PAINT & INKS

High shear rate characterization of ceramic inks

Introduction

Historically, inks were formulated using a colourful plant or material (ex. carbon) but today's industry demands reflect on the complexity of ink formulations. Chemicals commonly used as base are: water, petrochemical solvents or oils, and the main ingredient - responsible for the ink color and intensity - is either a dye or pigment. Dyes are small molecule blends with water based solution while pigments are much larger insoluble molecules but more light resistant.

We have focused in this paper on studying rheological behavior of ceramic inks. These inks contain ceramic particles (metal oxide pigments) and require a melt carrier that sticks the metal oxides to the body in a glass. Each system has its own properties and behavior making it essential to predict the behavior of every formulation.

KEY BENEFITS

- HIGH SHEAR RATE
- HASSLE - FREE
- FAST & SIMPLE

Reminder on the technique

FLUIDICAM uses a co-flow microfluidic principle to measure viscosity. Sample and reference standard are pushed together to the microfluidic channel (typically 2.2mm X 150µm) under controlled flow rates. In this laminar flow, interface position between sample and reference relates the viscosity ratio between the two to the flow rates.

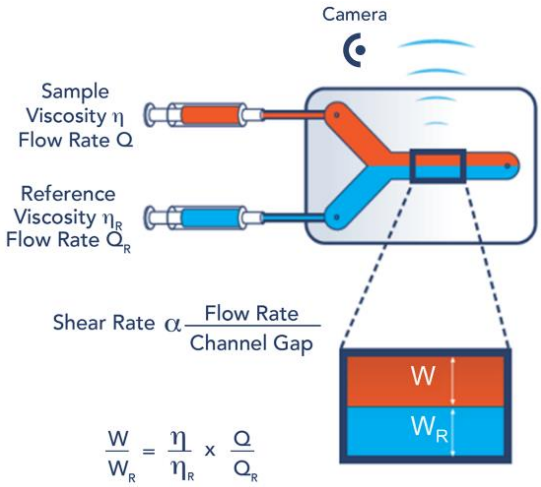
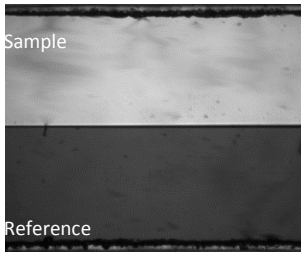


Fig. 1: Fluidicam measuring principle

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



Method

Using FLUIDICAM Rheo, we have measured the viscosity of 3 ceramic inks (A, B, C) of a dark brown color and unknown composition. The analysis took 4 minutes and less than 4mL of sample for a high shear rate analysis (1000 – 15000 s^{-1}). Fluidicam works with visual acquisition system and allows observation of the product directly during the measurement.

Precise and repeatable measurements

Inks were first tested from 1000 to 5000s^{-1} in 3 replicas and less than 1.5% relative standard deviation was obtained. It can be noticed that Ink C and B have similar viscosities, while Ink A is slightly more liquid. In this range of shear rate, all inks seem to have a Newtonian behavior

Sample	Viscosity (mPa.s)	Standard Deviation	RSD %
Ink A	20.79	0.18	0.85
Ink B	21.94	0.22	0.99
Ink C	21.86	0.26	1.20

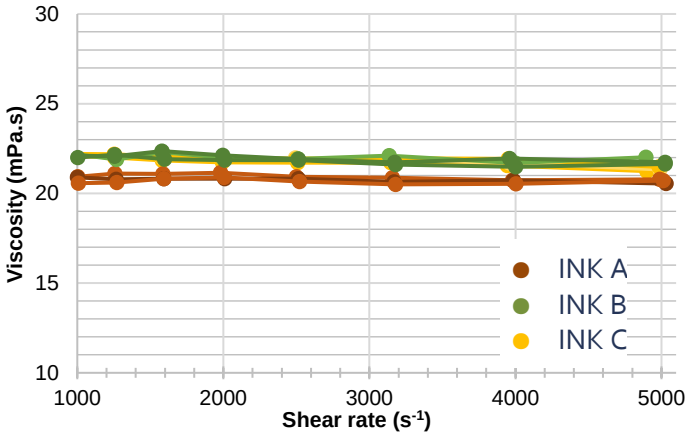


Fig 2. Viscosity different ink formulations at 25°C.

High shear analysis

Resulting flow curves allow to distinguish three different behaviors. Inks B and C have similar viscosities and shear thinning properties while Ink A presents a lower viscosity at low shear rate but tends to same values at higher shear

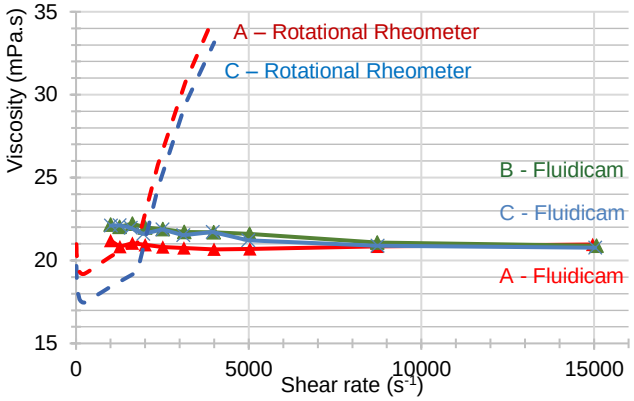


Fig 3. Comparison of ink viscosity with FLUIDICAM and a rotational rheometer at 25°C.

Compared to rotational rheometers FLUIDICAM favors high shear rate analysis. Thus, shear thinning behavior of inks can be determined and quantified while standard techniques do not allow observation of such phenomena. The analysis is also conducted in a fast and simple manner with a minimal sample volume required. Fluidicam does not require any calibration or gap setting that would

CONCLUSION

FLUIDICAM RHEO is an innovative rheological instrument for visual flow tests at wide shear rate ranges. It allows to identify and distinguish products even with low viscosity differences. It lets fast and precise analysis with less than 1mL of sample consumption and visual control of the sample behavior in the chip.