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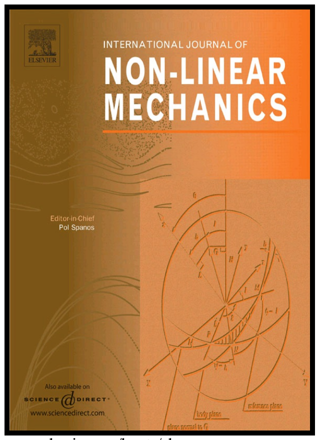

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A Model of Two-Velocity Particles Transport in a Porous Medium

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Abstract
A one-dimensional flow of suspension with two types of solid particles moving with different velocities in a porous medium is considered. A mathematical model of deep bed filtration which generalizes the known equations of mass balance and particle capture kinetics for a flow of fluid with identical particles is developed. The exact solution is evaluated at the filter inlet and on the concentration front of fast suspended and retained particles, asymptotic solutions are provided in certain vicinities of these lines. A global asymptotic solution to the problem with a small limit deposit is constructed. The asymptotics rapidly converges to the numerical solution.

Keywords
Porous media, Deep bed filtration, Suspended and retained particles, Mathematical model, Exact and asymptotic solutions

1. Introduction
The problem of particle transport through a porous medium is actual in many areas of industry and technology. The flow of suspension – (the flow of a fluid with tiny suspended solid particles) through a porous medium is accompanied by particle capture [1, 2]. The clogging of the pores with the suspension particles leads to formation damage and causes problems in the petroleum industry [3, 4], obstructs the filtering of drinking water and of the industrial waste [5-7] and results in soil salinization [8, 9].

The long-term transport of particle suspensions in porous media with particle capture throughout the entire length of the filter is called deep bed filtration. Depending on the composition of the suspension and on the properties of the porous medium different mechanisms of particle retention prevail (mechanical capture, diffusion, viscosity, electrostatic and gravity forces) [10-12].
The classical mathematical model of deep bed filtration for a mono dispersed suspension flow in a porous medium includes the equations of the particle balance and of the capture kinetics [13]. The second equation contains the empirical filtration coefficient which can be determined from laboratory tests. Analytical solutions to this problem with different types of the filtration coefficient are presented in [14-16]. The numerical calculation of a model of bimodal suspension filtration through porous media is performed in [17].

For the description of poly dispersed suspension motion in a porous medium population balance models are used [18-21], taking into account the size distribution of pores and particles. If these distributions overlap, the size-exclusion becomes the main mechanism for the particle capture. It is assumed that the suspended particles of small diameter pass freely through large pores and are stuck in the pore inlets, if their size is larger than the diameter of the pores. The retained particles can not leave the clogged pores and form a deposit. The size-exclusion is assumed below to be the main cause of the particle retention.

All these models assume that the suspended particles move with the same speed. However, experimental studies have shown that the velocities of the particles depend on their size [22]. A suspension in a porous medium moves unevenly due to the different sizes of the pores. The velocity of the fluid with suspended particles becomes greater with the increase of the pore diameter. The