technische universiteit eindhoven

DEM simulations of the DI toner assembly

I.E.M. Severens, J.M.L. Maubach, A.A.F. van de Ven and R.M.M. Mattheij

Introduction

The Océ CPS700, see Figure 1, is based on the new Océ color technology Direct Imaging (DI).

Figure 1: The Océ CPS700.

This technology consists of seven separate color units. In each of these DI-units a bitmap image is transferred directly into a visible toner image on a DI-drum.

Objective

The printing quality of the DI technology is primarily determined by the toner flow in the region between the DI drum and the development drum where it shows a dynamic behavior, see Figure 2.

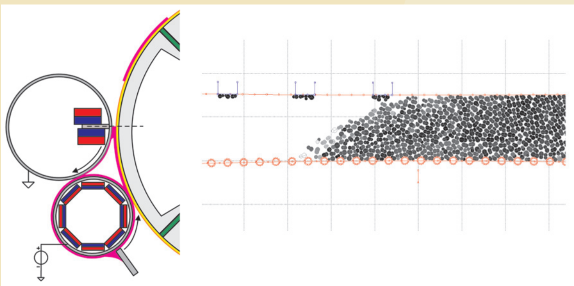

Figure 2: Fltr: development drum, supply drum, and DI drum and a cross-section of the front region of the DI toner assembly.

Insight in the underlying physical processes of Direct Imaging is obtained by experimental research, theoretical modelling and numerical simulation. Within Océ a method has been developed that accounts for the interactions in combination with other forces driving the motion of an assembly of small toner particles bumping and bouncing onto each other. This method is based on the Discrete Element Method (DEM).

If a voltage is applied over the tracks of the DI drum, charging of the conducting toner particles will take place. An accurate description of this charging is important, since the size of the electric force exerted on particles in the front region determines whether toner particles can be printed from this region.

Method

The Local Defect Correction (LDC) technique is applied to solve this two-dimensional Laplace problem with mixed boundary conditions, as depicted in Figure 3.

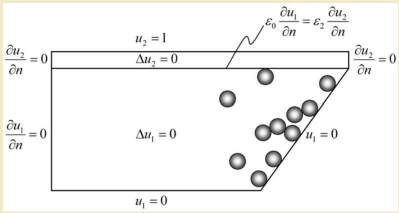

Figure 3: The electrostatic problem in the front region of the DI toner assembly.

Grounded particles:

$$u = 0.$$

Floating particles:

$$u = g \in \mathcal{R},$$
$$\varepsilon_0 \oint_{\partial\Omega_L} \frac{\partial u}{\partial n} ds = Q.$$

The general idea of the LDC method is:

1. Solve the global problem without local disturbances (i.e. toner particles),
$$A^H u_i^H = b^H.$$
2. Solve the local problem (around a toner particle) with artificial Dirichlet boundary conditions,
$$A_l^h u_{l,i}^h = b_L^h - B_{l,\Gamma}^h P^{h,H} u_i^H|_\Gamma.$$
3. Calculate the local defect,
$$d_{l,i}^H = \chi_l^H \left(A^H R^{H,h} u_{l,i}^h - b^H \right).$$
4. Calculate the new global solution,
$$A^H u_{i+1}^H = b^H + d_{l,i}^H.$$
5. Go to (2) if not converged.

Results

The Local Defect Correction technique converges to the exact solution for problems, having the basic features of the original problem, but in a simplified form.

References

1. Cundall, P.A. (1971) A computer model for simulating progressive large-scale movements in block rock systems, Proc. Symp. Int. Soc. Rock Mech. 2.
2. Anthonissen, M.J.H. (2001) Local Defect Correction techniques, Eindhoven, University Press.