Ink transportation in anilox offset printing

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Introduction and motivation

Due to the multitude of various advantages, offset printing is the most common printing method. The key benefits are the high printing quality, high printing speeds, the fast job change, the fast way of producing printing plates and small costs for printing forms. Conventionally, inking is carried out by long inking units. However, over the last years short inking units became more popular. These inking units have advantages in relation to the speed of job change, the decrease of waste paper and disburdening of the printer. Still, there are some unsolved problems, the color density is not easy to regulate, the ink transportation can become unequable and the mass of the transportated ink can not be calculated by he volume of the anilox roller alone. Previous investigations in the problem of ink transportation with engraved rollers concentrated on the flexographic process, where these inking units are state of the art for years. Results for the transportation problems of low viscosity newtonian fluids can not easily be transferred. The mass of the transferred ink is higher and certain problems such as ribbing effects are unknown in offset printing [1 and 2]. One drawback of previous investigations is, that the anilox rollers were examined during the printing process. On the one hand it is so far not known how much ink remains in the cells of the anilox roller after passing the doctor blade. On the other hand back splitting of the ink film has always influences on the result of the investigation.

Testing units and methods

Concentration lies on the examination of the processes in the nip between the anilox roller and the ink form roller. Therefore, appropriate testing devices were realised, respectively existing testing devices were adapted. The device for controlled emptying exists in the Prüfbau printability tester (figure 1 right). The device for filling of the anilox rollers has been newly developed (figure 1 left).

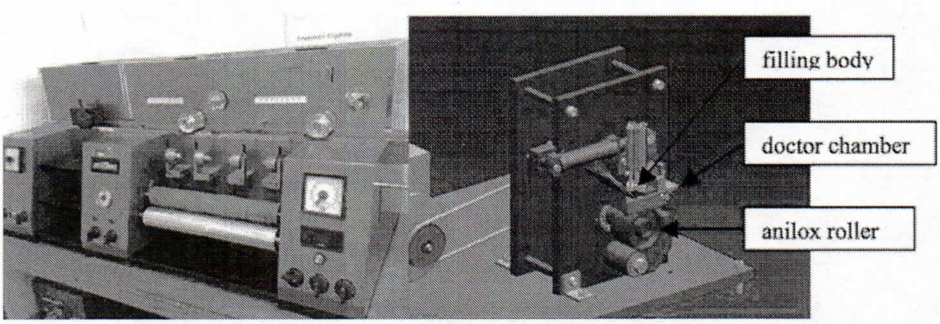

Figure 1: printability tester (left), single roller testing unit (right)

The anilox roller, which is displayed in figure 1, is set into rotation. Over a doctor chamber with negatively engaged doctor blade the ink is doctored into the cells. After 3 s the filling body is pneumatically lifted out of the doctor chamber. Due to the rotation of the anilox roller the ink in the doctor chamber moves on the doctor blade. This process is supported by an air stream. The ink is completely on the doctor blade after 2 s, after that the whole doctor chamber is panned off the anilox roller. The testing process consists of weighting the empty anilox roller, filling the anilox roller, weighting the filled anilox roller, transferring ink from the anilox roller and weighting the

anilox roller with remaining ink. The mass difference respectively the volume difference, which is connected via the mass density of the ink, will be evaluated.
Furthermore, for examination of the whole anilox offset process a short inking unit has been built in the laboratory printing press LaborMAN (figure 2).

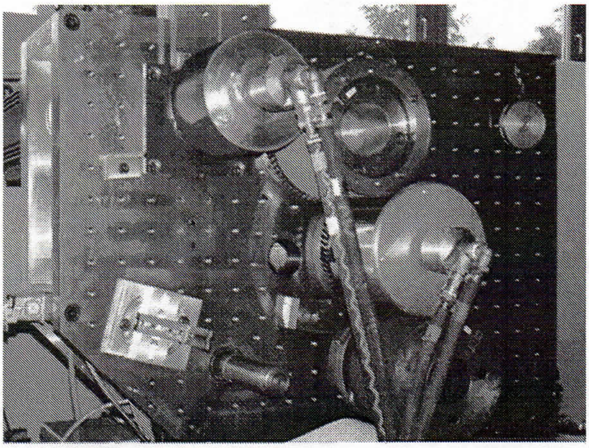

Figure 2: LaborMAN anilox inking unit

The LaborMAN is a web fed printing press with 140 mm web width and a printing speed of up to 7.5 m/s. Because of the single sided bearing of all rollers and cylinders a good observability of the printing process is given. The anilox offset printing unit consists of one anilox roller, one ink form roller, the plate cylinder, the rubber blanket cylinder and the impression cylinder. The anilox roller has a diameter of 180 mm and the other four cylinders of 220 mm. All rollers and cylinders are equipped with dedicated cylinder drives. The soft surface of the ink form roller is realised by a rubber blanket. Anilox roller and plate cylinder are temperature controlled by two independent water circuits. This experimental set up is appropriate for investigations in slip between anilox roller and ink form roller. Evaluated are ink consumption and printing results. Furthermore, the nip between anilox roller and ink form roller will be filmed by a high speed camera system. Additional examinations take place in the field of long time stability of the process.

Experimental results

In the theme complex of ink transportation/filling of the anilox roller two different anilox rollers of different theoretical volumes were examined. The remaining specifications of the gravure have not been varied and lie in a range of typical values for the anilox offset process.
First results show that none of the tested rollers is filled to the border of the measured theoretical volume (table 1).

Table 1: filling degree and released ink volume

Theoretical volume [cm^3/m^2]	Filled volume [cm^3/m^2]	Filling degree [%]	Released volume [cm^3/m^2]
11.8	8.7	74	1.45
16.0	12.1	76	1.63

One explanation model for the filling behaviour presented in table 1 is the development of a streaming profile in the cells while passing the doctor blade. At the bottom of the gravure the transported

ink moves with the circumferential speed of the anilox roller. In the zone of the doctor blade the top ink layer is stopped by the doctor blade, a speed profile develops and the intermediate streaming speed of the ink decreases. When leaving the doctoring zone, the ink adopts the circumferential speed of the anilox roller again. As the volume flow $\dot{V} = A * \omega$ inter alia described in [3] has to be of constant value, the transported ink volume has to decrease.
When releasing ink from the anilox rollers to a dry rubber blanket, it was noticed that both anilox rollers release just a small amount of the contained ink, which is moreover nearly independent from the theoretical volume (table 1). This behaviour has been described by Meyer for the flexographic process with differences in the total ink volume. The optical density of the printed product decreases when the anilox roller runs with externally forced slip on the ink form roller. Figure 3 shows this relation for the printing speeds of 1 m/s and 2 m/s.

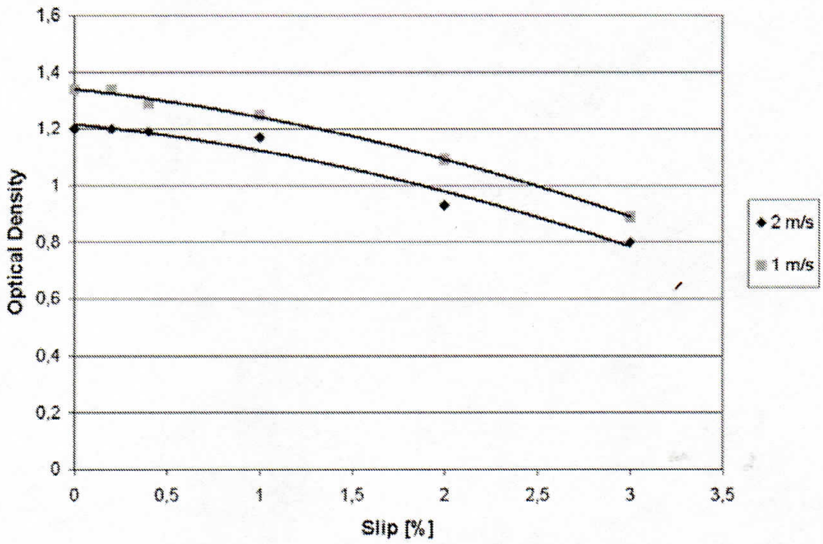

Figure 3: optical density vs. slip

In the presented experiments the anilox roller runs faster than the ink form roller. In [5] decreasing optical density respective ink transport was published for slower running anilox rollers, too. Therewith, the ink film splitting under the influence of slip represents a contrast to the ink film splitting in classical inking units with smooth rollers. According to [4], the ink transportation under slip conditions is dependent on the direction. Moreover, the amount of released ink decreases more with anilox rollers than with smooth rollers.

Procpectus and conclusions

The presented results give just a small first insight into current and pursuing work. For the field of filling and emptying of anilox rollers large investigations on anilox rollers with varied gravures will follow. In addition the influence of the arriving ink layer thickness on the ink form roller will be examined. Furthermore, an observation of the leaving nip between anilox roller and ink form roller during the printing process will be carried out. In this paper methods and first experimental results for the description of ink film splitting between anilox roller and ink form roller were presented. The single roller testing unit represents a new approach for investigation on the problem of filling anilox rollers. So far, the results show that anilox rollers can not be filled to the value of their theoretical volume and that they release only a small amount of ink to the ink form roller. With increasing slip between anilox roller an ink from roller the optical density decreases.