

00 Printing Paste Management

Technical Description

Printing paste is used in textile finishing industries to print fabric (mostly woven fabric but also other fabrics but very limited i.e. knitted fabric) at different printing machines such as rotary and flatbed printing machines. Printing paste comprises of different dyes, pigments and auxiliary chemicals which are mostly organic in nature therefore contribute in enhancing Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) of wastewater. As printing paste is very expensive, therefore printing paste wastage through washing in the wastewater not only contributes in increasing wastewater pollution but also an economic loss. The detail of printing paste constituents is annexed at the end of this description.

Printing paste is formulated for each pattern to be printed on fabric in different colors. Its quantity is estimated on the basis of the type of the pattern, and percent of fabric surface area coverage. The quantity of the printing paste formulation will be more for those patterns which cover 100% of the fabric surface area as compared to those designs which partially cover the surface area. However, about 15-20% of surplus paste is prepared for each pattern and printing lot to avoid risk of its shortage during printing process and remaking and spending time again. After the completion of each printing lot, the rotary printing machine auxiliary parts such as pumps, pipes, squeegees and screens are washed with water to remove residual paste inside the system. This residual paste is about 4-8 kg which is washed with water after the completion of each batch of printing.

It is important to implement printing paste management system at the printing facility to avoid printing paste wastage. The purpose of the printing paste management is as under:

- To avoid excess or surplus preparation of printing paste and its wastage at the end
- To collect the residual printing paste from the system (pumps, pipes, squeegees) and paste drums
- To reuse/recycle the excess and collected printing paste in the printing process

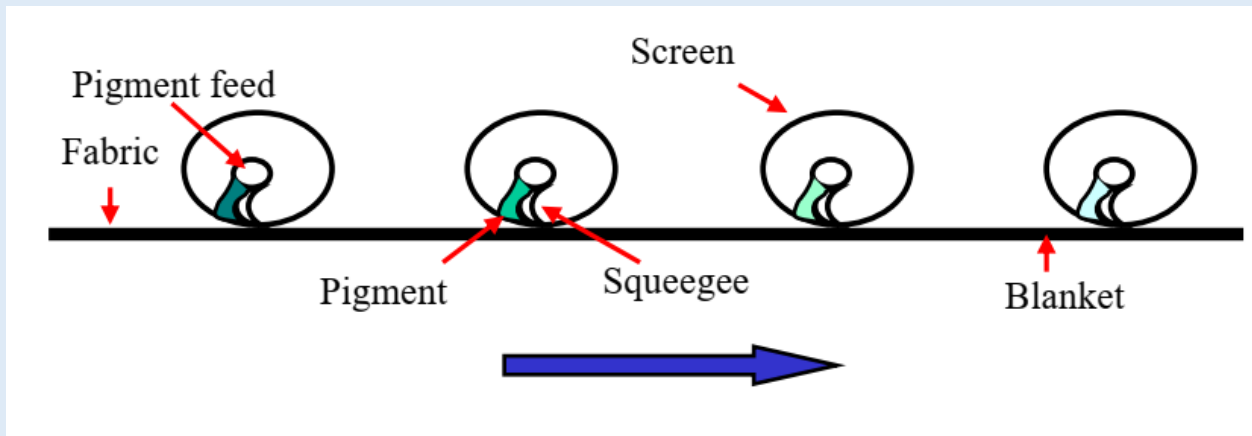


Figure-1: Illustration of Rotary Printing Machine



Figure-2: Rotary Printing Machine in Operation

Achieved Environmental Benefits

Printing paste is mainly organic in nature which contributes in increasing COD and BOD, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), color and some other pollutants when printing paste is washed off with water and mixed with wastewater or directly drained in the wastewater. The wastewater pollutants, generated through

printing paste, need to be treated in the wastewater treatment plant which increases treatment cost and sludge production. Sludge disposal is another environmental concern for the textile industries.

Printing paste management will also allow the minimum quantity of printing paste to be washed off or wasted in the drain, resulting in wastewater pollution control, reduced wastewater treatment cost and low quantity of sludge production.

Printing paste management will also result in resource efficiency where optimum resources (dyes, pigments and auxiliary chemicals) and water will be used and resource wastage will be reduced.

Operational Data

The quantity of printing paste formulated and used for printing fabric depends on percent of fabric surface area coverage by the pattern, the intensity of the colors (bright, dark, light) and the size of the printing lot. For maximum coverage of the surface area by any pattern (about 100%), printing paste of about 105 gm/m² is formulated. Generally, about 15-20% of surplus paste is formulated to avoid any risk of its shortage during the printing process and fear of remaking and spending time again on it. About 17 gm/m² surplus printing paste is formulated which is left after completing the printing lot in the paste drums.

When one batch of printing lot of any specific pattern is completed. Some quantity of printing paste remains in the system (pump, pipes, squeegees, screens) whose quantity is about 4-8 kg. After completion of printing batch of specific pattern, the system is washed off with huge amount of water and about 4-8 kg of printing paste is discharged into the wastewater. Average cost of 1 kg of printing paste is about US\$ 0.4.

Example

Following example will explain the actual wastage of printing paste annually in the textile industry in quantity and monetary terms:

Annual quantity of printed fabric	= 9,029,267 m ²
Annual printing paste formulation	= 948,073 kg
Annual surplus printing paste formulation (20%)	= 153,498 kg
Annual cost of surplus printing paste formulation	= US\$ 61,399
Annual wastage of printing paste from the system	= 8,760 kg (8 x 3 times/d x 365 d)
Annual cost of printing paste wastage from system	= US\$ 3,504
Total annual loss of printing paste	= 162,258 kg or US\$ 64,903

Existing Practices

Following are the existing practices of printing paste formulation and its wastage in most of the industries:

Manual Printing Paste Making: Existing practices in most of the textile finishing mills are to manually prepare the printing paste. Thickener is prepared by mixing different chemicals and then specific dye or pigment is mixed as per the recipe in the thickener in the paste drums. The number of printing paste drums depend upon the quantity of the fabric to be printed, color intensity, surface area coverage and the number of colors in the pattern. These printing paste drums are attached with the machine paste feeding system (pumps, pipes, squeegees). Paste is pumped through the pumps into the squeegees and passed on to the fabric surface through rotating screens in the given pattern.

There is lack of accuracy in the manual print paste formulation in terms of its quality and quantity and requires much time and labor.

Wastage of Surplus Printing Paste: The surplus printing paste, left after the completion of the printing lot in the paste drums is mostly wasted into the drain by washing the drums with water.

Washing of the Machine Feeding System and Screens: After the completion of printing lot of any specific pattern, the paste feeding system (pumps, pipes, squeegees) and screens are dismantled and washed with water so that the system and screens could be used for next batch.



Figure-3: View of Manual Color Kitchen



Figure-4: Washing of Squeegees

Printing Paste Management System

The printing paste can be managed in the following ways:

- Installation of automatic printing paste dispensing system
- Collection of all the surplus printing paste from the paste drums and the system
- Reuse of collected printing paste

Automatic Printing Paste Dispensing System: Automatic print paste dispensing system is composed of two main units i.e. a thickener preparation unit and a paste dosing unit. Both units can work either in standalone mode or together. The thickener preparation unit cooks the thickener automatically with minimum manual intervention as per the recipe fed in its computerized system. All powder and liquid ingredients can be dispensed automatically and can work with different recipes. The dosing unit prepares the printing paste by mixing thickener and dye or pigment in required quantity, in a small or big quantity based on the recipes. This automatic system reduces about 20% of surplus preparation of the print paste and reduces 25% of the time of paste making and dispensing.

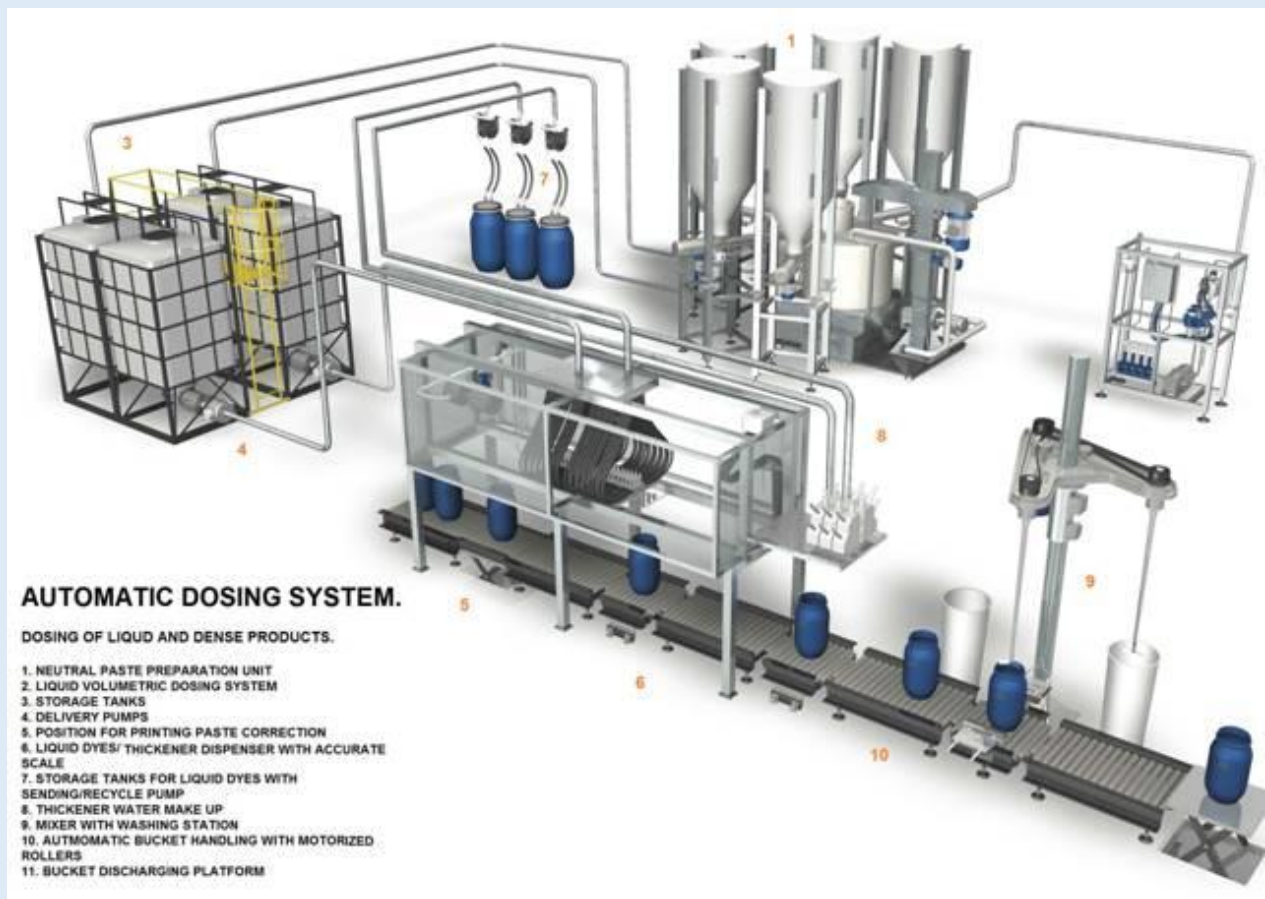


Figure-5: Illustration of Automatic Printing Paste Dispensing System (Source: Color Service)

Collection of Surplus Printing Paste: After completion of the printing lot for specific pattern, all the surplus and leftover printing paste from the drums and the machine system (pumps, pipes and squeegees) is collected. It needs to install paste pumps able to operate in forward and reverse direction. After the completion of printing lot, all the paste remained in the pumps, pipes and squeegees is removed and collected by operating the paste pumps in reverse direction. The paste adhered to screens cannot be collected. About 8 kg (6 kg from system and 2 kg from the drums) of the printing paste can be collected from the system and paste drums.

Reuse of Collected Printing Paste: The collected printing paste can be reused in other printing lots of any pattern. Also printing paste of different colors can be mixed together to produce new color or mixed with black dye/pigment and used as black color printing paste. The pigment based printing paste can be reused within 10-15 days whereas reactive dye based paste can be reused within 1-3 days as it loses its property due to chemical reaction between different ingredients. Even the pigment based printing paste in semi hard condition can be used again after softening it. About 8 kg of the printing paste can be reused.



Figure-6: View of Automatic Printing Paste Dispensing System at Industry (Pakistan)

Cross Media Effects

Wastewater pollution and sludge production will be reduced by implementing print paste management system in the textile finishing industry. The quantity of water used for washing the paste drums, pumps, pipes and squeegees will be reduced.

Technical Considerations relevant to Applicability

The printing paste management system can be installed at all the textile finishing industries where rotary printing machines are used either for new installations or the existing machines. In case of new installations, the decision makers should consider to install automatic printing paste dispensing system along with the rotary printing machine and the rotary printing machine should be equipped with those type of paste pumps which can operate in both the direction.

The operator of the automatic printing paste dispensing system will require training for operating and maintaining the system from the technology vendor initially. The

automatic system will require dedicated staff for operating and maintaining the system, collection of surplus and leftover paste from the machine and storing at appropriate place and handing over to the machine operators for reusing it.

Economics

Capital cost of automatic printing paste dispensing system = US\$ -----

Capital cost of printing paste pump (operating in forward and reverse direction) = US\$ ---

Annual saving = 162,258 kg or US\$ 64,903

Driving Force for Implementation

Following are the driving forces for the implementation of printing paste management system:

- Financial saving in terms of reduction in surplus printing paste preparation
- Increase in productivity (25% time is reduced in printing paste making)
- Reduction in washing water
- Reduction in wastewater pollution
- Reduction in wastewater treatment cost
- Reduction in sludge

Reference Industry

There are some industries in Pakistan which have implemented printing paste management system.

Annexure

Printing Paste

Printing paste is used at rotary printing machine to print the fabric with varying designs and colors. Typical ingredients in most of the paste formulations include dyes or pigments, thickeners, sequestering agents, dispersing or suspending agents (surfactants), water-retaining agents (humectants), defoamers, catalysts, and hand modifiers. In addition to the ingredients, pigments require a binder or resin system to fix the pigment and may include adhesion promoters. The most important ingredients of any print paste formulation are the colorants and the thickener system. Mostly dyes used in the printing paste include reactive, vat, naphthol, and direct. For blended fabric, a combination of different dyes will be used. Pigments are not dyes, but are colored particles glued to the surface of the fabric. The colorfastness of pigments directly depends on the binder system employed. Binders are chemicals, which have

the ability of forming a three-dimensional film used to hold the pigment particles in place on the surface of a textile substrate. Binders can be water-based (latex) or solvent-based and vary widely in their stiffness. Adhesion promoters (low crock additives) are chemicals added to increase the adhesion of the binder to the fabric.

The thickener system is the next crucial component of print paste. The purpose of the thickener system is twofold. First, the thickener gives the print paste the proper viscosity or flow characteristics, so the color can be applied uniformly and evenly. Second, it holds the color in place so that one color paste can be applied adjacent to another without the color bleeding onto the other. With dyes, the thickener also holds the color in place after drying until the printed fabric goes through the fixation process where the dye is released from the thickener and is diffused into the fiber. Thickeners used with dyes are then washed off the fabric before any chemical or mechanical finishing is performed. However, the thickener applied with a pigment system will remain with the print, as no after washing is required.