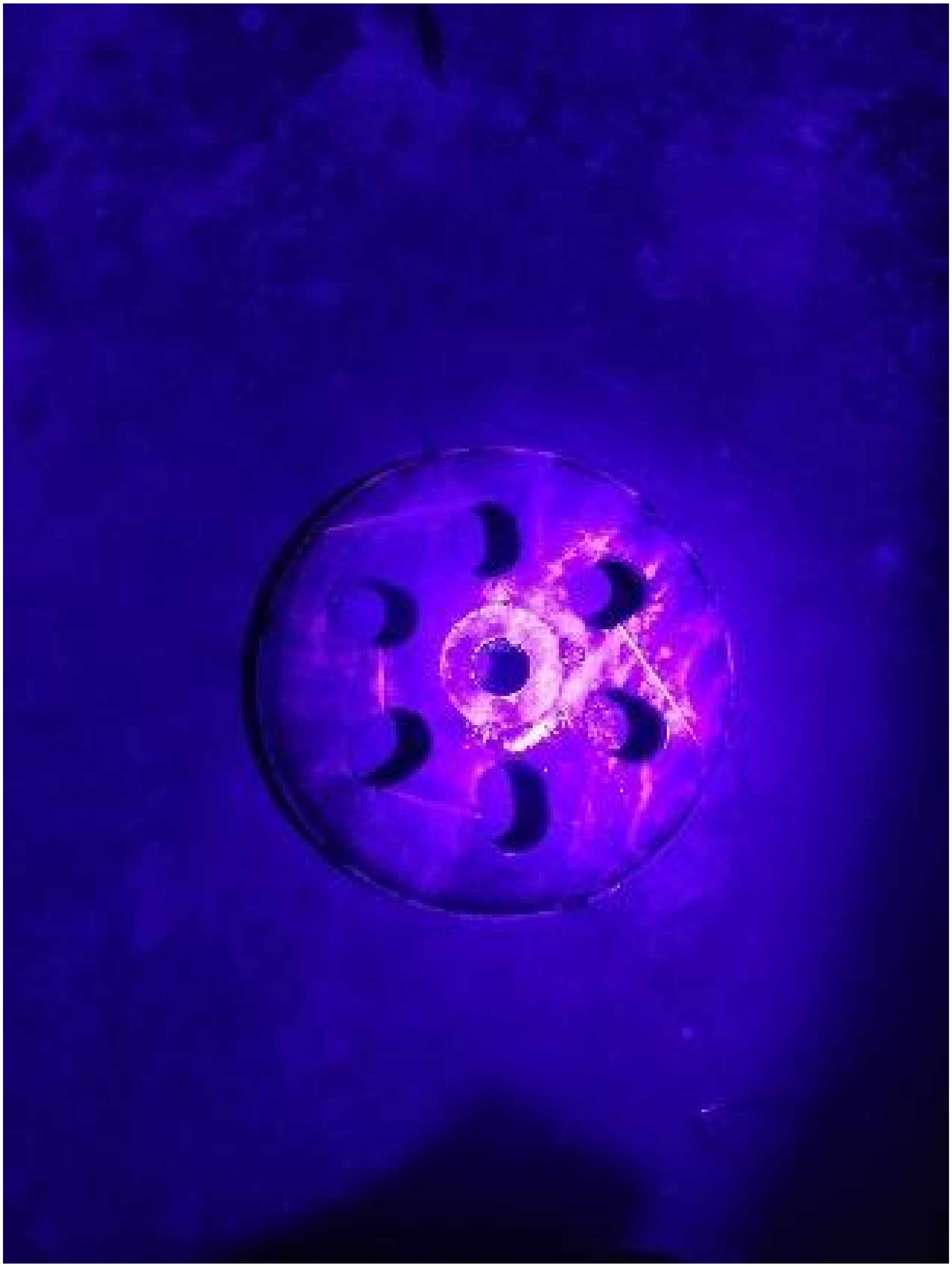

Figure 29. Trial 4: UV Light Evaluation

Figure 30.Trial 5: Natural Light Evaluation

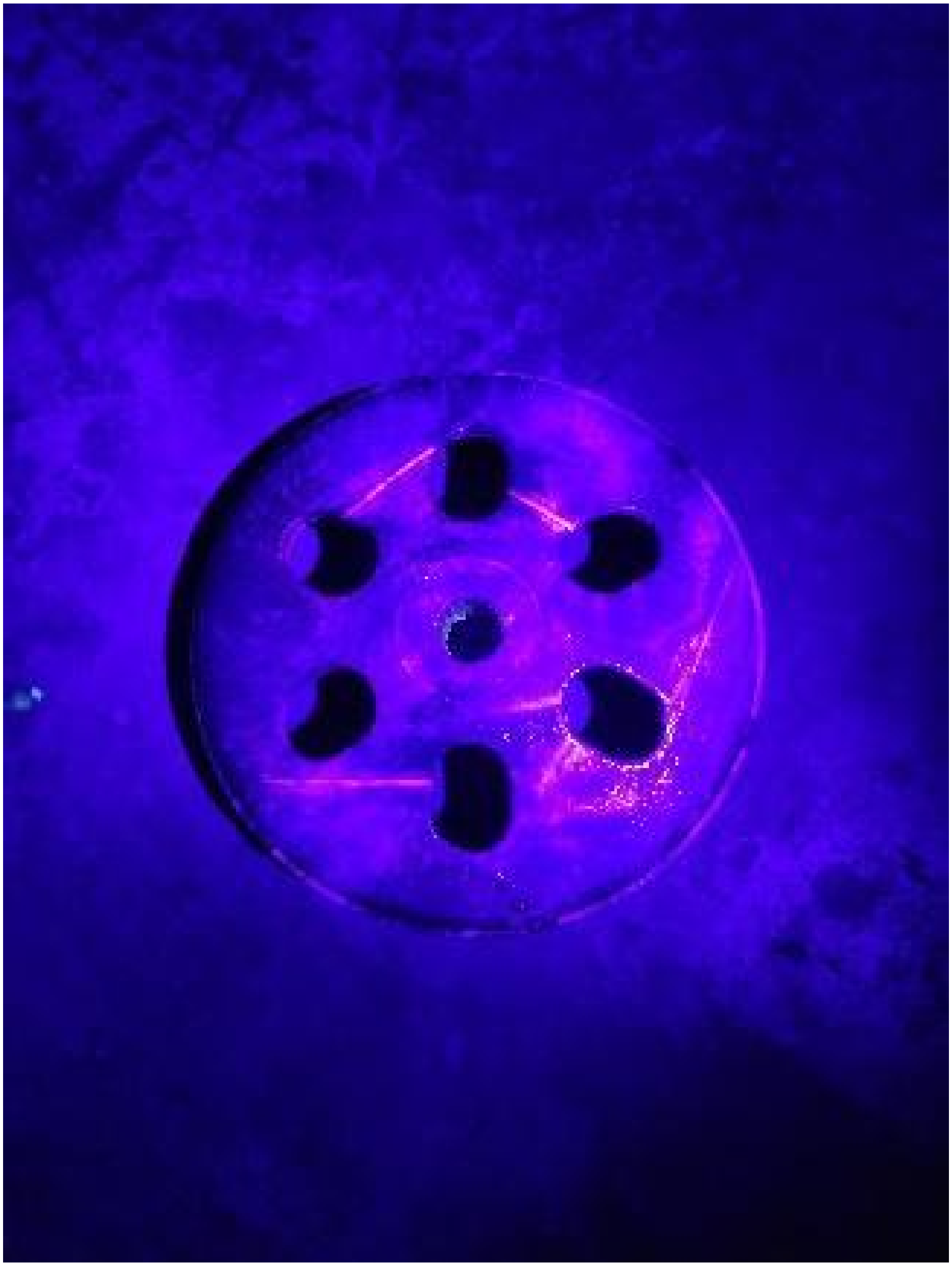

Figure 31. Trial 5: UV Light Evaluation

Figure 32. Trial 1: Natural Light Evaluation

Figure 33. Trial 1: UV Light Evaluation

Figure 34. Trial 2: Natural Light Evaluation

Figure 35: Trial 2: UV Light Evaluation

Figure 36.Trial 3: Natural Light Evaluation

Figure 37. Trial 3: UV Light Evaluation

Figure 38. Trial 4: Natural Light Evaluation

Figure 39. Trial 4: UV Light Evaluation

Figure 40. Trial 5: Natural Light Evaluation

Figure 41. Trial 5: UV Light Evaluation

Appendix B

Project Documentation

Figure 42. Preparation of Materials for the experiment.

Figure 43. preparing the penetrant by mixing alcohol, red dye and fluorescent dye.

Figure 44. Cleaning the samples to remove excess dirt.

Figure 45. Spray testing to determine the quality of sprayed water.

Figure 46. Preparation of penetrant, developer, and samples to undergo several trials.

Figure 47. Application of the Developer to determine the emergence of red dye.

Figure 48. Evaluation of Sample through UV light to detect surface crack.

Figure 48. Group experiment.

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Engage in Nuclear Energy Career Symposium with DOE

Name: Caina, John Rovic O..
Address: Cawitan, Sta. Catalina Negros Oriental
Contact No.: 09667345416
Email Address: cainajohnrovic@gmail.com

Birthdate: January 16, 2003
Age: 22
Sex: Male

Educational Background:

- **Tertiary Education**

Negros Oriental State University Main Campus I & II
Dumaguete City, Negros Oriental, Philippines
Bachelor of Science in Geothermal Engineering
S.Y. 2021-2025

- **Secondary Education**

Sta. Catalina Science High School (S.Y. 2015-2019)
Cawitan, Sta. Catalina Negros Oriental
STEM (Science, Technology, Engineering and Mathermatics)
Sta. Catalina Science High School (S.Y. 2019-2021)
Cawitan, Sta. Catalina Negros Oriental

- **Primary Education**

Cawitan Elementary School(S.Y 2009-2013)
Cawitan, Sta. Catalina, Negros Oriental

Sta. Catalina Science Elementary School
Bliss, Sta. Catalina, Negros Oriental

Seminars and Trainings Attended:
GE Forum with Engr. Steve Nas
GE Forum with Engr. Isaac Simat
Engage in Nuclear Energy Career Symposium with DOE

Name: Ablong, Angelo .
Address: Candau-ay, Dumaguete City, Negros Oriental
Contact No.: 09911845293
Email Address: angeloablong093@gmail.com

Birthdate: May 17, 2002
Age: 23
Sex: Male

Educational Background:

- **Tertiary Education**

Negros Oriental State University Main Campus I & II
Dumaguete City, Negros Oriental, Philippines
Bachelor of Science in Geothermal Engineering
S.Y. 2021-2025

- **Secondary Education**

Taclobo National High School
Taclobo, Dumaguete City, Negros Oriental
SY: 2014 – 2018

Ramon Teves Pastor Memorial – Dumaguete Science High School
Daro, Dumaguete City, Negros Oriental
Science Technology Engineering and Mathematics
SY: 2018 - 2020

- **Primary Education**

West City Elementary School
Poblacion 7, Dumaguete City, Negros Oriental

Seminars and Trainings Attended:
GE Forum with Engr. Steve Nas
GE Forum with Engr. Isaac Simat
Engage in Nuclear Energy Career Symposium with DOE

Name: Lutero, Jeane Ruth Cadayday.
Address: Datagon, Pamplona, Negros Oriental
Contact No.: 09651920777
Email Address: cadaydayruth@gmail.com

Birthdate: February 6, 2004
Age: 21
Sex: Female

Educational Background:

- **Tertiary Education**

Negros Oriental State University Main Campus I & II
Dumaguete City, Negros Oriental, Philippines
Bachelor of Science in Geothermal Engineering
S.Y. 2022-2025

- **Secondary Education**

Tanjay City Science High School
Tanjay City, Negros Oriental, Philippines
Science, Technology, Engineering, and Mathematics
S.Y. 2020-2022

Pamplona National High School
Pamplona, Negros Oriental, Philippines
S.Y. 2016-2020

- **Primary Education**

Datagon Elementary School
Datagon, Pamplona, Negros Oriental, Philippines
S.Y. 2010-2016

Seminars and Trainings Attended:
GE Forum with Engr. Steve Nas (2025)
GE Forum with Engr. Isaac Simat (2025)
Engage in Nuclear Energy Career Symposium with DOE (2025)
GIS: An Introduction to Mapping as Data Visualization, Participant (2024)
GPS Motions Associated with the Recent Earthquakes in the Philippines, Participant (2024)