AIR LIFT III. EXAMINE THE EFFECT OF THE IMPORTANT PARAMETERS OF IN THE AIR LIFT TANK MOVING SOLID PARTICLES

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Abstract
The papers [1] and [2] deal with the mathematical-physical model for describing the important physical parameters of the air lift tank and in the mixing area of the air lift. The results of the theoretical calculations are given in the following diagrams: pressure, solid and air velocity and concentration distributions, at parameters:

- *Air permeability of the distribution layer*
- *Solid material mass flow*
- *Height of the solid material column in the air lift tank*
- *Loosening velocity*
- *Bulk density*
- *Solid material friction coefficient*
- *Velocity of air flowing out from the nozzle*

In the course of changing the parameters having the greatest influence on two-phase flow taking place in air lift tanks, the variations in the distribution functions obtained as the solutions of the differential equations set up for the mathematical-physical model – i.e. the changes in gas velocity $v_g(R)$, loosening velocity $v_{g1}(R)$, material velocity $v_m(R)$, concentration $\rho_m(R)$, air mass flow $\dot{m}_g = f(R)$ and material mass flow $\dot{m}_m(R)$ versus radius – were studied.

The following constant data were used for this study:
b=0.2 m; H=4 m; k_o=50000 m/s;
$\dot{m}_m$=30 kg/s; p_1=129.1 kPa;
p_t=115.69 kPa; p_k=109.69 kPa; R_t=1 m;
R_p=0.1 m; v_k=100 m/s; β=0.15;
ρ_b=400 kg/m^3; ρ_s=2600 kg/m^3 ;
d_o=1.5*10^{-4} m; solid material: fly ash.

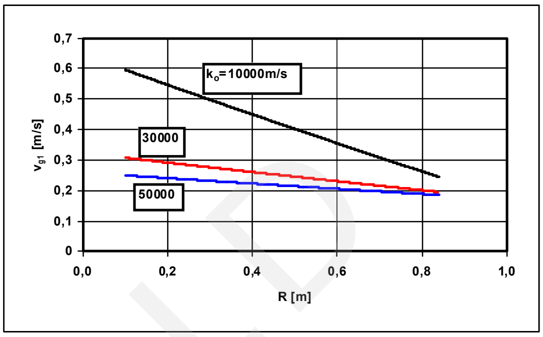

Fig. 1 Loosening velocity distribution. Parameter: fluid insert characteristic

Changing the resistance factor „k_o" of the air distribution layer, as shown in Figure 1, results in a more uniform distribution of loosening velocity v_{g1}=$f(R)$, i.e. the loosening velocity varies to a less extent along the radius.

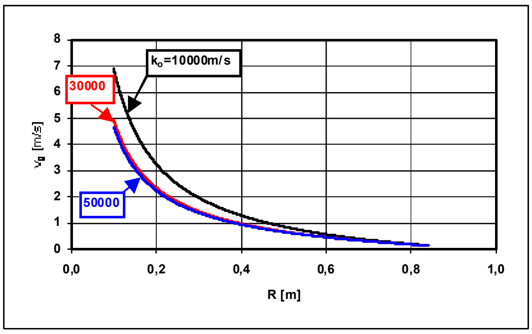

Fig. 2 Radial gas velocity distribution. Parameter: fluid insert characteristic

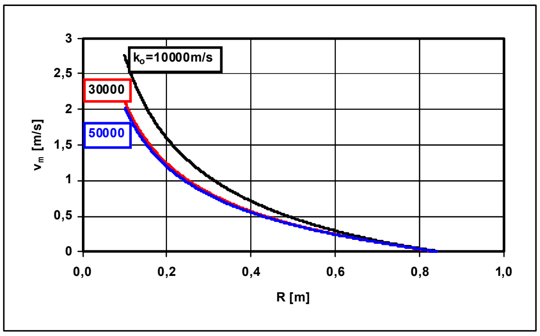

Fig. 3 Radial solid material velocity distribution. Parameter: fluid insert characteristic

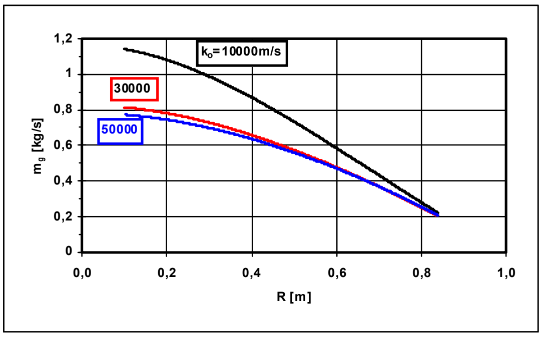

Fig. 4 Gas mass flow distribution. Parameter: fluid insert characteristic

Changing the flow resistance of the distribution layer influences also the radial variations of gas velocity $v_g(R)$ shown in Figure 2 and material velocity $v_m(R)$ shown in Figure 3 as well as of air mass flow $\dot{m}_g = f(R)$ shown in Figure 4 and concentration $\rho_m(R)$ shown in Figure 5.

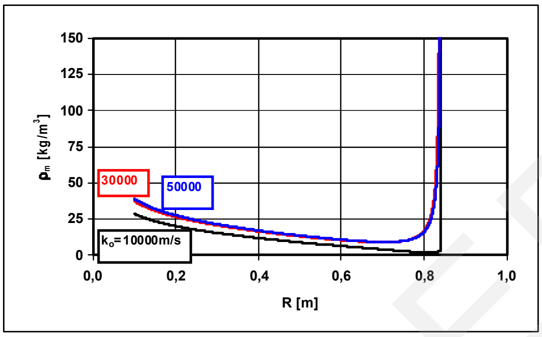

Fig. 5 Concentration distribution. Parameter: fluid insert characteristic

Changing material mass flow „$\dot{m}_m$" – at constant air mass flow – obviously influences the radial variations of concentration $\rho_m(R)$ shown in Figure 6 and material mass flow $\dot{m}_m(R)$ shown in Figure 7.

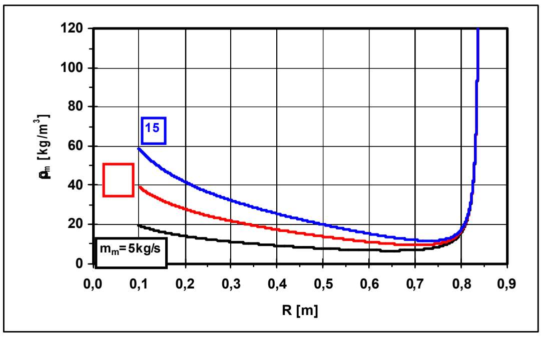

Fig. 6 Concentration distribution. Parameter: Solid material mass flow

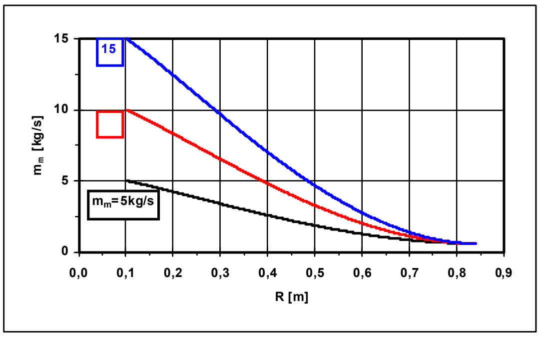

Fig. 7 Solid material mass flow distribution. Parameter: Solid material mass flow

Changing height „*H*" of the material column formed in the tank of the air lift has fundamental effects on the radial variation of pressure *p(R)* shown in Figure 8. With the other parameters kept constant, the radial variations in gas velocity, material velocity and concentration are negligible, these curves almost coincide in the sample example.

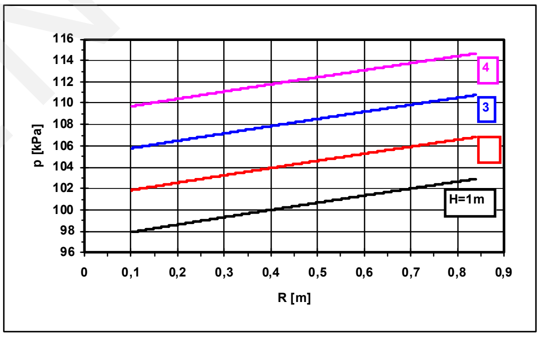

Fig. 8 Pressure distribution. Parameter: Solid material column height

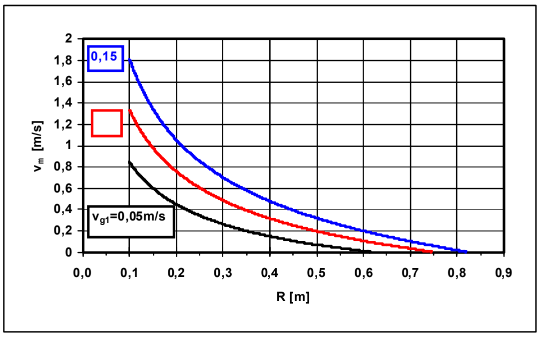

Fig. 9 Solid material velocity distribution. Parameter: Loosening velocity

The parameter of loosening velocity „v_{g1}" has two major effects: this determines the size of the dead space or equivalently, the functioning range of the loosening layer in the air lift, on the one hand and furthermore it influences considerable the shapes of the distribution curves of radial material velocity $v_m(R)$ (Figure 9), gas velocity $v_g(R)$ (Figure 10), loosening velocity $v_{g1}=f(R)$ (Figure 11), concentration $\rho_m(R)$ (Figure 12) and material mass flow $\dot{m}_m(R)$ (Figure 13).

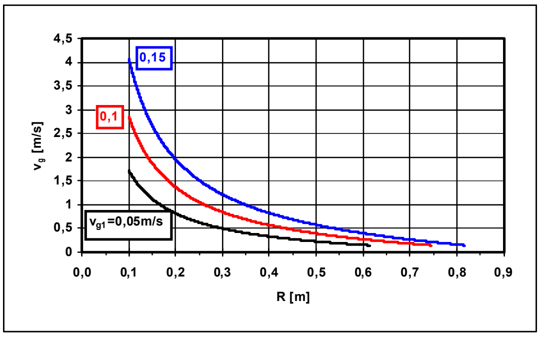

Fig. 10 Gas velocity distribution. Parameter: Loosening velocity

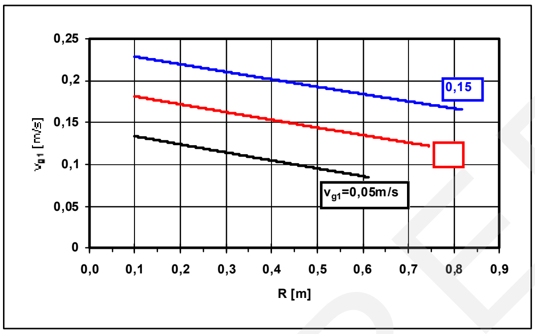

Fig. 11 Loosening velocity distribution. Parameter: Loosening velocity

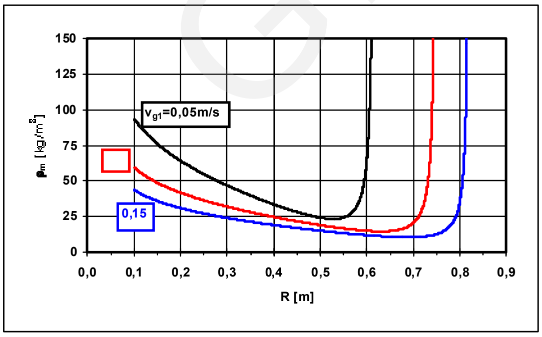

Fig. 12 Concentration distribution. Parameter: Loosening velocity

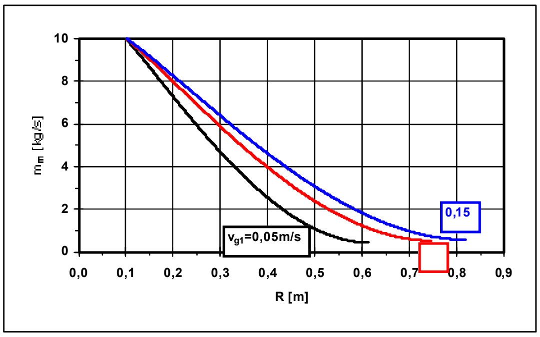

Fig. 13 Solid material mass flow distribution. Parameter: Loosening velocity

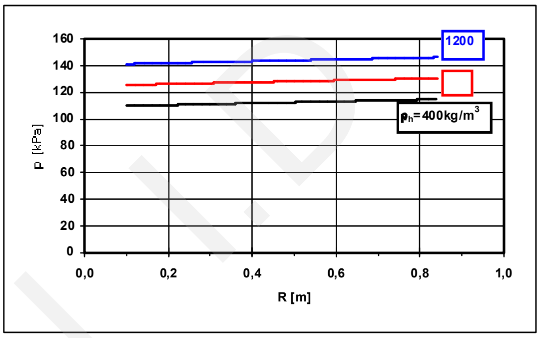

Fig. 14 Pressure distribution. Parameter: bulk density

Changes in bulk density „ρ_b" have fundamental effects the magnitude of the pressure developing in the air lift tank (Figure 14) and influence the radial variations in concentration $\rho_m(R)$ (Figure 15) and loosening velocity $v_{g1}=f(R)$ (Figure 16) to a less extent.

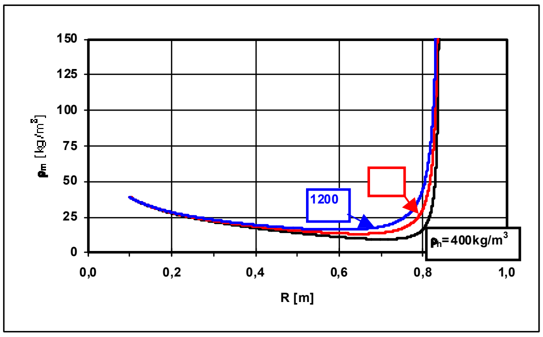

Fig. 15 Bulk density distribution. Parameter: bulk density

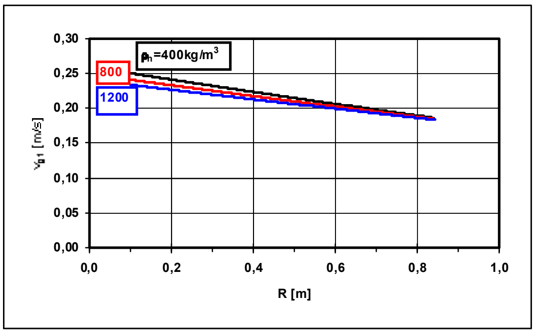

Fig. 16 Loosening velocity distribution. Parameter: bulk density

Changes in the parameter of friction coefficient have two major effects: determine the size of the dead space on the one hand and fundamentally influence the radial variations of material velocity $v_m(R)$ shown in Figure 17 and concentration $\rho_m(R)$ shown in Figure 18.

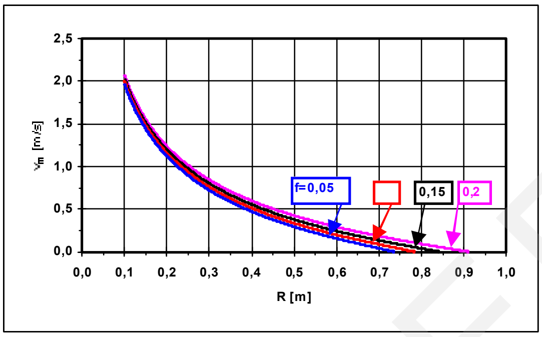

Fig. 17 Solid material velocity distribution. Parameter: friction coefficient

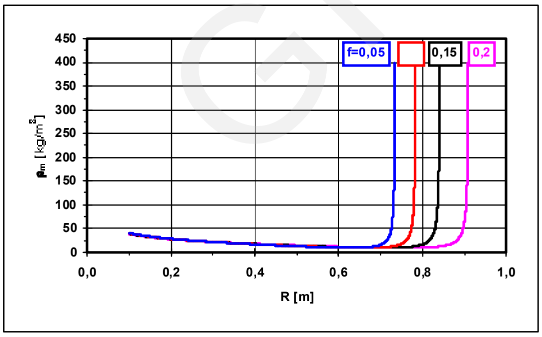

Fig. 18 Concentration distribution. Parameter: friction coefficient

Changes in the parameter of nozzle outlet velocity „v_k" has a fundamental effect on the radial variation of pressure $p(R)$ shown in Figure 19. The pressure function can be specified, naturally, in some other form as well (see Figure 20) and the final solution can be obtained by way of experiments.

References

1. L. KOVÁCS and S. VÁRADI: AIR LIFT I. Determination of in the air lift tank moving solid particle parameters. BULK ASIA 2005
2. L. KOVÁCS and S. VÁRADI: AIR LIFT II. Two phase flow in the mixing area of the air lift. BULK ASIA 2005

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