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STUDYING THE EFFICIENCY OF INK RECEPTIVE MATERIALS IN LITHOGRAPH PRINTING ON ALUMINUM PLATES

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ABSTRACT
The study aimed to investigate the efficiency of printing ink receptive materials in the lithograph printing process on aluminum printing plates, with the following objectives: 1) Study the properties of printing ink receptive materials by creating printing plates in the lithography. 2) Test and compare the efficiency of printing ink receptive materials with red lacquer in creating printing plate images in the lithography process. 3) Evaluate and analyze the efficiency of printing ink receptive materials with ingredients from Thailand to reduce costs and provide alternatives for creating lithograph printing plate images in Thailand. The research was qualitative and involved the following steps: 1) Study the production of printing ink receptive materials with local ingredients to find suitable properties by comparing their efficiency with red lacquer in the lithography process. 2) Develop tools for analyzing and comparing the efficiency of printing ink receptive materials with red lacquer in the lithography process. 3) Verify the efficiency of printing ink receptive materials in the lithography process using questionnaire analysis and content analysis from comparative print results. 4) Collect data from tools to conduct comparative analysis of the efficiency of printing ink receptive materials with red lacquer in the lithography process. The research findings were as follows: 1) Printing ink receptive materials served as a base for ink absorption from the rollers, increasing the ink quantity for printing plates. They also strengthened printing plates in thin areas and resisted acid erosion. Furthermore, the ingredients were locally available and odorless during use. 2) Printing ink receptive materials were as efficient as red lacquer and performed well with all types of printing plate equipment. 3) The evaluation and analysis confirmed that printing ink receptive materials with local ingredients were efficient for creating printing plates, comparable to red lacquer in the lithograph printing process. This suitability and usefulness can contribute to the practical creation of aluminum printing plates in the lithography process.

Keywords: Printmaking, Lithograph, Aluminum Plates, Red lacquer, Ink Receptive

Introduction

Currently, the creation of art encompasses a wide range of content, formats, and processes that vary according to social contexts. Printmaking is considered one of the artistic processes that has been passed down through generations, continuously evolving in terms of content and format presentation under traditional processes. This evolution has led to contemporary printmaking, which is prevalent today. Educational institutions worldwide offer courses in printmaking due to its diverse printing processes, such as woodcut, metal engraving, screen printing, and lithography. Each printing process allows for the creation of numerous prints from a single plate and can be presented in various formats through technical advancements, leading to the unique styles and expertise of individual artists. This contemporary relevance and popularity of printmaking persist to this day.

The lithograph printing process falls under the category of planograph processes. It differs from other methods in that the surface of the printing plate is flat, unlike plates created through other processes. The materials used for making the printing plate include limestone, zinc plates, or aluminum plates (Charoensupkul, 2007). In Thailand, aluminum plates are commonly used due to their lightweight nature, ease of transportation, and the ability to reuse them after removing the old plate surface. The process of lithograph printing consists of several steps, including preparing the plate, drawing on the plate, etching, and printing. The creation of a lithograph printing plate involves the reaction between grease and water. Therefore, materials made of grease are used for drawing on the plate before proceeding to the etching process, which involves a chemical reaction known as gum etch. This reaction helps the greasy parts adhere to the plate. Afterward, the printing process begins, requiring the use of a chemical called red lacquer to coat the plate's surface. This red lacquer acts as an intermediary medium that receives the printing ink from the drawn image on the plate. However, since red lacquer is a chemical substance typically imported from abroad, it is expensive and emits strong odors, which can have long-term health effects. These limitations, particularly due to the reliance on imported chemicals with associated health risks, significantly impact the creativity and teaching of lithograph printing processes.

In 2019, there was research conducted to study and explore locally sourced components within Thailand that could be used as ink receptive materials without emitting chemical odors during usage. The research found that a mixture of black varnish and soy wax could be used as ink receptive materials, yielding good results when tested for printing images on paper (Chlomruk, 2019). Additionally, in 2020, further in-depth research was conducted regarding ink receptive materials by allowing artists and students to experiment with ink receptive materials through the creation of planographic printing processes. The results showed that the ink receptive materials exhibited properties suitable for receiving ink and could replace red lacquer in the planographic printing process (Chlomruk, 2020). However, from the past research findings, there is still a lack of testing on the efficiency of ink receptive materials compared to the use of red lacquer, especially when tested on plates with drawings made of grease and various types of equipment. It remains to be seen whether ink receptive materials can match the efficiency of red lacquer and provide sufficient durability for aluminum printing plates, particularly for high-volume printing. Moreover, previous research has also identified issues with excessively liquid ink receptive materials due to Thailand's hot climate. Therefore, further research titled "Studying the Efficiency of Ink Receptive Materials in Lithograph Printing on Aluminum Plates" aims to compare the efficiency of ink receptive materials with red lacquer in the planographic printing process.

2. Research Objectives

The objective of this research is to study the properties of ink receptive materials derived from the creation of aluminum printing plates in the lithograph printing process. The aim is to test and compare the efficiency of ink receptive materials with red lacquer in plate creation, evaluating the effectiveness of ink receptive materials composed of locally sourced ingredients within Thailand. This endeavor seeks to reduce costs and provide alternatives for both education and artistic creation in planographic printing. The research involves testing and comparing the performance of ink receptive materials with red lacquer in the creation of lithograph printing plates. This is achieved by writing on aluminum plates using various types of equipment and grease. The goal is to identify the effectiveness of ink receptive materials in enhancing the durability of printing plates while reducing the importation costs of chemical substances. Additionally, this research aims to extend and develop knowledge in the creation of lithograph printing artworks within Thailand.

3. Conceptual Framework

4. Literature Review

The research investigates the effectiveness of inkjet ink in the lithograph printing process on aluminum printing plates. It gathers information from books, academic papers, and relevant research on the lithograph printing process to study and analyze the efficiency of inkjet ink and red lacquer in creating aluminum printing plates with increased precision and clarity.

4.1 The origin of lithography.

The earliest lithographs used printing plates made from limestone, hence called lithographs or lithography, originating from the Greek words "litho" meaning stone and "graphein" meaning to write. Subsequently, zinc plates and aluminum plates were introduced as printing plates, yet the fundamental process of creating the printing plates remained similar to that of lithographic stone, hence the continued use of the term lithograph. This process falls under the category of planographic printing within the realm of graphic arts because of the smooth surface characteristics of the printing plates, which differ from plates created by other methods. Additionally, lithographs or stone prints have processes that cater to the commercial printing industry, such as for advertising leaflets, posters, song lyrics, plays, and more.

Beginning in the late 18th century in Germany, lithography was pioneered by Alois Senefelder (1771 - 1834). He initiated the printing of artworks by reproducing images from original paintings or drawings of renowned artists of the past. These were line drawings transferred onto lithographic stone plates and then printed for distribution at prices affordable to the general public. For instance, works of line drawings by Albrecht Durer (15th - 16th century) gained significant popularity (Charoensupkul, 2007), to the extent that the Munich Museum even reproduced important artworks using the lithographic printing method (Porzio et al., 1983: 23). Subsequently, European artists experimented and developed methods of creating printing plates by drawing solely with lithographic crayons and grease pencils. This is evident in the work "Danai" by Hyacinthe Aubry-Lecomte (1787 - 1858), who drew the lithographic plate directly with lithographic crayons. This artwork is considered exceptionally beautiful and artistically valuable. For his contributions, he was bestowed the title "Prince of Lithographers," (Charoensupkul, 2007) making him one of the first successful lithographic artists.

Furthermore, European artists such as Francisco Goya (1746 - 1828), Eugene Delacroix (1798 - 1863), Henri de Toulouse-Lautrec (1864 - 1901), and Edvard Munch (1863 - 1944) also contributed to the creation of lithographic artworks.

There was further development in lithographic artworks evident among the Impressionist artists of France. They employed distinctive styles and color techniques, separating lithographic prints from the traditional methods, especially during the 20th century. They selected color pairs based on the theory of color, utilizing characteristics of translucent and less opaque atmospheres. Through overlapping or adjacent printing, their works showcased unique features that stood out, not merely imitating paintings. This can be seen in the works of Pierre Auguste Renoir (1841 - 1919), Camille Pissarro (1830 - 1903), and Edgar Degas (1834 - 1917), among others (Charoensupkul, 2007).

In the United States, lithographic prints in the early period did not differ significantly from those in Europe. This method was widely used in the commercial printing industry, establishing a solid foundation for lithographic artists from the mid-20th century to the present day. Additionally, there have been ongoing developments and innovations in lithographic printing techniques and materials to enhance the quality of the artwork. Looking back to 1818, Alois Senefelder experimented with using metal plates for lithographic printing (Porzio et al., 1983). This led to research and experimentation with new etching solutions for lithographic plates, known as "Gum etch," which differed from traditional methods. In 1904, American lithographer Ira Rubel devised a successful offset printing system, which contributed to the widespread use of aluminum plates for lithographic printing. The use of lightweight and large-sized metal plates resulted in lithographic prints by later artists being more vibrant and larger in size. When the successful coating of aluminum plates with water-based solutions for photographic plate making was achieved, artists began utilizing these coated metal plates or applying the coatings themselves. This led to a variety of artistic styles and rapid developments and changes in the art of lithographic printing.

In Thailand, lithographic prints entered the commercial printing scene much like in Europe and the United States. Private printing houses were established to produce commercial printed materials such as calendars, product labels, newspapers, posters, etc., using lithographic stone plates that were imported from abroad. However, with the introduction of aluminum plates as a new option, replacing limestone, due to their larger size and lighter weight, lithographic printing underwent significant advancements.

The development led to the popularization of offset printing systems in printing houses up to the present day. In terms of fine arts and education, the Department of Lithography was established in the Faculty of Fine Arts at Silpakorn University in 1966 by Professor Chalood Nimsamer (1929 - 2015). He was responsible for teaching all four primary lithographic processes and laid the groundwork for lithographic art education in Thailand. Subsequently, after a few years of decline in lithographic art education due to difficulties in sourcing materials and the unsuitability of Thailand's climate for the process, efforts were made to revive lithographic education in 1985. Professor Kanya Charoensupkul conducted research and brought back experiences from studying lithographic printing in the United States (Charoensupkul, 2007). This led to a formal reintroduction of lithographic education, with attempts to adapt materials and equipment available domestically. These efforts facilitated adjustments to the lithographic printing process to suit Thailand's climate and geography, establishing an important foundation that has enabled Thai artists, students, and scholars to produce a plethora of lithographic works up to the present day.

4.2 Lithography Process

Lithography originated in countries with cooler climates. When the process was introduced in Thailand, it became necessary to conduct it in air-conditioned rooms with consistent temperatures. The optimal temperature range is 22-25 degrees Celsius. The primary importance lies in the quality of the printing plate, whether it's made of limestone or aluminum. With high-quality plates, numerous prints can be produced. The lithographic process consists of plate preparation, plate drawing, etching, and printing. It relies on the principle of the mutual repulsion between grease and water. This research focuses on the lithographic process on aluminum plates due to their lightweight, easy mobility, lower cost compared to limestone plates, and the ability to re-polish the plate surface for reuse.

The process of preparing aluminum printing plates requires a rough surface to ensure that the drawing material adheres well to the plate. Before drawing, the aluminum plate needs to be cleaned by washing it with diluted sulfuric acid. The ratio typically used is 2 ounces of sulfuric acid to 20 liters of water. This helps remove any debris or grease from the surface of the plate.

The fundamental principle and key method of creating aluminum lithographic plates lie in the principle of the mutual repulsion between water and grease. This involves creating a plate from materials that contain grease, such as litho-pencil, litho-crayon, stick tusche, or other materials with greasy components. These materials are used to draw directly onto the aluminum plate.

The etching process of the plate, after drawing or creating an image on it with materials containing grease, involves a chemical process called gum etch. The acid used for this purpose needs to be diluted, typically with a mixture of phosphoric acid and Arabic gum, in suitable proportions for the plate (Chlomruk, 2019). The appropriate ratio depends on the type of material used to draw the grease, which varies in weight, so the etching time must be adjusted accordingly. Once the acid mixture is prepared, it is applied to the surface of the plate, where it etches the areas not protected by grease, revealing the drawn or created image. After etching, the plate is left for approximately 6 to 12 hours to improve its condition. Following the etching process, only the grease adhered to the surface remains, acting as a medium to accept ink from the ink roller.

After etching and leaving the plate, the next step is to clean the grease from the plate to its utmost cleanliness, leaving only faint traces of the drawn grease image. This is done using a mixture of sennelier oil and thinner, which is used to clean the drawn areas. The plate is then wiped with a soft cloth dipped in red lacquer remover, focusing specifically on the areas where the drawing and image creation were done. The red lacquer remover must be thinly coated to act as a medium to accept ink in the drawn areas, improving ink adhesion. Afterward, ink is applied or rolled onto the plate and then washed off with water. Using a water fountain, excess gum etch, red lacquer, and ink are rinsed off to ensure cleanliness. Then, the printing process begins. Water is applied by dipping a sponge into water and rolling it evenly across the plate's surface. The small hydrophobic areas on the plate's surface hold the water, and the ink-receptive areas repel it. When rolling the ink onto the plate's surface, the ink adheres to the areas with grease, making them ink receptive.

Meanwhile, the non-greased areas that retain water naturally repel ink due to the greasy ink's natural properties. The process of rolling ink and rolling water alternates on the plate's surface, maintaining water presence throughout. Once enough ink is on the plate, paper is placed and pressed onto the plate to transfer the image from the plate to the paper. Repeating these steps allows for the printing of multiple copies (editions) as needed.

The process of creating lithographic printing plates, as mentioned earlier, involves the use of various chemicals from etching to printing. One of these chemicals is red lacquer, which is essential but often imported, expensive, and has a strong odor. This led to the innovation of an ink-receptive solution that could be sourced locally to reduce production costs and minimize the health risks associated with strong chemical odors from red lacquer. The development of ink-receptive solutions aimed to replace red lacquer required a study and compilation of red lacquer's properties. It was found that red lacquer plays a crucial role in creating the bottom layer of the image on the plate, which serves as a medium for the grease drawn onto the plate during etching. This layer facilitates ink adhesion from the roller, resulting in better ink transfer onto the plate (Charoensupkul, 2007). Additionally, coating aluminum lithographic plates with red lacquer extends their lifespan, allowing for multiple printing cycles (Ross et al., 1990). Red lacquer also strengthens the areas drawn with grease on the aluminum plate, enhancing ink receptivity.

Moreover, the application of red lacquer onto aluminum lithographic plates improves the durability of the drawn grease areas, ensuring better ink adhesion and preventing the loss or expansion of small details. The red lacquer coating forms a thin film that enhances detail and strengthens fine lines, making the drawn areas crisper and more resistant to acid. This prevents small details from being lost or enlarged during the printing process (Musashino Art University Printmaking Laboratory, 2002).

Further research revealed another technique called Chemical Printing, pioneered by Alois Senefelder. This method utilizes chemicals such as wax shellac or rosin as mediums for ink adhesion (Porzio et al., 1983), enhancing the plate's ink receptivity . Chemical Printing, employing wax as an aid in ink receptivity, provides an alternative method for creating lithographic plates using chemical reactions.
In addition to red lacquer, another type of ink-receptive base used in the lithographic printing plate process, particularly for stone plates, is asphaltum. Asphaltum is applied before red lacquer, as it has been historically used in the image-making and printing process for stone plates predating aluminum plates. Asphaltum contains grease components, making it suitable for drawing images. Apart from using a wiping solution to increase the grease quantity on the plate during plate preparation for the second acid etching or before inking, asphaltum is utilized (Charoensupkul, 2007).

Utilizing asphaltum helps increase the grease quantity on the lithographic plate, facilitating better ink adhesion from the roller, particularly for aluminum plates. Moreover, according to The Tamarind Book of Lithography: Art & Techniques by Garo Z. Antreasian (1922 – 2018), asphaltum serves as a base for ink adhesion, aiding in increasing the grease quantity in the drawn and imaged areas. This ensures uniform image density when inking the plate and reinforces the plate's strength, especially in areas where grease drawing has been etched away by acid. Additionally, asphaltum can be used to create plates with smooth, dense surfaces, applicable to both zinc and aluminum plates using the same process as for stone plates. Asphaltum is applied or spread onto the desired area to create a smooth, dense surface, followed by drying and then proceeding to the acid etching process.

From the above information, there are two types of chemicals that serve as a base for ink receptivity after the etching process. These are Red Lacquer, which is commonly used with aluminum lithographic plates, and Asphaltum, which is preferred for use with stone lithographic plates. Both types have similar properties as they serve as a base for ink receptivity from the rollers onto the printing plate. Therefore, the development of an ink receptive solution to replace Red Lacquer necessitates properties that can serve as a base for ink receptivity from the rollers onto the printing plate, helping to increase ink volume and strengthen the plate in areas that have been partially etched away by acid. This led to the search for an ink receptive solution with these characteristics. Additionally, it needed to be locally sourced and odorless during use. The most effective ink receptive solution found after printing trials on paper was a mixture of Black Varnish and Soy Wax in a ratio of 2:1. (Chlomruk, 2019)

By incorporating the ink receptive solution obtained from testing into the flatbed printing process on aluminum lithographic plates, instead of using Red Lacquer in the printing step, we first dilute it slightly with mineral spirits and then apply it to the printing plate. Because the ink receptive solution is based on the fundamental principle of flatbed printing, where ink adheres to ink but separates from water, applying the solution to the inked areas of the printing plate helps increase ink volume and ensures better adhesion of ink from the rollers onto the printing plate. Therefore, the ink receptive solution has properties similar to Red Lacquer and Asphaltum as a medium for accommodating ink from the rollers. The ink receptive solution utilizes soy wax to increase ink volume in the inked areas, facilitating better ink absorption from the rollers. Additionally, Black Varnish helps coat the printing plate to increase its durability after etching. Furthermore, it strengthens the plate in areas that have been partially etched away by acid, ensuring more consistent printing and allowing for a greater number of print runs. Both components of the ink receptive solution can be sourced domestically, are cost-effective, and pose no health hazards.
From reviewing and gathering information about the flatbed printing process, it becomes evident that various chemicals are used in the process to achieve desired results. These chemicals are integral to understanding the principles and methods of using ink receptive solutions.

5. Methodology

Unit of Analysis

Research on Studying the Efficiency of Ink Receptive Materials in Lithograph Printing on Aluminum Plates is a qualitative research aimed to: 1. Investigate the characteristics of lithographic printing ink solutions generated from creating aluminum plate substrates in the lithographic printing process. 2. Test and compare the efficiency of lithographic printing ink solutions with red lacquer in creating lithographic printing plate substrates. 3. Evaluate and analyze the efficiency of lithographic printing ink solutions containing ingredients from within Thailand. The researchers have defined the research procedures and methodology as follows:

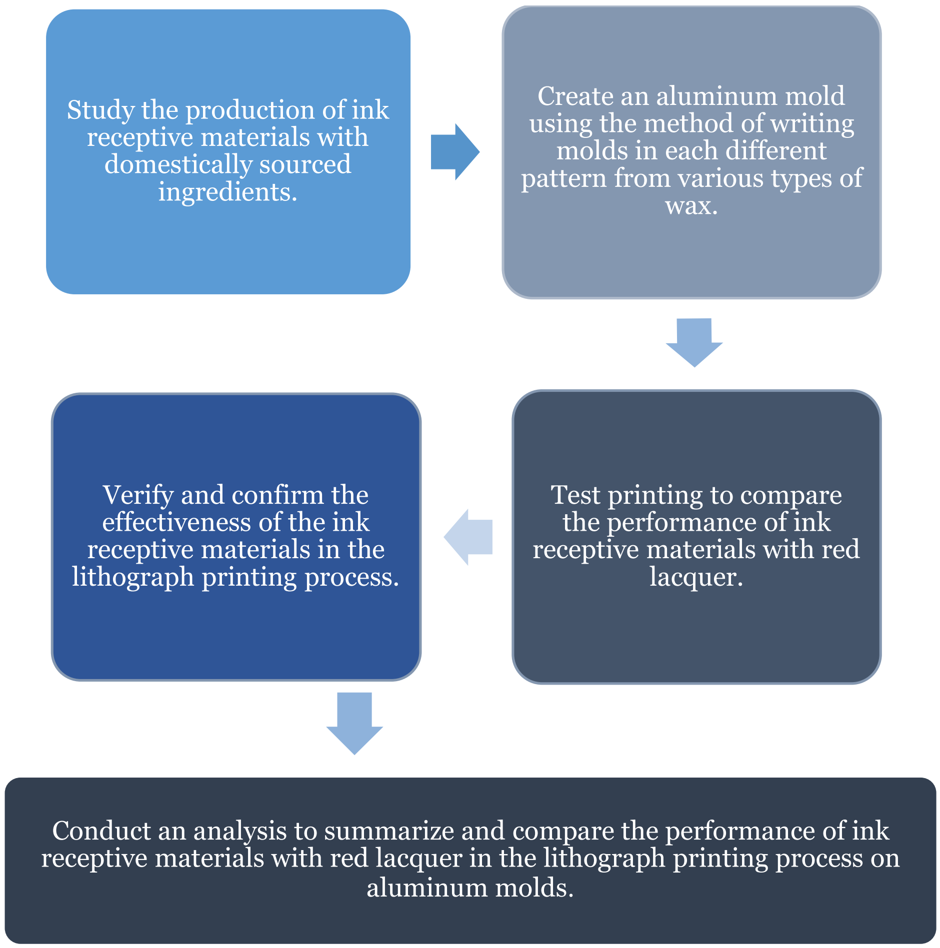

Figure 1 **Conceptual Framework**

Starting with gathering data on researching lithographic printing ink solutions from ingredients within Thailand, the research then proceeded to test the lithographic printing ink solutions and red lacquer on aluminum plates with various types of ink writing characteristics. This was to establish a tool for comparing the efficiency of lithographic printing ink solutions with red lacquer, determining how their properties differ. Subsequently, the quality of the research tool was examined by comparing the printing results and conducting surveys and evaluations by six experts and nine students. After obtaining the printing results and survey responses from a total of 15 individuals, all the data was compiled for analysis to draw conclusions by comparing the efficiency of lithographic printing ink solutions with red lacquer in the lithographic printing process on aluminum plates.

Research Process

1.1 Mixing printing ink.

From researching the lithograph printing process to find the properties of red lacquer and asphaltum through literature reviews, related research documents, to be used in studying the components in producing printing ink for the offset printing process on aluminum plates, it led to the search for raw materials with ink components to be tested as ink ingredients. The criteria were that these materials should be readily available within the country, with low cost, for teaching purposes, and should be substances or chemicals with the least odor to avoid long-term health effects. The main ingredients identified were black varnish. Black varnish has properties similar to lacquer, such as acid and alkali resistance, readily available at an affordable price domestically. Another raw material is soy wax, which acts as an ink. It can help increase the ink quantity on the plate and support ink from the rollers. Black varnish is mixed with soy wax at a ratio of 2:1 (Chlomruk, 2019). The result of this hot melt blending process is that the printing ink has a suitable viscosity and consistency, with a slight odor.

Figure 2 Black Varnish : Soy Wax = Ink Receptive Materials: Chlomruk, 2024

1.2 The steps of using printing ink varnish compared to red lacquer

Creating an aluminum plate in the lithograph printing process, using various types of etching tools for each plate type, then testing and comparing the efficiency of printing ink varnish with red lacquer on the same plate. The ink varnish and red lacquer are applied separately, with the ink varnish entering the lithograph printing process in the same step as the red lacquer. After acid etching, the plate is wiped clean, then the ink varnish, mixed with a small amount of turpentine, is applied evenly across the plate, ensuring it adheres uniformly to the faint image areas until the entire plate is coated. It should be left for approximately 1-2 minutes to allow the turpentine mixed in the ink varnish to evaporate. Then, a soft cloth soaked in the desired color is used to lightly apply the ink varnish, followed by water bubbles to rinse off excess glue, ink varnish, and color. Finally, the plate is ready for printing with the ink roller transferring ink onto the plate.

Figure 3 The steps of using printing ink varnish: Chlomruk, 2024

From the collected data on the components of printing ink varnish and the process of using printing ink varnish to create images in the lithograph printing process, it can be summarized that the components of printing ink varnish are black varnish mixed with soy wax in a ratio of 2:1. Printing ink varnish has the property of coating the surface of the printing plate, making it resistant to acids and bases, increasing the amount of ink on the plate, and serving as a medium to support ink from the rollers. In the printing ink varnish mixture, soy wax is used to increase the amount of ink in the written areas, serving as a medium for receiving ink from the rollers more effectively. Additionally, black varnish helps to coat the plate, making it resistant after acid etching. Furthermore, it strengthens the plate in areas where there is thin writing and where acid erosion occurs, resulting in more consistent image weight and enabling the printing of a larger number of artworks. Both components can be found domestically at an affordable price and without chemical odors during use.

1.3 Participant

The participants in the research provided information for the questionnaire on the efficiency of printing ink varnish in the process of creating aluminum printing plates in the planographic printing process. There were 6 experts and 9 students involved, totaling 15 individuals, to evaluate the printing results and compare to determine the effectiveness of printing ink varnish against red lacquer in lithograph printing.

1.4 Research Instrument

1. Collecting print results from aluminum plate printing processes using various plate-making methods with different types of plate-making equipment. This includes separating the side using the ink fountain solution from the side using the dampening solution in the printing process, in order to compare the effectiveness of the ink fountain solution and the dampening solution on the same printing plate.
2. Conducting a questionnaire (Opinionnaire) to analyze the effectiveness of the ink fountain solution by surveying 15 experts and students.

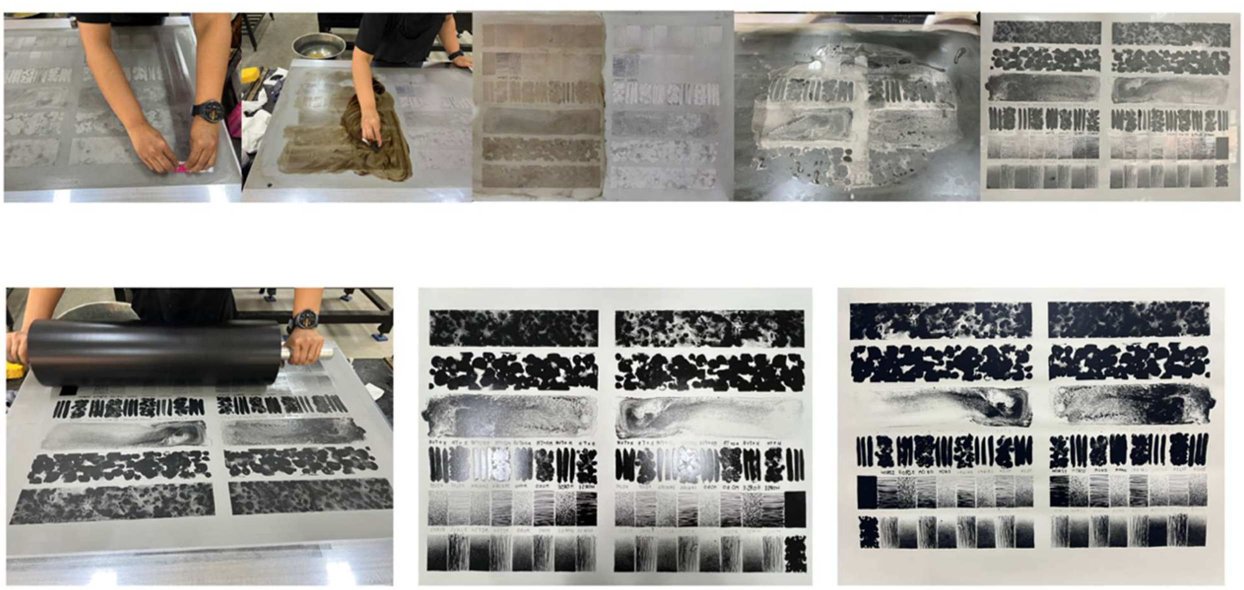

Figure 4 Steps to create a comparative tool using ink solvent and red lacquer on an aluminum plate mold: Chlomruk, 2024

From Figure 4, it illustrates the process of creating a comparative tool using ink solvent and red lacquer on an aluminum plate mold in the flexographic printing process. It can be observed that ink solvent washes off easily and leaves no color residue on the plate when wiped with water for the first time. Meanwhile, red lacquer still retains color residue, necessitating multiple wipes and rubs. Additionally, as the ink rolls on the ink solvent side of the plate, the ink quantity gradually increases until it fills according to the printing sequence.

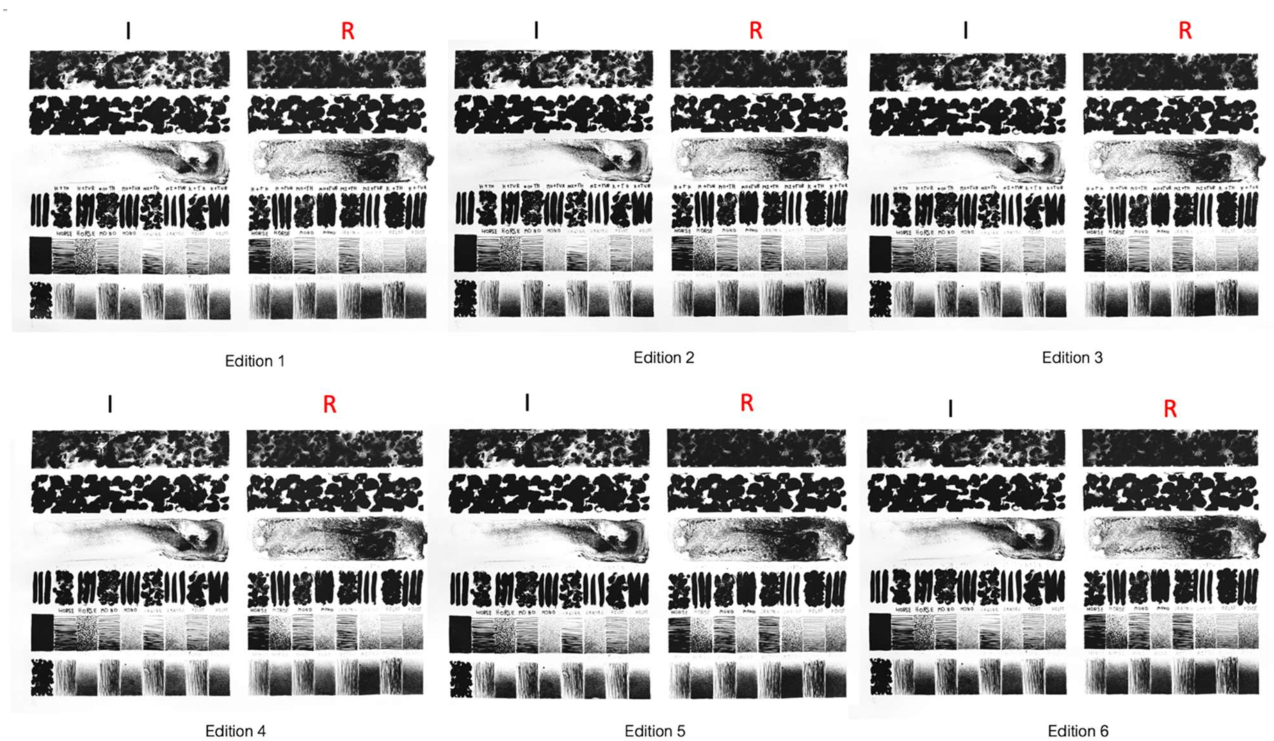

Figure 5 Shows the print results comparing the performance of ink solvent and red lacquer from the aluminum plate mold created in the lithograph printing process: Chlomruk, 2024

From Figure 5, the print results comparing the performance of ink solvent and red lacquer from the aluminum plate mold created in the lithograph printing process can be observed. On the left side of the image, denoted as "I," representing the side using ink solvent, and on the right side of the image, denoted as "R," representing the side using red lacquer. It can be seen that the overall weight of the images on the surface using different writing tools on the "I" side, which uses ink solvent, is almost the same. However, in Edition 1, the ink quantity is less and gradually increases with each edition or print sequence, while still maintaining good line, dot, and surface quality according to the writing tools used in each type. This allows for the printing of a large volume of work because the mold is strong and does not receive too much or too little ink. However, in terms of using ink solvent for writing with the Solid method, in Edition 1, there is still insufficient ink quantity. In Edition 2, there is enough ink, up to Edition 6. On the "R" side, using red lacquer, the ink quantity increases rapidly in areas where there is oil or a significant amount of ink, causing some parts of the mold to receive too much ink, resulting in a solid texture. Therefore, it can be seen that ink solvent is as effective as red lacquer in the lithograph printing process, usable with all types of writing equipment, providing durability to the mold, and ensuring consistent image weight.

6. Research Results

Research on "Studying the Efficiency of Ink Receptive Materials in Lithograph Printing on Aluminum Plates is conducted as qualitative research.

6.1 The study examined the properties of ink solvents from the creation of aluminum plate printing plates in the lithograph printing process

The study investigated the flat printing process to identify the characteristics of red lacquer and asphaltum through literature review and related research documents to find the properties of both chemicals. The research found that the best ink solvent composition after printing tests on paper was black varnish mixed with soy wax in a ratio of 2:1. This combination was found suitable to replace red lacquer and asphaltum in the printing process. The solvent was applied by lightly diluting with a small amount of mineral oil before wiping the printing plate. This ink solvent is effective because it adheres well to the printing plate's inked areas, increasing the amount of ink from the ink roller. Additionally, black varnish helps protect the printing plate from acid etching, reinforcing its strength, especially in areas where the ink is thin or affected by acid. This ensures consistent printing results and allows for high-volume printing. Both ingredients are locally available at affordable prices and pose no health risks.

6.2 Examining the printing results to compare the efficiency between inkjet printer ink and red lacquer in the lithograph printing process.

The printing results were examined to compare the performance of ink solvent with red lacquer in the lithograph printing process. Fifteen participants, including six experts and nine students, provided data through a questionnaire to assess the effectiveness of ink solvent compared to red lacquer in lithograph printing.

Table 1. The results confirmed the effectiveness of ink solvent from aluminum plate printing with various types of equipment in the flat printing process.

The Question									**Summarize the opinions of experts and students.**		
The efficiency of printing inkjet ink from creating aluminum plate molds using various equipment.			Least	Low	Moderate	High	Most		Mean	Percentage	Score Range Level
			1	2	3	4	5				
1	Litho - Pencil	Do you think printing ink has efficiency in creating molds with Horse brand Litho-Pencil?	-	-	1	2	12		4.73	94.6	Most
2		Do you think printing ink is efficient for creating molds with Mono brand Litho-Pencil?	-	-	-	6	9		4.60	92	Most
3		Do you believe printing ink is effective in creating molds	-	-	-	3	12		**4.80**	**96**	Most

		with Mitsubishi 7600 Litho-Pencil?								
4		Do you believe printing ink is effective in creating molds with Korn's Litho-Pencil?	-	-	-	6	9	4.66	93.2	Most
5	Permanent Marker	Do you think printing ink is effective for creating molds with Horse brand Permanent Marker?	-	-	-	5	10	4.66	93.2	Most
6		Do you think printing ink is effective for creating molds with Mono brand Permanent Marker?	-	-	-	4	11	4.73	94.6	Most
7		Do you think printing ink is effective for creating molds with Sakura brand Permanent Marker?	-	-	1	9	5	4.26	85.2	Most
8		Do you think printing ink is effective for creating molds with Pilot brand Permanent Marker?	-	-	1	1	13	**4.80**	**96**	Most
9	Stick tusche	Do you think printing ink is effective for creating molds with Stick tusche?	-	-	-	3	12	**4.80**	**96**	Most
10		Do you think printing ink is effective for creating molds with Stick tusche?	-	-	2	6	7	4.33	86.6	Most
11		Do you think printing ink is effective for creating molds with Stick tusche?	-	-	-	4	11	4.73	94.6	Most
12	Ink Receptive Materials	Do you think printing ink is effective for creating molds using the Solid method?	-	-	-	2	13	**4.86**	**97.2**	Most

The scoring criteria for evaluating performance are as follows:

- Average score of 4.21 – 5.00 indicates Excellent
- Average score of 3.41 – 4.20 indicates Good
- Average score of 2.61 – 3.40 indicates Fair
- Average score of 1.81 – 2.60 indicates Poor
- Average score of 1.00 – 1.80 indicates Very Poor

The evaluation results regarding the efficiency of inkjet ink from creating aluminum plate printing plates using various types of equipment:

- Horse brand litho-pencil achieved an average score of 4.73, equivalent to 94.6%, indicating the highest level of effectiveness.
- Mono brand litho-pencil scored an average of 4.60, which is 92%, also indicating the highest level of effectiveness.

- Mitsubishi 7600 brand litho-pencil achieved an average score of 4.80, equivalent to 96%, indicating the highest level of effectiveness.
- Korn's brand litho-pencil scored an average of 4.66, equivalent to 93.2%, also indicating the highest level of effectiveness.
- Horse brand permanent marker achieved an average score of 4.66, equivalent to 93.2%, indicating the highest level of effectiveness.
- Mono brand permanent marker scored an average of 4.73, equivalent to 94.6%, indicating the highest level of effectiveness.
- Sakura brand permanent marker achieved an average score of 4.26, equivalent to 85.2%, indicating the highest level of effectiveness.
- Pilot brand permanent marker scored an average of 4.80, equivalent to 96%, indicating the highest level of effectiveness.
- Tusche with water scored an average of 4.80, equivalent to 96%, indicating the highest level of effectiveness.
- Tusche wo with thinner scored an average of 4.33, equivalent to 86.6%, indicating the highest level of effectiveness.
- Tusche with mineral oil scored an average of 4.73, equivalent to 94.6%, indicating the highest level of effectiveness.
- Creating a printing plate from inkjet ink using the Solid method scored an average of 4.86, equivalent to 97.2%, indicating the highest level of effectiveness.

Based on the evaluation results of the efficiency of inkjet ink from creating aluminum plate printing plates using various types of equipment, the summary is as follows:

- Mitsubishi 7600 brand litho-pencil achieved an average score of 4.80, which is 96%, indicating the highest level of effectiveness.
- In the permanent marker category, Pilot brand scored an average of 4.80, equivalent to 96%, also indicating the highest level of effectiveness.
- Additionally, Tusche mixed with water scored an average of 4.80, equivalent to 96%, indicating the highest level of effectiveness.
- Furthermore, creating a printing plate from inkjet ink using the Solid method scored an average of 4.86, equivalent to 97.2%, indicating the highest level of effectiveness.

Table 2. The confirmation result of the effectiveness of printing ink from creating aluminum plate molds in the lithograph printing process.

	The Question	**Summarize the opinions of experts and students.**	
		Agree (person)	Percentage
1	Do you think printing ink is as effective as red lacquer in creating molds for lithograph printing?	15	100
2	Do you think printing ink contributes to the durability of aluminum plate molds in lithograph printing?	15	100
3	Do you think printing ink is suitable for creating aluminum plate molds in lithograph printing?	15	100

4	Do you think printing ink is beneficial for creating aluminum plate molds in lithograph printing?	15	100

From the evaluation in Table 2, the confirmation of the effectiveness of the ink fountain solution in aluminum plate lithograph printing processes can be summarized as follows:

- The ink fountain solution is as effective as the dampening solution in the lithograph printing process, agreed by all 15 respondents, representing 100% agreement.
- The ink fountain solution provides durability to aluminum plate lithograph printing, agreed by all 15 respondents, representing 100% agreement.
- The ink fountain solution is suitable for creating aluminum plate lithograph printing, agreed by all 15 respondents, representing 100% agreement.
- The ink fountain solution is beneficial for aluminum plate lithograph printing processes.

7. Discussion & Recommendations

From the research on studying the efficiency of inkjet ink from creating aluminum plate printing plates in the planographic printing process, the objectives can be summarized as follows:

1. To study the properties of inkjet ink from creating aluminum plate printing plates in the lithograph printing process.
2. To test and compare the efficiency of inkjet ink with red lacquer in creating lithograph printing plate.
3. To evaluate and analyze the efficiency of inkjet ink with components from Thai raw materials.

These objectives aim to investigate various aspects of inkjet ink and its application in creating aluminum plate printing plates, as well as to assess its performance compared to traditional red lacquer and evaluate the potential of utilizing locally sourced materials in inkjet ink production.

The research findings indicate that the properties of inkjet ink are consistent with those of red lacquer, as described in an article by Kanya Charoensupkul in 2007. Red lacquer is a chemical compound that aids in creating an image on the lower layer, which serves as a medium for the ink applied by the roller after acid etching, facilitating better ink adhesion to the printing plate. It was found that inkjet ink has the property of being a suitable ink-receiving base from the roller, helping to increase the amount of ink on the printing plate and strengthening the plate in areas that are thin and have been etched by acid. These properties closely resemble those of red lacquer. Additionally, locally sourced ingredients can be found, and there is no unpleasant odor during use. The best-performing inkjet ink mixture after printing tests on paper was found to be black varnish mixed with soy wax at a ratio of 2:1, which can be used as a substitute for red lacquer and asphaltum in the printing process.

In addition to red lacquer, asphaltum is another chemical commonly used in the lithographic printing process. It shares similarities with red lacquer in its role as a base for ink adhesion on lithographic stones. This research aligns with the ideas of Garo Z. Antreasian (1922 – 2018), who stated that asphaltum aids in increasing the ink volume on the areas that are written on, resulting in a more consistent image when the ink is rolled onto the printing plate. It also strengthens the plate in areas that are thinly written on or etched by acid. Both red lacquer and asphaltum serve as bases for ink adhesion, prompting the testing and comparison of the efficiency of ink and red lacquer in creating lithographic printing plates. The research findings indicate that ink acts as a suitable base or medium for ink reception from the roller and performs well with all types of printing plate writing equipment. It provides durability to the printing plate. Moreover, inkjet ink performs best with Mitsubishi 7600 litho-pencil brand, while Pilot permanent marker brand are most efficient with mixed tusche and water. Additionally, inkjet ink can effectively create printing plates using the solid method.

The evaluation and analysis of the effectiveness of the printing ink solvent that incorporates domestically sourced materials in Thailand has been confirmed by experts and students. They found that the printing ink solvent is effective in creating printing plates comparable to red lacquer in the flat printing process. This enables the printing plates to withstand wear and tear effectively, making it suitable and beneficial for creating aluminum printing plates in the flat printing process in reality.

Suggestions

Ink solvent's suitability and benefits for creating aluminum plate printing plates provide alternative avenues for education and artistic creation in flatbed printing. Ink solvent contains domestically sourceable ingredients and lacks the strong chemical odor of red lacquer, which may have long-term health implications. This helps reduce costs and advances knowledge in creating lithograph printing artwork in Thailand.
Thailand's hot climate causes ink solvent to be more volatile than usual, affecting its application. Therefore, it's necessary to refrigerate ink solvent to preserve it and extend its shelf life.

References

1. Antreasian, G.Z., & Adams, C. (1971). *The Tamarind Book of Lithography: Art and Techniques*. Los Angeles: Tamarind Lithography Workshop Inc. & New York: Harry N. Abrams Inc.
2. Charoensupkul, K. (2007). *Lithograph*. Bangkok: Art Gallery Silpakorn University.
3. Chlomruk, D. (2019, May). Citation: Finding Effective Ink Receiver Ingredient in Image Creation on Aluminum Plate to Replace Red Lacquer in Lithograph Process. *The 11th Asian Conference on Arts & Humanities (ACAH)*. Tokyo. Available at https://papers.iafor.org/submission50703/
4. Chlomruk, D. (2020, November). The Study of Ink Receiver on Aluminum Plate Artwork in Lithograph Process (November 5, 2020). *Proceedings of the 4th International Symposium of Arts, Crafts & Design in South East Asia (ARCADESA)*, Available at SSRN: https://ssrn.com/abstract=3807687 or http://dx.doi.org/10.2139/ssrn.3807687
5. Devon, M., Lagattuta, B., & Hamon, R. (2009). *Tamarind Techniques for Fine Art Lithography*. New York: Harry N. Abrams, Inc.
6. Porzio, D., et al. (1983). *Lithography: 200 Years of Art, History, & Technique.* NewYork: Harry N. Abrams.
7. Musashino Art University Printmaking Laboratory. (2002). *Printmaking.* Tokyo: Musashino Art University Press Publication Bureau.
8. Ross, J., Romano, C., & Ross, T. (1990). *The Complete Printmaker*. New York: The Free Press.

9. Ngarmchuachit, T. (1986). *Printmaking29*. Bangkok: Bouluangprinting.
10. Sakulchatri, Y. (2015). Sketch in Lithograph: Case Study of Learning Lithograph the Faculty of Fine and Applied Arts, *Journal of fine arts research and applied arts.* Faculty of Fine and Applied Arts, Rajamangala University of Technology Thanyaburi, 147-169.