Case Study on the Quality Improvement of Dry Offset Letterpress Printing on Aluminium Collapsible Tubes

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Abstract:

Purpose – Case study on improving the printing quality of Dry Offset Letterpress (DOL) on aluminum collapsible tubes. The study includes the analysis of the current situation within the quality of printing (the current process and to identify existing problems), an improvement study (analyze the cause of existing printing problems and the recommended solutions) and implementation to obtain the required levels of printing quality.

The aim of this research is to identify the printing problems of aluminum collapsible tubes facing Medical Appliances and Packages Company (MAPC) during the printing process.

Design/Methodology/Approach – The researcher identified the current situation with the printing problems of aluminum collapsible tubes in MAPC as well as determining the possible remedies. The researcher identified methods to solve the printing problems and enhance printing quality.

Findings – Approximately seven major problems were found with tube printing, which can be associated with the ink application to the tube surface, the machine condition, the heat treatment after printing process and characteristics of dry offset printing technology.

Value – This research is useful for industries in the production of aluminum collapsible tubes to eliminate any printing problems to enhance the levels of printing quality.

Keywords:

Aluminum Collapsible Tubes
Dry Offset Letterpress
Printing Quality
Printing Problems
Pharmaceutical Packaging

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1. Introduction

The main objective of this study is to improve the printing quality of Dry Offset Letterpress (DOL) on aluminum collapsible tubes. The study includes the analysis of the current situation within the quality of printing (the current process and to identify existing problems), an improvement study (analyze the cause of existing printing problems and the recommended solutions) and implementation to obtain the required levels of printing quality.

The company studied was the Medical Appliances and Packages Company (MAPC), a subsidiary of the Holding Company for Pharmaceuticals (HOLDI Pharma) in Cairo, Egypt. It is the first company that began producing aluminum collapsible tubes in Egypt. MAPC has a long history in the production of aluminum collapsible tubes, recently the company encountered problems with the production of aluminum collapsible tubes, especially in the printing which increased the process waste and reduced the overall production capacity.

This research is structured in the following: Section 2 is a literature review, which includes the theory of DOL printing in addition to the printing process methods of aluminum collapsible tubes. Section 3 analyzes the current print quality of aluminum collapsible tubes. Section 4 is an improvement study of the printing quality and the recommended solutions. Section 5 is the conclusion.

2. Literature Review

2.1. Dry Offset Letterpress Printing Theory

Dry Offset Letterpress is a relief printing process in which the image areas are raised above the level of the non-image areas and transferred from the inked printing plate to the tube surface by means of an intermediate resilient rubber surface.

This process is used to print aluminum collapsible tubes. Since the tubes must be supported by a mandrel during the printing process, it is essential that one end of the tube be of the unrestricted aperture. A base coat of white enamel is first applied to the tube by roller coating and set by partial baking. The next operation of printing itself is restricted to the cylindrical surface as the actual (relief) printing plate is wrapped around a cylinder in a similar manner to a lithographic plate.

Each tube is supported separately on a mandrel which can rotate freely on its axis. The inking stations apply their separate images to the same rubber-faced blanket cylinder and the composite image is transferred to the tube in a single revolution of the latter. The printed tubes are then dried again. A period of 4 min at 170–230°C is

normally adequate, depending on the nature of the enamel and the inks. The decorative effects which can be achieved by dry offset letterpress printing are much more limited than those available by offset lithography. (Pharmaceutical packaging, 2000).

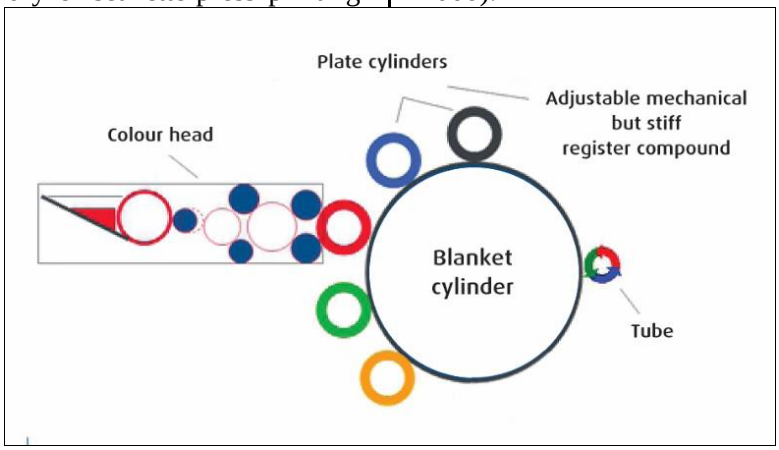

Figure 1: The principle of dry offset letterpress printing

2.2. Method of Print Application

The inks are applied to the tube by the rotary offset process using a purpose designed, Figure 1. These comprise a large drum made up of individual offset printing blankets around which are set of printing heads. Each printing head has an ink duct, a set of inking rollers and a printing plate with a raised image area which carries one part of the printed design. As the drum rotates each printing plate adds its image to the blanket and the full design is then transferred to the tube in one operation as it rotates in contact with the blanket.

This method restricts the type of designs that can be printed, as any areas of the design where inks touch or overlay one another do so while the inks are still wet on the blanket (wet-on-wet printing). The final part of the printing process involves passing the tubes through an oven to cure the inks. (MAPC, Poly topics, 2014).

2.3. Dry Offset Letterpress Machine Structure

2.3.1. Printing Unit:

Each printing unit comprises an inking unit, a printing plate cylinder, and the blanket cylinder, Figure 2.

2.3.2. Inking Unit

The essential purpose of the inking unit is to generate an adjustable, thin, consistent layer of ink to the raised areas of the printing plate. The inking system comprises an ink fountain. The metering of the ink is achieved by a doctor blade, adjusted by a series of metering screws, against a fountain roll. The ink is transferred from the fountain roll to a series of oscillating rolls by a dab roll. The dab roll cycle is adjustable depending on the quantity of ink which must be transferred to a series of oscillating, metering rolls which split down the ink layer. The inking train is completed by a number of rubber covered form rolls which ink up the printing plate.

2.3.3. Plate Cylinder

This cylinder is used to hold the image carrier (plate) for printing, the printing plate is made from a photopolymer plastic, backed by a steel plate. The plate thickness is nominally 0.73 mm thick and the etching depth is in the region of 0.3 to 0.4 mm. The Nyloprint plates are precisely pre-punched in register with the image, and gripped on the cylinder, in the register, with a pin gripper mechanism. In this way, since all the printing plate cylinders are geared in register with each other, the complete, multicolor image is pre-registered before start up. The printing plate cylinders can be individually fine-adjusted whilst in operation, for both lateral and longitudinal register.

2.3.4. Blanket Cylinder

This is used to hold the resilient rubber material called blanket for printing. Functions of the blanket cylinder are to make the offset blanket to contact with the plate for the transfer of inked image, and then transfer the inked image onto the tube. (Poly topics, 2014).

2.4. Printing Cycle & Product Handling

The peripheral equipment for the handling and transfer of the tube throughout the printing cycle is designed specifically for the tube shape. Tubes are tapered wall containers which readily stack inside each other. Sticks of such tube are de-nested and automatically fed onto a rotating dial which is fitted with a series of mandrels. The mandrels are manufactured to the same diameter and taper as the tube. Each position on the dial represents a specific function during the rotation of the dial, which rotates in the perfect register to the blanket cylinder, and stops intermittently at each function point. e.g. Functions: Position 1- feed on; position 2- printing; position 3- take-off. The mandrels are driven and rotate during the fraction of a second

that the dial stops cycling. The blanket cylinder can be adjusted to the mandrel at the printing position, for both pressure and angle according to the taper of the tube. (The Wiley Encyclopedia, 2009).

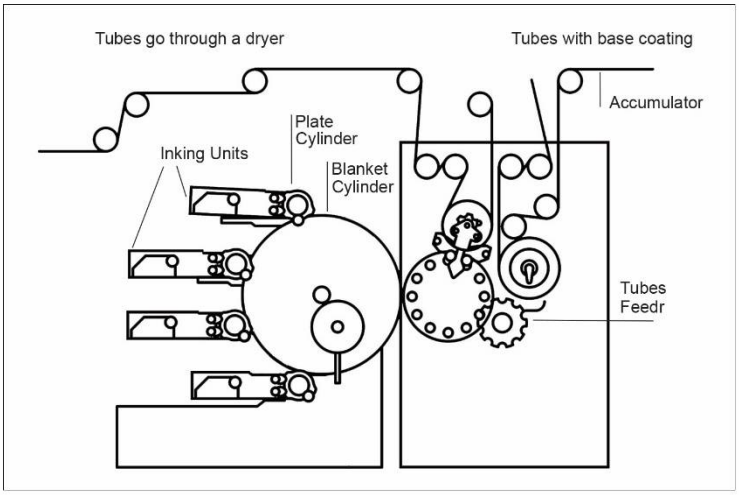

Figure 2: Rotary dry offset letterpress machine structure

2.5. Preferred Printing Position

The conditions at the printing position are important to achieve optimum image transfer. With tapered tubes especially, the screen count of the printing plates must take into account the mean diameter of the tube, and be adjusted accordingly. The quality of the tube (e.g. consistency of wall thickness) can be accommodated to some extent by the compressibility and quality of the blanket chosen.

2.6. Inks

The inks are thermally dried by hot air ovens. The ink must be individually formulated to prevent back coloring and contamination of the inking units. Since one common blanket is inked up with all the colors consecutively in one pass, there is a danger that the image in the area of color overlap will be picked off by the subsequent printing plate and transferred through to the inking train, resulting in back coloring.

With this in mind, the inks are fine-tuned to resist this possibility. During the rotating cycle of the blanket cylinder, the lighter color images are printed onto the blanket first, progressing to the final color, generally black, in the last printing unit, where color overlap occurs. The lighter colors will have the higher green tack (i.e. resistance to being picked off the blanket) and the darker colors are smoother with a lower green tack level. This allows the blanket to retain the complete image. (The printing ink manual, 2007).

3. Analysis of the Current Printing Quality of Aluminium Collapsible Tubes

As with any manufacturing process, solid measurement, management, and modification can eliminate variation in the overall workflow. The key is to break down each facet of the workflow and understand how to evaluate and control each part of the whole.

The operator must make sure to use the correct plate material for optimum ink transfer. Prepress also assumes responsibility for ensuring that all bearings and bushings are in proper working condition so that bounce or slope is not a factor. Producing a repeatable press characterization and implementing processes will allow operators to follow what was learned and measure all components, such as density and registration.

In conjunction with MAPC quality control groups, the researcher conducted semi-open examinations and engaged in discussion forums which highlighted seven issues that exist with the printing process of aluminum collapsible tubes.

3.1. lining up

The design which involves lining up a strip of color around the entire circumference of the tube should be avoided, an alignment is difficult as the tube may not be truly cylindrical and in any case, it is rotating freely on its mandrel. Also, where the overlap occurs, there may be double ink film which can mar the desired effect, particularly with light colors. It is, therefore, preferable to leave a gap rather than insist on an overlap. Figure 3.

3.2. Feathering

Feathering is defined as uneven edges around the print area. Figure 4 offers a common visual reference of this problem.

Like many troubleshooting problems, there are multiple causes of leathering. The causes can range from very simple adjustments to more involved ink formulation issues. Causes of feathering could include the following:

- Ink is drying on plates.
- The incorrect pressure between ink form roller

and plate cylinder.
- Ink viscosity is too high.
- Lint on the plate from wiping cloth.
- Resins in the ink precipitating out under certain circumstances and drying onto stereo.
- Improper setting of the ink roller nip.
- Low spot on the plate causing over impression.

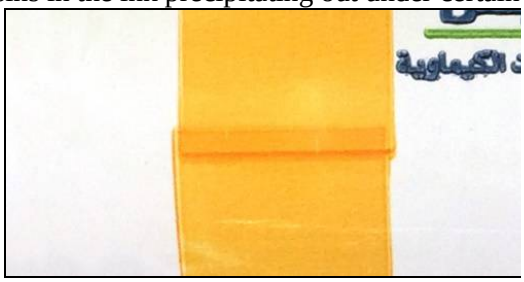

Figure 3: Lining up

Figure 4: Feathering

In order for an operator to determine the true origin of one of the above-mentioned causes, an operator should first visibly check the plate surface, being sure that there is not dried ink, lint or other foreign particles present. Also, the operator should check the ink viscosity to further define the cause of the feathering problem.

Once the causes analysis has been completed and the cause has been determined, the following corrective actions could be implemented dependent upon the cause:

-If the ink is drying on the plate, the operator should clean the plate and have the ink blender adjust the solvent blend by adding retarder to the ink.

-If there is incorrect pressure between the ink form roller and plate cylinder, the operator should reset the deck, thus adjusting the pressure.

-If the ink viscosity is too high, the viscosity should be lowered by adding the right solvent. The operator should also check if ink trays are covered and remove any obstacle.

-If lint appears on the plate from the wiping cloth, the operator should clean the plate thoroughly. In this cleaning, as well as future cleanings, a lint-free wiping cloth should be used. Cleaning materials with the right means help to extend the life of the equipment being used.

-If the resins in the ink are precipitating out under certain circumstances and drying onto stereo, the operator should avoid using a tacky ink. A solvent blend that would keep resin in solution should be used instead.

-If there is the improper setting of the ink roller nip, the operator should adjust the pressure setting of the ink roller nip.

-If the operator is experiencing a low spot of a plate material or other cylinder issues, prepress personnel must provide the correct tools so that the operator can reproduce with minimum plate impression.

3.3. Halos

The halo effect can be defined as a printed image surrounded with an undesired line encircling the printing areas. Figure 5.

There are multiple causes of the halo effect. The causes can range from very simple adjustments to more involved ink formulation issues. Causes of the halo effect could include the following:

- The disproportionate ratio between the plate cylinder diameter to the actual gear.
- Ink volume transferred is too high.
- Too much pressure between the plate cylinder and the tube.
- Excessive pressure exists between the ink form roller and the plate cylinder.

In order for an operator to determine the true origin of one of the above-mentioned causes, it is necessary to check the outer diameter of the cylinders and gears. Also, impression settings would need to be checked.

Once the causes analysis has been completed and the root cause has been determined, the following corrective action steps could be implemented dependent upon the determined root cause:

- If there is a disproportionate ratio between the plate cylinder diameter and the actual gear, the operator should check the thickness of each element on the plate cylinder, in order to determine the appropriate ratio, the ratio between these two points is highly important in order to achieve the desired clean print.
- If the ink volume being transferred is too high, the operator must consider changing the ink form roller to one of lower volume and higher line.
- If the pressure has been determined to be too high between the plate cylinder and the tube, the operator should reduce the pressure thus eliminating the halo effect.
- Should excessive pressure exist between the ink form roller and the plate cylinder, the press operator should reduce the pressure to the appropriate level thus alleviating the issue.

3.4. Misregister

One part of the design is not correctly positioned with another. Figure 6.

There are multiple causes of leathering. The causes can range from very simple adjustments to more involved printing press mechanical condition issues. Causes of feathering could include the following:

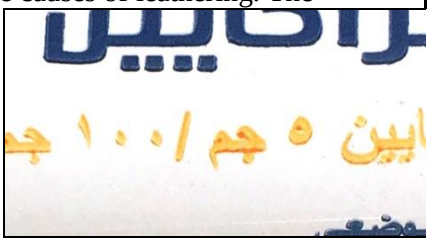

Figure 5: Halos

Figure 6: Misregister

- Plates not mounted in the register.
- Incorrect drive-roller adjustment.
- Press register compensator not centered.
- Press out of alignment.
- Damaged drive gear or journal.

Once the causes analysis has been completed and the cause has been determined, the following corrective actions could be implemented dependent upon the cause:

- The operator should remount plate in the register, and check make-ready procedures, also plate thickness and relief depth.
- Check drive roll parallel for constant side-to-side pressure.
- Centre individual advance running registers and side-to-side register compensators before manually keying in job register.
- Realign press.
- Replace drive gear or journal.

3.5. Ink Drying

Drying too fast: When ink is drying too fast the operator may first notice ragged edges on type and images or poor coverage. To resolve this issue, examine the printing plate to see it there is a buildup of ink on the plate. Dried ink on the plate will not transfer to the substrate creating dirty print and poor coverage.

To resolve this, first, check the airflow around the printing press. Many times fans, open doors and windows create unnecessary airflow around the ink pan and rollers. Next check for a proper balance between unit dryers. If airflow and dryers appear to be in order, the operator can slow the dry rate with small additions of 2 percent to 3 percent propylene glycol.

Drying too slowly: If the ink is drying too slowly the operator will notice that it is picking-oft or transfer to the press rollers or track on the print image. Two things to check are ink viscosity and airflow between stations. Check airflow and dryer settings, if these are in balance and working properly the next thing to check is ink viscosity. ink viscosity is important because if it gets too high, the ink may not dry adequately. Figure 7.

Figure 5: Drying too slowly

Figure 6: Adhesion

3.6. Adhesion

Print can be removed by scratching the surface. Print fails adhesion tape, rub or wrinkle tests. Figure 8.

In the ink formulation, resin and melamine selection are the most important factors which affect adhesion. The other elements are the cure level of the ink, which should not be too low and the nature and cure of the base coat. The rate of cure will be affected after the first heat treatment, the pigment combination used and also by the base coat. Assuming that the ovens have been eliminated as the source of the poor cure, an effective lubricant is essential to ensure good adhesion resistance.

Assuming that the ink film is fully cured, the problem is likely to be caused by pigment on the surface of the print which is not fully bound by the resin. This is often caused by pigment degradation during the heat treatment or an incompatibility between the pigment and the resin system.

The causes can range from very simple adjustments to more involved ink formulation issues. Causes of adhesion could include the following:

- Wrong ink used for base coat;

- Ink over-thinned;
- Wrong or weak solvent mixture used;
- Insufficient heat or drying applied;

The following corrective actions could be implemented dependent upon the cause:

- If the wrong ink used, ink/plate combination is a very important factor, the operator should use the correct ink for the base coat.
- Correct viscosity and ink film weight by using the reducing medium.
- Check solvent mixture to give good ink film forming and wetting of substrate.
- Increase heat and air volume.

3.7. Plate Swell

High concentrations chemicals in solvent based inks can cause plate swelling. It's the required addition of a solvent blend of propyl alcohol and propyl acetate for viscosity adjustment at press side that is most often the root cause of the problem.

High concentrations of acetate lead to loss of plate performance and print quality. Ink maintenance and adjustment need to be done in a systematic and scientific manner to consistently print well and optimize plate life and performance.

It's important to note that while a particular plate from a supplier may not be compatible with the ink set, in most cases there is another product choice from the same supplier that will perform Without ill effects.

There is one thing that every operator can do regardless of the type of ink he prints with to eliminate another common cause of plate swell, by using the proper plate cleaning product for the specific ink. A soft brush and NP alcohol work very well for cleanup of solvent based inks. Homemade recipes of cleaning solutions often lead to unintended consequences, all of which are bad.

Business decisions based on price only without proper consideration of press room consequences are unfortunately a fact of everyday life. Plate suppliers and ink suppliers alike are not immune to those consequences either. The best and true solution to the problem of plate swell is to have compatibility (swell) testing before these business decisions are made. Either supplier can perform these tests which determine the ink/plate combination that doesn't cause this problem and identifies the combinations that might be a problem.

4. Conclusion

A case study on the quality improvement of dry offset letterpress printing on aluminum collapsible tubes. The researcher analyzed the current situation, identified any existing problems and analyzed the cause of the existing problems.

Approximately seven major problems were found with tube printing, most of the problems identified in this research, such as feathering, halos, adhesion and ink drying are associated with components and fits the coverage layer used, mainly due to differing ink specifications, others due to the machine condition and dry offset printing technology, thus ink transfers from blanket surface onto each tube which hold by mandrel to of the tubes, including the printing stage, which is why the unsteady control process during printing in very difficult, especially if there are defects in this mandrel, which was a major cause printing problems like lining up and misregister. Which requires the need to check mandrel quality periodically when changing production from tube size to another as well as checking it during the production of the same tube size. Also, there were problems associated with the heat treatment after printing process which had a big impact on drying and adhesion problems, therefore MAPC should give attention to this stage of production to keep heat degree stable.

A solid measurement and modification can eliminate variation in the overall workflow. The operator must make sure to use the correct plate material for optimum ink transfer. Prepress also assumes responsibility for ensuring that all bearings and bushings are in proper working condition so that bounce or slope is not a factor. Producing a repeatable press characterization and implementing processes will allow operators to follow what was learned and measure all components, such as density and registration.

5. Recommendations:

The researcher recommends the following:

- Business decisions based on price only without proper consideration of press room consequences are a fact of everyday life. Plate, ink, base coat suppliers alike are not immune to those consequences. The best and true solution to the most of the problems is to have compatibility testing before these business decisions are made. Either supplier can perform these tests which don't cause the problems.
- the heat treatment after printing process which had a big impact on drying and adhesion problems, therefore MAPC should give attention to this stage of production to keep heat degree stable.
- The design which includes a strip of color around the entire circumference of the tube should be avoided, an alignment is difficult as the tube may not be truly cylindrical and in any

case, it is rotating freely on its mandrel.

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