High shear characterization of ceramic inks

- In collaboration with Color Esmalt, Spain-

PAINT & INKS

Introduction

Ceramic inks are printed onto tiles using an inkjet printer. In the inkjet printer the nozzle has a small gap and so the shear rate applied to the ink as it is printed is very high.
In order to ensure high quality printing and no issues during the whole process (blocked inkjet nozzles, bleeding..) it is essential that the viscosity of ceramic inks is carefully controlled. This allows to preserve the required rheological properties of the ink in order to achieve desired conditions for the printing.

KEY **BENEFITS**

- ACCURATE
- RAPID SCREENING
- SMALL VOLUME

Reminder of the technique

Fluidicam^{RHEO} uses a co-flow microfluidic principle to measure viscosity. The sample and a reference solution are simultaneously introduced into the microfluidic channel (typically 2.2mm X 150µm) with controlled flow rates. This results in a laminar flow where the interface position between sample and reference solution relates the viscosity ratio and flow rates..

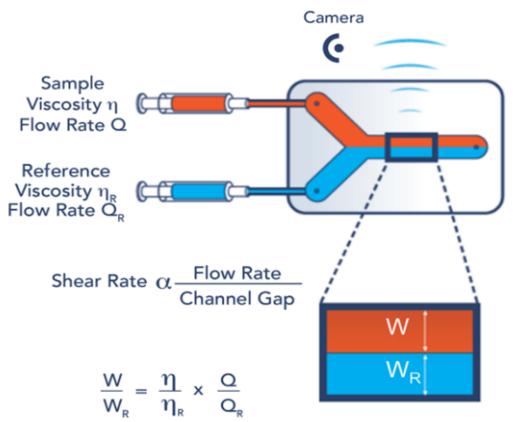
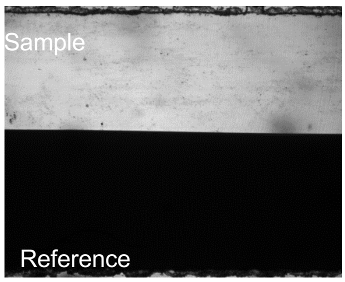


Figure 1: Fluidicam measuring principle

Images acquired during the measurement allow the software to calculate the position of the interface and directly plot an interactive flow curve.



Method:

The first experiment was carried out to determine the difference between an ink that causes problems and a “good” ink sample. Both inks were tested over a very wide range of shear rates from 5 000-100 000s^{-1} the higher shear rates mimic the printing conditions.

The tests were done using a glass 50µm chip (for the high shear) at a temperature of 45°C using a standard reference oil of 15mPa.s at 45°C.

The second experiment was used to quickly screen 10 different formulations containing various dispersants and solvents. This was done with the 150µm chip to achieve medium/high shear rates at 45°C using the same reference oil.

Results

High Shear Characterization – behavior determination

Flow curves were obtained one well performing ink dispersion (Sample 1) and second for an ink dispersion that caused problems during printing process (Sample 2).

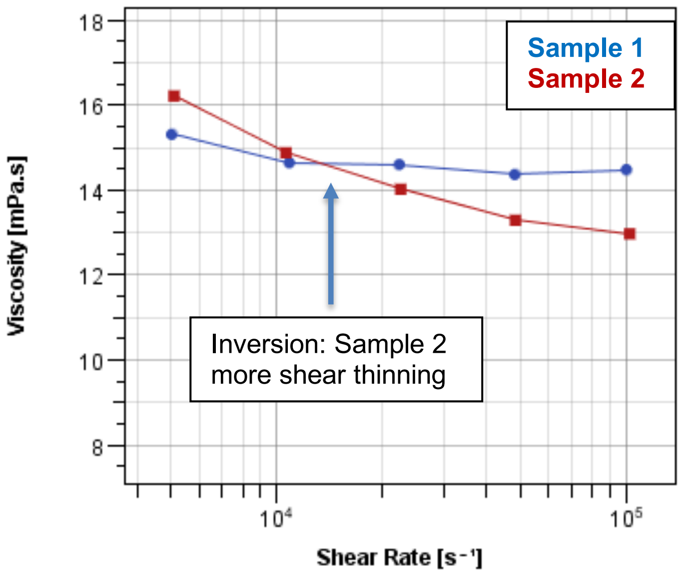


Figure 2 Flow curves for sample 1 and 2 at 45°C

At lower shear rates (below 10 000s^{-1}) **Sample 1** has a lower viscosity than **Sample 2.** However, at around 15,000s^{-1} there is a viscosity change that causes inversion - **Sample 2** is more shear thinning and becomes more fluid. Its viscosity continues to decrease without reaching a plateau even at $10^5 s^{-1}$.
On the other hand, **Sample 1** is subject to smaller viscosity change and shows a plateau approximately at 10 000s^{-1}.
The high shear analysis was essential in this case to undrestand the flow behavior at actual working conditions of the ink. The wide range of shear rates is covered to get a full characterization of the sample behaviour without using risky extrapolation methods.

Formulation Screening – Highly productive testing

10 different formulations of ceramic inks were tested in order to easily and precisely determine their viscosity and establish the relation betewwen the composition and the viscosity. **It is to be noticed that all samples were analyzed in less than 2 hours in total**

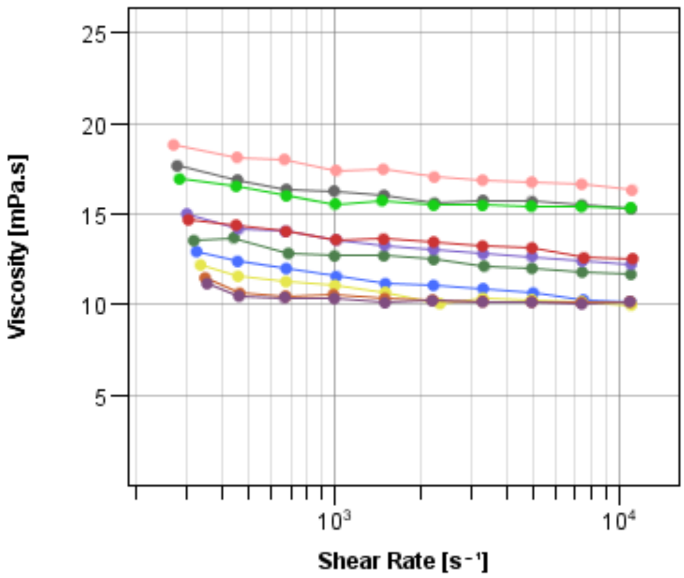


Figure 3. Flow curves for 10 ink formulations

All samples have a viscosity between 10 and 20mPa.s and this screening allowed to highlight even the smallest differences between viscosities due to the use of different solvents and dispersants.

As the viscosity has a direct impact on the printing quality the high precision of Fluidicam allowed Color Esmalt to easliy choose good candidates for well performing inks and optimize existing formulations to ensure high quality products..

CONCLUSION

Fluidicam^{RHEO} is a perfect tool for fast comparison of formulations with a very small viscosity variations (as small as 0.16mPa.s difference). The different tests have been conducted in less than 2 hours analysis time including the resampling and the temperature regulation. Thus , the methid is allowing high performance viscosity analysis.