

# Ink foaming of water-based inks

What is the reason and can it be resolved?

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*All printers using water-based inks will have had the problem of ink foaming. It is a costly problem resulting in machine downtime and operator frustration. Ink suppliers are doing their best to provide solutions, but the ink foam problem is never completely removed. Machine suppliers are putting extra attention into the design of the ink metering system to minimize the problem. But foaming of 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. He more likely 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

Water-based flexo ink nearly always foams. Mostly it remains unnoticed. However from time to time ink foaming becomes a problem. This can happen on any print machine using water-based ink from any ink supplier. It is more often reported on machines equipped with doctor chamber blade systems and 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

These are the areas involved which affect 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 to foaming.

The *system* holding the ink can worsen 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 ink foaming.

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

Ink foaming is the enclosing 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 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.

Little is known about how ink starts foaming. 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 in 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 mostly used 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:

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

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.

Some of the chemical components of 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 the 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 to foaming (e.g. avoid solids in the ink formulation).
- Have an agreed procedure for maintaining the ink properties (ink supplier and operators).
- Maintain a log of what is done during production. Record time and event for the individual inks. This log will help to take corrective ac-



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tions when foaming occurs. It also allows discussing the event with the ink supplier and/or the supplier of the ink metering system.

**The test**

Three ink suppliers were asked to provide two inks: Black and Green. The ink formulations to be stable over time and give minimum foaming. Before putting the ink on the machine the ink density was measured and recorded. Also measured and recorded during the test was:

- printed colour (using a spectrophotometer),
- paper colour (using a spectrophotometer),
- ink density.

More than 5 hours after each test the ink density was again measured and recorded. Each test consisted of a running production time of 1 hour at a production speed of 4000 sheets/hour.

The ink density was measured using an *Eppendorf Multipet* with a 50 ml tip. The 50 ml tip was filled with ink and put on a scale with a resolution of 0.01 g. The scale was set to Zero. 50 ml was dispensed back into 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 which is equal to kg/dm<sup>3</sup>.

The ink suppliers were allowed to make adjustments to the ink. The time of the adjustment was recorded also the quantity added. At regular intervals photos of the ink surface in the bucket were taken.

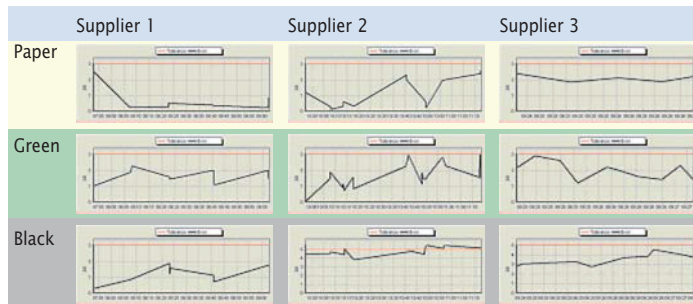
**Results of the test**

*Graph 1* shows the results of the density measurements.

All inks dropped in viscosity after a short period circulating the ink in the ink system. The black of supplier 2 was probably least affected of all inks.

Supplier 2 made an adjustment by adding a very small quantity of antifoam to the green ink 30 min after the start of the test. The impact was visible 35 min after starting the test but disappeared at the end of the test.

The densities of the black inks dropped less than that of the green



**Graph 1.**

inks. The inks returned to a similar density 5 hours after the test compared to the density measured before starting the test.

The colour variation during the test, for the three ink suppliers and the colours plus the paper, is shown in *figure 1*. The colour variation for all suppliers was within an acceptable level.

The green colour variation for supplier 2 followed the paper colour. It has to be noted that two paper types were used for the board in this test. Supplier one was printing on paper type A (apart from the first sheet), Supplier 3 was printing on paper of type B. Supplier 2 had a mixture of paper A and B.

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 4 hours adding 1 dm<sup>3</sup> of fresh ink every 30 min. 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 all foamed. The foaming of the ink did not result in a big colour variation over 1 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 anti-foam was able to reduce the foaming but that this reduction was only temporary.

The ink density readings taken more than 5 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 fresh ink at press viscosity at regular intervals (e.g. every 30 minutes). 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 does not provide information for corrective action when ink is foaming.
- Avoid high solids in the ink formulation especially when doctor chamber blade systems are used.
- Make sure that there is sufficient ink flow through the system.
- The ink system (fittings, pipes, pumps, and chamber) should not have sharp edges and corners. 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.

**Figure 1:** Colour variation during the test.

