DEVELOPMENT OF AUTOMATED DYEING MACHINE (BOAFO) FOR SMALL SCALE DYERS, BATIK, TIE AND DYE IN GHANA.

Safo-Ankama Kweku
Akrofi Moses

Abstract

Hand craft dyeing processes has been with traditional batik makers, tie dye producers for centuries coupled with indigenous techniques without any major technological advancement in their dyeing processes. These indigenous techniques most of the time result in varied dyeing defects. This project seeks to develop an automated dyeing machine (Boafo) for small scale dyers, batik, tie and dye in Ghana. The experimental approach was used in execution and testing of the machine. Findings revealed that the machine (Boafo) offers minimum handling of chemicals and fabric by operator. This speeds up production rate of a given time and maintains calendaring lustre of fabric even after dyeing process, thus improve performance in the dyeing methods adopted by local craft, small scale industries and institutions working in the domain of dyeing textile fabrics.

Introduction

Textile has been with man from the prehistoric times to this era .The quest for man to clothe himself, look different, identify himself, protect himself from the element of the weather, and paramountly, to cover his nakedness has accounted for the constant production of textile products from fibre, yarn, fabric to garment. The constant development of man based on sophisticated whims and caprices has accounted for the search and development of varied colouration techniques. Symbolic colours were employed to suit the need of the people in the domain of hunting for disguise, representation of thought in cloth and flags, magical purposes, for representation of beauty and exhibition of class and status. This constant requirement for dyed textile

fabrics propelled a lot of people to enter into the business of colouring fabrics by the 'hand dyeing' methods. The hand dyeing methods grew from just a hobby to a skilled occupation which attracted a lot of patronage from interested locals.

Gillow and Sentence (1999) opines that during the renaissance in Europe the art of dyeing became a skilled occupation, which brought about rapid development in the dyeing industry. Foulds (1990) also has it that the art of colouring textiles is very old, and that history can be traced from at least 4000years, starting in India and progressively spreading through Persia to Phoenicia and Egypt. Ingamells (1993) also states that the origin of dyeing is uncertain, but it is believed that the coloured fabric found in the ancient tombs of Egypt were in existence before 2500bc.

In Ghana there has also been conscious effort to develop the small scale dyeing industry as a source of creating small to medium scale employment through many youth and women empowerment programmes. For example the National Board for Small Scale Industry in providing support systems for the youth in augmenting the National youth employment policies, motivating and providing funds to some recruited personnel in the dyeing and printing industry to promote the growth of textiles. Already in Ghana, the small scale local dyeing industry is made up of a cluster of enterprises struggling to survive by serving local markets and developing local skills.

There have been numerous developments of local skills in the hand craft dyeing techniques in the domain of design improvement, developing and improving the fastness of dyes, development of basic tools. But there are major setbacks in achieving repeatability of shade, handling of chemicals posing health hazards to dyers, uneconomical usage of water and slow rate of production.

In this paper an attempt has been made to explain the development of a simple machine for dyeing textile fabrics that will facilitate and speed up production rate, minimal handling of chemical, level dyeing and achieving repeatability of shade for small scale dyers, batik tie and dye producers.

Materials and Methods

The materials adopted for the construction of the dyeing machine are common and available on the market making it possible for similar constructions and development. The main determinant for the selection of the material for construction is the reaction of dyeing chemicals during the dyeing process considering the dwell time for dyeing. This structure has been designed to curb the current challenges of achieving repeatability of shade, handling of chemical posing health hazards to dyers, uneconomical use of water

and slow rate of production. The main vat or trough is made of Perspex a material that has no chemical reaction with the dye bath. Underneath is a metallic stand that supports the vat and presents it at the waist level to an average human height of 30 inches from the ground. To achieve level dyeing and shade, the researchers introduced rollers in the vat to constantly roll and agitate fabrics to prevent folds and overlaps during dyeing. Another area of concern to the researchers was the minimal handling of chemicals by the operator to reduce health hazards, for this a motorized system was introduced to automatically power the system electronically and roll the fabric to replace the human power for agitation and submersion processes and also discharging of residue dye bath. The position of the rollers at the base of the vat was lower to the barest to allow the system to work at short liquor ratio using small quantity of water to dye large quantity of fabric.

Fabrication Processes

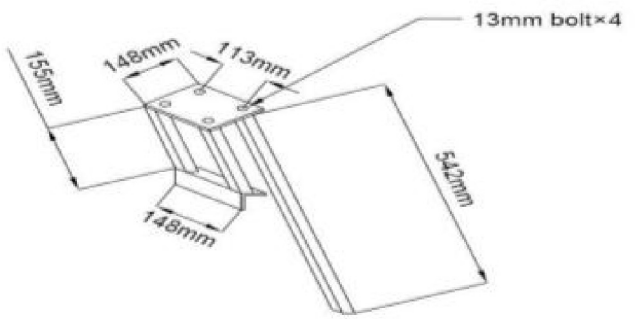

Fig 1 Seat for the motor

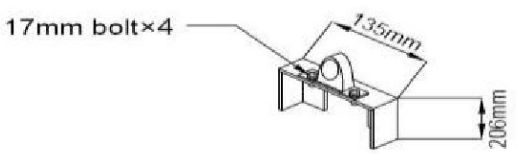

Fig 2. Bearing for the revolving shaft

ITEM	DESCRIPTION	QTY	ITEM	DESCRIPTION		QTY
1	SQUARE ROLLER	1	6	ROLLER STAND		2
2	STAND	1	7	BAERING BOLT		4
3	BEARING HOUSING	2	8	ROLLER STAND BOLT		8
4	ROLLER	1	9	MOTOR STAND		1
5	HOUSING					

Table 1
General parts of machine as indicated in fig 3.

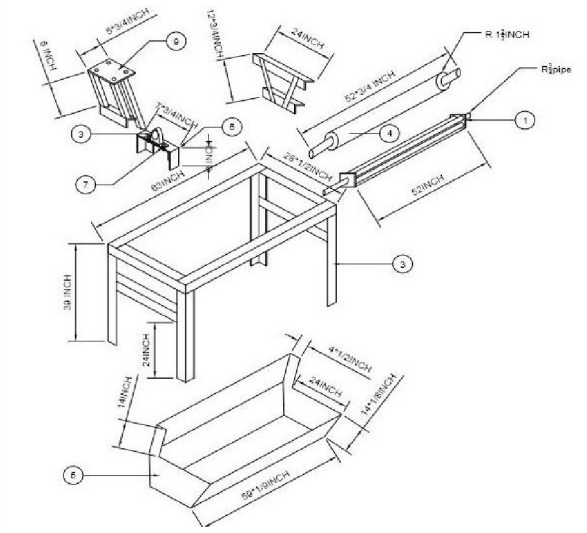

Fig 3 general parts of the machine with dimension

ITEM	DESCRIPTION	QTY	ITEM	DESCRIPTION		QTY
1	SQUARE ROLLER	1	6	ROLLER STAND		2
2	STAND	4	7	BAERING BOLT		4
3	BEARING HOUSING	2	8	ROLLER STAND BOLT		8
4	ROLLER	1	9	MOTOR STAND		1
5	HOUSING	1	10	DISCHARGE PIPE		1

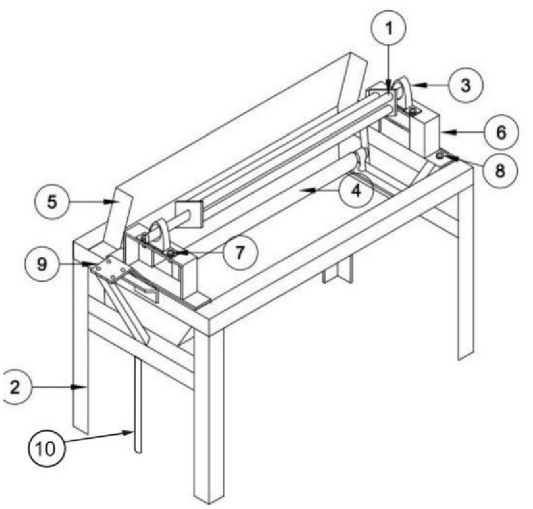

Fig 4 Assembled *Boafo* dyeing machine with labelled parts

Operating the Dyeing Machine

The machine operates on mainly electricity. It is also automated so it has a motorized system that controls the movement of the rollers. The horse power (speed) of the motor attached to the winch is 0.34hp making it possible for the fabric being dyed to gradually pick the dye molecules and gradually diffuse into the interstices of the fibre (fibre shaft). The fabric is processed in an open width orientation in order to prevent folds and creases that might lead to patch dyeing and strike defect.

The vat or trough that contains the dyebath has been designed and constructed in such a way that the discharge of residue dye is easy and convenient. The base of the trough or vat is slanted to one side to enable a complete disposal through the discharge pipe.

The maximum capacity of length of fabric to be dyed is twelve (12) yards by one ($1^{1/3}$) yards width wise; the size of mercerised cotton fabric. The fabric to be dyed is wound around the rollers by the operator, the lose ends that is the starting point and ending are stitched together to provide a continuous loop of fabric around the roller. This will allow a cyclic movement of fabric over and over again till level dyeing is achieved.

The fabric to be dyed is passed through a 'clear water' by turning on the motorized system to wet the fabric and open up it molecular structure making it receptive for dyeing.

The machine is turned on for the dyeing process to begin, the average time for the process is 10minutes reducing the handcraft manual dyeing method of 30 minutes, saving 20 minutes.

The machine also works with open width format avoiding the constant turning and agitation by human, thereby reducing the handling of chemicals that cause health hazards to operators.

Again the machine operates with short liquor ratio making it possible to save water, in that with the dyeing procedure of this machine there is not complete emersion of the whole quantity of fabric in the bye bath as in the case of exhaust dyeing. It works with the modus operandi of pad dyeing.

Testing the Dyeing Machine for its Efficiency

Sample of mercerized cotton was used in the testing of the machine because that is the raw material for most of the local batik, tie dye producers. The sample material was four (4) yards. The dye class used was vat due it wide usage by the local dyers. Most of the apparatus used were basic tools used by the local dyer for it to have direct developmental implications on their work.

The basic recipe used was ;

One (1) yard of fabric: one (1) spoonful caustic soda: Two (2) spoonful hydros: three (3) litres of water.

Four table spoons full of orange vat dye were fetched into a container with water for dye liquor preparation. Four (4) tablespoonful of caustic soda and eight (8) spoonful of sodium hydrosulphite respectively were added to the dye liqour solution based on the basic recipe being used. The mixture was stirred until an even consistency was achieved. The fabric was then wrapped around the rollers of the machine and the two ends of the fabric was stitched together to form a batch. Twelve litters of water was then poured into the vat and the machine switched on to wet the fabric, after few revolutions the fabric was lifted from the water. The dye liquor was poured into the vat and stirred, the fabric was lowered into the dye bath and the machine was switched on again. The dyeing went on for ten (10) minutes and the machine was put off (during the dyeing, the hand was used to stretch the fabric whenever the fabric folded up, in order to prevent creases). The stitched ends of the fabric were unstitched after a successful dyeing process and the fabric dried.

Several observations made in relation to the set objectives were that the new automated dyeing machine called Boafo dyes fabrics much faster, thus speeding up production rate. A piece of four (4) yards when taken through exhaust dyeing (normal local dyeing technique) could take thirty (30) minutes while the new Boafo machine reduced it to ten (10) minutes due to its open width format adopted for dyeing.

It was also noted that our invented machine, Boafo, does not exert any kind of stress or processing tension on the fabric which would have suffered rugged agitation and turn around manipulation in the dye bath by the exhaust dyeing (normal local dyeing technique) operator. This set back is eliminated due to the revolving nature of the roller thereby reducing creases and folds. Invariably the mercerized lustrous effect associated with the fabric is maintained and improved by the addition of colour.

It was also observed that Boafo was economical in the use of water thereby reducing drastically the use of water in the dyeing process. The average operational water to be used for (normal local dyeing technique) would be in the ratio of four (4) yards of fabric: twenty eight (28) litres of water this is based on principle that with exhaust dyeing there is complete immersion of the textile fabric under the dye bath to prevent patchy dyeing as a result of irregular exposure of the fabric as compared to four (4) yards of fabric: Twelve (12) litres of water.

It was also observed that Boafo solved a major problem associated with the local dyeing industries minimizing the issues of chemical accidents, because it was noted that the local dyeing operators paid little or no attention to Personal Protection Equipments (PPE). The machine encourages minimal handling of chemicals. After mixing of the dye liquor the operator does not play any role except occasionally straightening slight fabric folds until dyeing is complete. The health issues of using your hands to agitate and turn fabrics in the dye bath is eliminated completely, direct inhalation of dye through this act is also avoided.

Lastly, the automated winch machine was fabricated to dye six(6) yards of fabric but after the test dyeing, it was realized that the machine could process six yards and above without having any effect on the fabric and also could be used to dye lighter fabrics in rope form.

Implications for Development

Awedoba, (2007) emphasizes that development takes into accounts many other aspects of life operating in synergy with the economic and the political. These include environmental and health issues, education, access to information, appropriate technology and science as well as the perceived broader cultural goals and objectives of life and existence such as the arts and aesthetics; these are each relevant to the developmental aspiration of a people.

The Boafo dyeing machine has major relevant implications for developments; it approaches diverse developmental issue in the desire of small scale and medium scale batik tie and dye producers in Ghana.

Growth of the Textile industry
(small and medium scale enterprise)

The Boafo addresses a developmental concern in the domain of growing the collapsing textile industry. It tends to approach the growth from the low to middle drive, thereby empowering the local industry through mechanization to be able to stand the challenges of hand production in this 21st century. The Boafo tends to bring the local small scale dyer almost at par with some industries operating with order basis due to the current challenges facing the major giants in textile production in Ghana. The Boafo will serve as a stop gap in' small scale production to salvage the local textile industry.

Quality Control

The Boafo also solves a wide range of quality control issues which are evident with most small scale batik tie and dye operators, ranging from problems associated with repeatability of shades, patchy dyeing, retaining of lustre. Observations made which can help develop the industry were that finished products from Boafo were free from patches which is undesirable, and also retained the calendared luster which serves as a tool in marketing textile products.

Speeding Up Production Time

It was also noted that the rate of production (yardage wise) increases and (time wise) reduces. This means that the operator will be producing more, making more money with a shorter time thereby creating more wealth.

Minimal Handling of Chemical (Health)

Boafo guarantees the operator minimal handling of chemicals where in the case of typical hand craft dyeing chemical forms about eighty (80%) of accidents in the industry. Invariably the health related issues are minimized thereby cutting down the company budget on health and channelling all resources towards production. Again the cost of acquiring PPE's will be drastically reduced.

Conservation of Water/Chemicals

Water for dyeing process should be as neutral as possible on the pH scale; the closest possible source is the treated water from our pipes. This is because water with metallic oxides may alter shades of colour during the dyeing process. Treated water is expensive so reducing usage by a margin of sixteen litre (16lit.) in dyeing four (4) yards is significant, this will absolutely save the company in domain of water bills.

Conclusions

On the strength of the testing and findings, the conclusion drawn was that the Boafo machine is capable of promoting the growth of the small and medium scale dyeing industries, in the domain of preventing patchy dyeing, achieving repeatability of shades, speeding up production, achieving minimal handling of chemical and conservation of water and chemicals.

Recommendation

Based on the finding from the testing the machine is recommended for institutions and local /cottage industries engaged in dyeing to promote production.

References

Awedoba, A.K. (2007). *Culture and Development in Africa.* Accra: Historical society of Ghana publishers.

Foulds, J. (1990*). Small Scale Textiles, Dyeing and Printing* . U. K: Intermediate Technology Publication.

Gillow, J. & Sentance, B. (1999). *World Textiles, A visual Guide to Traditional Technique.* U.K: Thames and Hudson ltd.

Ingamells, W. (1993*). Colour for Textiles, A Users Handbook*. England: Society of Dyers and Colourists publishers.