

Ink foaming of water based inks, what is the reason and can it be resolved?

Wilbert Streefland has carried out investigations and offers some answers to this problem.

All printers using water based inks will have had the problem of ink foaming. It is a costly problem resulting in machine down-time and operator frustration. Ink suppliers are doing their best to provide solutions but the ink foam problem is never completely removed. Machine suppliers are paying extra attention to the design of the ink metering system to minimize the problem but foaming water based ink will always be there.

The printer first needs to ask himself if foaming ink really is a problem for the print customer? The print customer will never complain about the print because the ink was foaming, more likely he will complain about colour consistency, register, edge sharpness, not being able to read a barcode or defects in print. In this article we will show the results of tests done with different ink suppliers where we have monitored water based ink foam and the printed colour consistency.

The problem

Flexo water based ink nearly always foams. From time to time ink foaming becomes a problem but mostly it goes unnoticed. This can happen on any print machine using water based ink of any ink supplier. It is more often reported on machines equipped with doctor chamber blade systems. This is independent of the supplier of the chamber blade system. The presence of foam means there are now two ink phases instead of one. The foam phase has a different composition per unit volume of foam to the ink phase.

The flexo printing industry has many explanations for ink foaming however there is now proof for some of these explanations and solutions provided.

Basics

There are three parts involved that have an effect on ink foaming:

- The ink;
- The system that holds the ink (ink pumps, pipes and metering system);
- The operator.

The ink supplier can influence the

formulation to make the ink less sensitive for foaming.

The system holding the ink can excel the foaming if the ink flow is turbulent or air is captured in the ink.

The operator can take the wrong action which results in the increase of the ink foaming.

When the ink foams then it is very unlikely that there is only one part responsible. Each of the three parts has its own responsibility to create a stable situation that minimizes the risk for excessive ink foaming.

Ink foaming is the including of a gas in the ink. The density of the ink decreases significantly when foaming starts. The viscosity increases when measured using a flow cup. The foaming increases if the operator adds water to reduce the viscosity. If ink is foaming then measuring the ink viscosity might result in taking the wrong corrective action.

Ink suppliers often advise the addition of an antifoam when ink starts foaming. However this only works if the foam is on the surface of the ink. If the ink foam is evenly distributed (micro foam) then mostly there is nothing either the operator or the ink supplier can do to correct this.

There is little known about how the ink starts foaming. A common belief is that it is related to the use of doctor chamber blade systems and that it happens at the forward positioned doctor blade. It is assumed that air is pulled into the chamber by the screen roll. It is also believed to be linked to the ink pumping system and ink flow. No information is available about the 'gas' that is contained in the foam of the ink when the ink starts foaming.

Most materials can foam. Heat is used mostly to start the foaming process of e.g. plastics or to turn corn into popcorn. For foam bubbles in a liquid, physics tells us that when a bubble of radius 'r' in a liquid of interfacial tension 'Y' is formed the vapour it contains is at a pressure P given by:

$$P = \frac{2 * Y}{r}$$

Heat is used to release vapour from the liquid or solid. The vapour bubbles

remain partly captured by the solid to produce rigid foam; in liquids the bubbles rise to the surface and burst.

Part of the chemical components from which water based flexo inks are made resemble soap. The formation of bubbles has been very thoroughly investigated by detergent people who have published many articles on stability of foams in terms of interfacial energy.

What can be done to minimize the risk of water based flexo ink foaming:

- Minimize the agitation of the ink caused by the system used for the ink circulation;
- Minimize unnecessary water addition (by the operator and from the water left in the ink system after wash-up);
- Use an ink formulation that is less sensitive for foaming (e.g. avoid solids in the ink formulation);
- Have an agreed procedure for maintaining the ink properties (ink supplier and operators);
- Keep a log of what is done during production. Record time and event for the individual inks. This log will help to take corrective actions when foaming occurs. It also allows discussion of the event with the ink supplier and/or the supplier of the ink metering system.

The Test

Three ink suppliers were each asked to provide two inks: black and green, the ink formulations to be stable over time and giving minimum foaming.

Before putting the ink on the machine the ink density was measured and recorded.

Measured and recorded during the test were:

- Printed colour (using a spectrophotometer);
- Paper colour (using a spectrophotometer);
- Ink density.

More than five hours after each test the ink density was again measured and recorded.

Each test was running a production time of one hour at a production speed of 4,000 sheets/hour.

The ink density was measured using an Eppendorf Multipet with a 50ml tip. The 50ml tip was filled with ink and put on a scale with a resolution of 0.01g. The scale was set to zero. 50ml was dispensed back in the ink bucket and the pipette put back on the scale. The value indicated by the scale was divided by 50 resulting in a value for the density of the ink in g/ml is equal to kg/dm³.

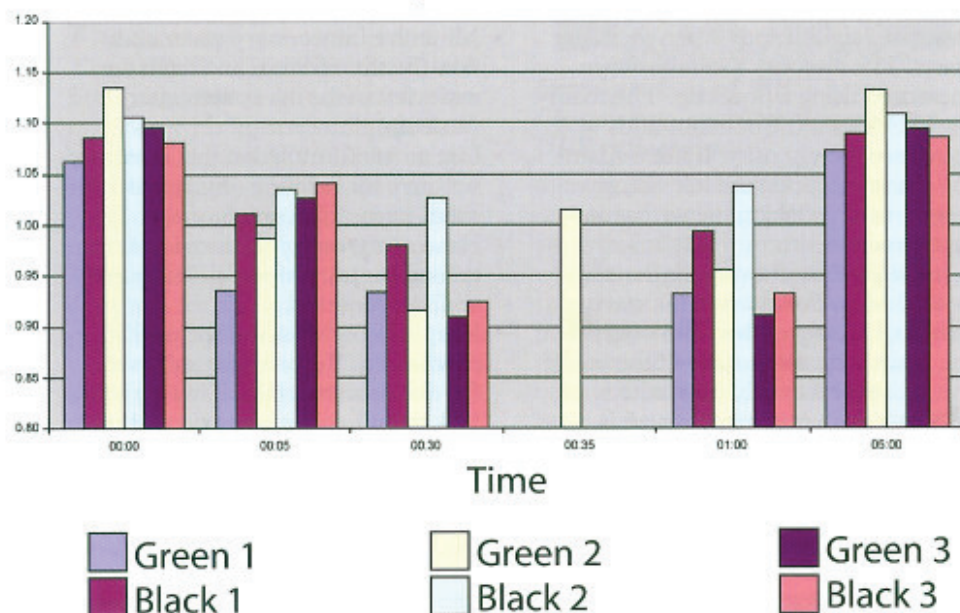
The ink suppliers were allowed to make adjustments to the ink. Time of the adjustment was recorded also the quantity added.

At regular intervals photographs of the ink surface in the buckets were taken.

Results of the test

The following graph shows the results of the density measurements.

Density values over time



All inks dropped in viscosity after a short period circulating the ink in the ink system.

The black of supplier 2 was probably least effected of all inks.

Supplier 2 made an adjustment by

adding a very small quantity of antifoam to the green ink 30min. after the start of the test. The impact was visible 35min. after starting the test but disappeared at the end of the test.

The densities of the black inks were dropping less than that of the green inks.

The inks returned to a similar density five hours after the test compared with the density measured before starting the test.

The colour variation during the test for the three ink suppliers and the two colours plus the paper, is shown in the graphs at the foot of the page.

The colour variation for all suppliers was within an expectable level.

The green colour variation for supplier 2 was following the paper colour. It has to be noted that two

There was ink foaming as can be concluded from the density measurements but it did not affect the printed colour nor were there any problems with the ink related to foam.

The order used for testing was completed running the same ink for four hours adding every 30 min 1dm³ of fresh ink. During this period the colour printed was stable and foaming did not increase more than was noticed during the test using the inks of the three different ink suppliers.

Conclusion

The inks supplied by the three ink suppliers for this test were all foaming.

The foaming of the ink did not result in a big colour variation over the time of one hour.

The inks started to foam immediately after the ink system started and the foaming did not significantly change over the testing period.

Supplier 2 showed that its antifoam was able to reduce the foaming but that this reduction was only temporary.

The ink density readings taken more than five hours after the tests were completed indicated that the ink foam disappeared and that there was an insignificant change in density, not affecting the ink viscosity.

Recommendation

Add at regular intervals (e.g. every 30 minutes) fresh ink at press viscosity. The ink supplier has to optimise the ink formulations for this.

Measuring of ink viscosity can be done before ink is put in the ink system but during production the viscosity measurement is not providing information for corrective action when ink is foaming.

Avoid high solids in the ink formulation especially when doctor chamber blade systems are used.

Ensure that there is sufficient ink flow through the system.

The ink system (fittings, pipes, pumps and chamber) should not have sharp edges and corners. The changes of the inside diameter of the piping should be avoided.

A good interaction between operators, ink supplier and the design of the ink metering system together with the setting of the positive measurable and achievable target: colour consistency, helped to overcome the problems caused by foaming ink. It did not stop the ink from its ability and sometimes willingness to foam. ■

