DISTRIBUTION OF GAS STREAMS IN NEIGHBORHOOD OF A PLANE JET IN A HIGH GRANULAR LAYER

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Formulation of problems about the flow generated by jets in a fixed or fluidized granular bed is discussed. The solution of such a problem is considered for a single plane jet in a high layer.

Two related problems arise in analyzing jet flows in granular layers. The first ("internal") problem concerns the investigation of the hydrodynamics and mixing processes within individual jet tongues taking account of the presence of suspended particles therein and is examined semiempirically in [1], for instance. The second ("external") problem refers to an investigation of the perturbing influence of the jet on the hydrodynamics and transport process in the dense phase of the layer outside the tongues; there is an example of such a problem in [2]. The solution of the internal problem is especially important for modeling apparatus in which the main technological process is realized, namely, within the tongues of two-phase jets; the solution of the external problem is needed to analyze the structure of the near-grid zones of reactors with a fluidized bed, in estimating the shape of dead zones, etc.

In principle these problems should be solved simultaneously under the imposition of conditions connecting the internal and external solutions in some zone separating the external and internal domains, where the shape of this zone (i.e., actually the jet configuration) as well as the parameters characterizing the exchange of the continuous and disperse phases between the domains mentioned are unknown beforehand and should be determined during the solution. So complete an analysis of two-phase jet flows is hardly possible at this time because of the uncertainty which occurs in the formation of both problems and the numerous mathematical difficulties which are apparent during their study in particular formulations. Hence, simplifying considerations must be used which permit separation of the formulation into the external and internal problems.

In particular, the external problem can be considered independently of the internal problem if the boundary of the jet tongues is given from some additional considerations say, on the basis of test data. Then in the external region we arrive at problems about particle motion and about the filtration of the continuous phase in the moving porous body they formed, which is similar in meaning to the problems discussed in [2] in application to stationary jet propagation in a low fluidized bed. In the higher layers (such that jet tongues do not emerge at the upper boundary of the bed), the flow generated by the jets is substantially nonstationary: Periodic bubble formation occurs accompanied by the collapse of the old and the subsequent development of new tongues [3-5].

Keeping in mind the construction of the simplest models of the continuous phase flux distribution due to the jets, it is reasonable to limit oneself to an analysis of only the filtration problem in a stationary formulation. The passage from a real nonstationary problem to a model stationary problem corresponds to taking the average of the flow picture in a time interval which is large in comparison to the duration of a single cycle of bubble formation; the solution of this latter problem permits estimation of only the mean fluxes. It is hence necessary to use the appropriate mean boundary, introduced in [1, 3] and other papers, as the stationary jet tongue boundary.

Analogously to [2] we assume that the continuous phase is a gas so that changes in the dynamic gas pressure along the jet tongues can be neglected with a high degree of confidence, as compared to pressure changes in the dense phase of the layer due to the hydraulic drag of

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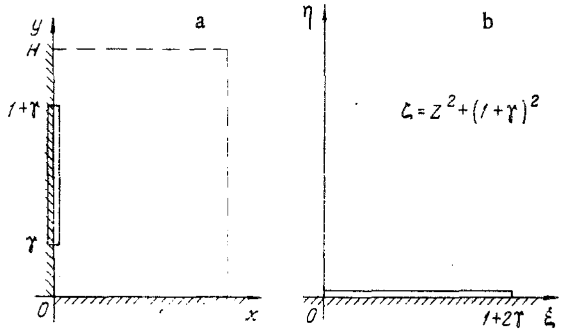

Fig. 1. Conformal mapping of the first quadrant of the flow plane into the upper half-plane. A slit on the imaginary axis of the z plane corresponds to the jet. The dashes denote the boundary of the region transformed into a bed of finite height in the case of injection of a collective of identical jets.

the disperse phase. Additionally taking into account that the quantity of particles within the tongues is relatively small in conformity with test results [3-5], we arrive at the conclusion that the pressure within each tongue can be considered independent of the coordinates. Furthermore, because of the smallness of the characteristic particle velocity in the dense phase as compared to the gas velocity, in a first approximation it is generally possible to neglect the disperse phase motion by modeling it as a fixed porous body. Finally, for simplicity we consider the hydraulic drag to the flux being filtered as linear in the filtration rate (i.e., the Darcy law is valid) and the porosity of the granular layer outside the jet tongues as homogeneous. The former of these assumptions is of no value in principle since some effective proportionality factor can always be introduced which would play the part of the permeability of the porous body, while the latter assumption corresponds closely to reality outside the thin layer separating the dense phase from the jet tongues [4], whose existence in this context can be neglected.

The considerations elucidated permit correct formulation of the mathematical problem for arbitrary plane and spatial flows. Only the plane problem, for whose solution the powerful methods of analytic function theory can be used, will be considered below in the example of a flow near a single jet. For simplicity we consider the bed sufficiently high so that the influence of its upper boundary on the situation in the direct neighborhood of the jet could be neglected. The method of extending the results obtained to plane flows generated by a collective of jets in a granular bed of finite height is indicated at the end of the paper.

Within the framework of the approximate formulation of the problem being considered, excess detailing of the jet tongue shape is meaningless and it is sufficient to investigate just the flow in the neighborhood of a jet of simplest shape to obtain qualitative results. We characterize the jet below by using a single parameter, its effective height h, by considering the jet as infinitely thin. The quantity h is evidently a parameter which cannot, in principle, be determined just from an analysis of the external problem examined here and should be given a priori, for example, on the basis of experimental results.

It is convenient to use the dimensionless coordinates x and y in the flow plane, which are introduced by using the scale h; the jet height is one in these coordinates. In the general case, the base of the jet is at the height γh above the lower boundary of the bed so that the jet is a unit slit on the imaginary axis in the complex plane $z = x + iy$, as is shown in Fig. 1a. The analytic function

$$\zeta = z^2 + (1+\gamma)^2 \tag{1}$$

transforms the first quadrant of the flow plane into the upper half of the plane $\zeta = \xi + i\eta$, where the corresponding edge of the slit is transformed into the segment $(0.1 + 2\gamma)$ on the real axis of the ζ plane (Fig. 1b).

We describe the unperturbed state of the granular bed by using the relations

$$u_y^\circ = u^\circ = \text{const}, \quad \frac{dp^\circ}{dy} = -\alpha h u^\circ, \tag{2}$$

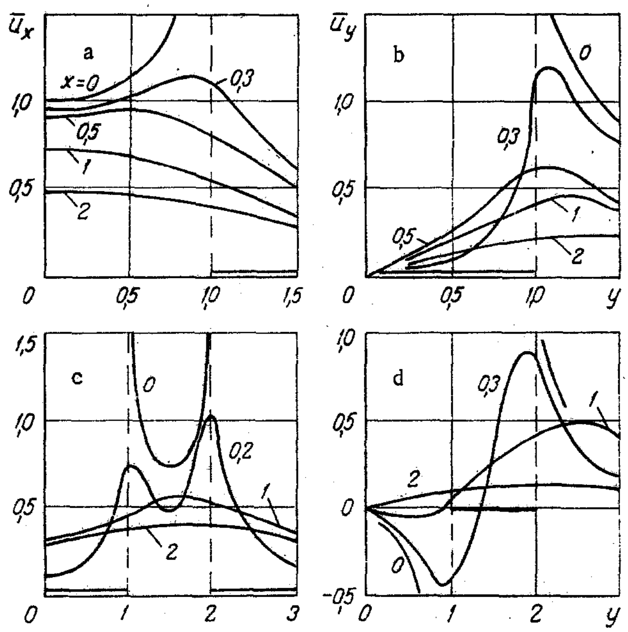

Fig. 2. Dependences of the dimensionless velocity components, introduced with the scale $Q/\pi h$, on the dimensionless height y for different x (the numbers on the curves) and $\gamma = 0$ (a, b) and $\gamma = 1$ (c, d) for the injection of a single jet into a stagnant granular bed. The dashes denote the velocity jump on the line $x = 0$.

where the filtration rate u° can be both greater and less than the minimum rate of fluidization u_*. The hydraulic drag coefficient α of the bed depends on the porosity; for $u^\circ > u_*$ the quantity αu° equals the weight of unit volume of the bed, which determines its porosity as a function of u°.

The gas pressure in the bed perturbed by the jet is a solution of the Laplace equation in the domain $x > 0$, $y > 0$ which satisfies the condition that the normal derivative vanishes on the boundaries ($y = 0$ and $x = 0$, $y < \gamma$ or $y > 1 + \gamma$) and takes on a constant value for $x = 0$, $\gamma < y < 1 + \gamma$ (which can be made equal to zero because of the selection of the pressure reference point). It is convenient to introduce the velocity potential of the filtration flow due to the presence of the jet so that

$$\varphi = -\frac{p - p^\circ}{\alpha h}, \quad \mathbf{u} = \mathbf{u}^\circ + \mathbf{v}, \quad \mathbf{v} = \nabla\varphi. \tag{3}$$

We then have the following problem for ϕ:

$$\Delta\varphi = 0, \quad \frac{\partial\varphi}{\partial y} = 0\,(y = 0), \quad \nabla\varphi \to 0\,(|z| \to \infty),$$
$$\frac{\partial\varphi}{\partial x} = 0\,(x = 0,\ y < \gamma,\ y > 1 + \gamma), \quad \varphi = u^\circ y\,(x = 0,\ \gamma < y < 1 + \gamma). \tag{4}$$

Let us note that the condition at $y = 0$ corresponds to the assumption of constancy of the normal gas velocity component on the gas distributing grid and is customary for grids with high hydraulic drag. In principle, it is simple to consider other variants of the boundary condition at $y = 0$; for instance, for grids with vanishingly small hydraulic drag the condition of constancy of the pressure (φ vanishes) in the grid plane is more natural. The condition as $|z| \to \infty$ reflects disappearance of the flow due to the jet at an infinitely remote point.

In addition, let us consider the total gas discharge in the jet Q to be given. It is clear from physical considerations that a relationship exists between the quantities Q and h which should be considered known within the framework of the theory being developed.

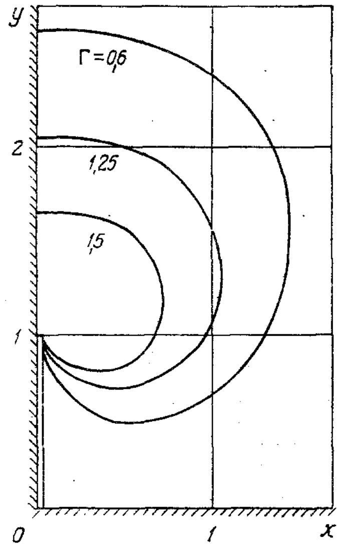

Fig. 3. Boundaries of the domain of possible ascending particle motion during injection of a single jet through a hole in the base of an injected bed, corresponding to different Γ.

Let us introduce the complex potential $\Phi = \varphi + i\psi$, where ψ is a harmonic conjugate function of φ. In the ζ plane we have a mixed boundary-value problem of analytic function theory for Φ, when the value $\mathrm{Re}\,\Phi$ is given on the segment $0 < \xi < 1 + 2\gamma$ of the real axis, while the normal derivative of this quantity vanishes on the rest of the axis. Let us introduce yet another analytic function $F(\zeta) = d\Phi/d\zeta$ which plays the part of the "complex velocity in the ζ plane." According to [6], we have a particular case of the Hilbert problem for $F(\zeta)$ when the value $\mathrm{Re}\,F$ is given on part of the boundary of the domain $\eta > 0$ of the definition of $F(\zeta)$, while the value $\mathrm{Im}\,F$ is given on the rest of the boundary. Namely, by using the general method [6], we obtain

$$\mathrm{Re}\,F(\zeta) = \frac{\partial\varphi}{\partial\xi} = \frac{\partial\varphi}{\partial y}\cdot\frac{\partial y}{\partial\xi} = \frac{u^\circ}{2}\,[(1+\gamma)^2 - \xi]^{1/2},$$
$$0 < \xi < 1 + 2\gamma, \quad \eta = 0, \tag{5}$$
$$\mathrm{Im}\,F(\zeta) = 0, \quad \xi < 0, \quad \xi > 1 + 2\gamma, \quad \eta = 0$$

after a simple computation using (4). Moreover, boundedness of $F(\zeta)$ at all points of the upper half-plane, with the exception of the points $\zeta = 0$ and $\zeta = 1 + 2\gamma$ at which the integral of $F(\zeta)$ [i.e., of $\Phi(\zeta)$] is bounded, and finiteness of the limit of $F(\zeta)$ as $|\zeta| \to \infty$, are needed.

The Hilbert problem formulated is solved by formal application of the known Keldysh–Sedov formula [6]. Taking account of (5), we obtain

$$F(\zeta) = \frac{u^\circ}{2\pi}\left[\frac{\zeta}{\zeta-(1+2\gamma)}\right]^{1/2}\int\limits_0^{1+2\gamma}\left[\frac{1+2\gamma-t}{(1+\gamma)^2-t}\right]^{1/2}\frac{dt}{\sqrt{t}\,(t-\zeta)} +$$
$$+ \frac{C}{[\zeta(\zeta-(1+2\gamma))]^{1/2}} + F(\infty)\left[\frac{\zeta}{\zeta-(1+2\gamma)}\right]^{1/2}, \tag{6}$$

where the complex velocity $U = v_x - iv_y$ is expressed in the form

$$U(z) = \frac{d\Phi}{dz} = \frac{d\Phi}{d\zeta}\cdot\frac{d\zeta}{dz}\bigg|_{\zeta=\zeta(z)} = 2zF(z^2 + (1+\gamma)^2). \tag{7}$$

From the condition that $U(z)$ vanishes at infinity there follows that $F(\infty) = 0$; the arbitrary constant C can be determined from the condition that the gas flow in the jet equals Q. The complex potential $\Phi(\zeta)$ is found from (6) after integration with respect to $d\zeta$, where

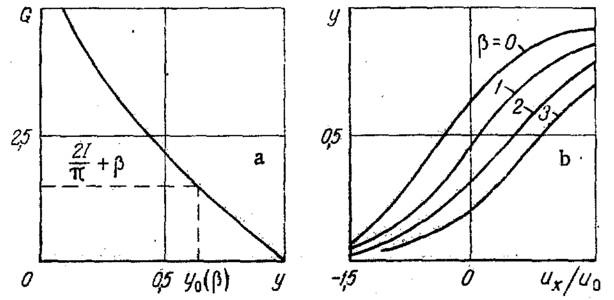

Fig. 4. Dependence of G on y (a) and profiles of the dimensionless rates of injection from the jet (b) for different β. The dashes denote the definition of $y_0(\beta)$.

the new arbitrary constant appearing here is evaluated in conformity with the last condition in (4).

For any γ the integral in (6) can be expressed in terms of elliptic functions, but a numerical investigation in the general case turns out to be quite awkward. We consider here only two important particular cases.

Injection of a Jet into a Fixed Bed ($u^0 = 0$). In this case we obtain from (6), (7) and the definition of Φ(z) after simple calculations

$$\varphi(z) = 2\,\mathrm{Re}\,(C \ln \{(z^2+\gamma^2)^{1/2} + [z^2 + (1+\gamma)^2]^{1/2}\}) + C',$$
$$U(z) = 2Cz\,\{(z^2+\gamma^2)\,[z^2+(1+\gamma)^2]\}^{-1/2}. \tag{8}$$

Let us find the constants C and C'. There follows from the definition of the discharge Q

$$Q = 2h \int\limits_{\gamma}^{1+\gamma} u_x|_{x=0}\,dy, \tag{9}$$

where for x = 0, $\gamma < y < 1 + \gamma$ we have from the second relationship in (8)

$$u_x = v_x = 2Cy\,\{(y^2-\gamma^2)\,[(1+\gamma)^2 - y^2]\}^{-1/2}. \tag{10}$$

Integrating, we obtain an expression from (9) and (10)

$$C = \frac{Q}{2\pi h}. \tag{11}$$

Furthermore, from the last condition in (4) and from (11) for x = 0, $\gamma < y < 1 + \gamma$ we have

$$C' = -\frac{2Q}{\pi h}\ln(1+2\gamma), \tag{12}$$

which finally determines the relationship in (8).

Using the definition of the complex plane, and separating into real and imaginary parts in its expression in (8), we obtain a representation for the gas filtration velocity components

$$u_x = v_x = \frac{Q}{\pi h}\cdot\frac{r}{r_1 r_2}\cos(\lambda_1+\lambda_2-\lambda),$$
$$u_y = v_y = \frac{Q}{\pi h}\cdot\frac{r}{r_1 r_2}\sin(\lambda_1+\lambda_2-\lambda), \tag{13}$$

where we have introduced the notation

$$r = (x^2+y^2)^{1/2},\quad \lambda = \mathrm{arctg}\,\frac{y}{x} = \frac{1}{2}\,\mathrm{arctg}\,\frac{2xy}{x^2-y^2};$$
$$r_1 = \{[x^2 - y^2 + (1+\gamma)^2]^2 + 4x^2y^2\}^{1/4}, \tag{14}$$

$$\lambda_1 = \frac{1}{2}\,\mathrm{arctg}\,\frac{2xy}{x^2 - y^2 + (1+\gamma)^2};$$

$$r_2 = \{[x^2 - y^2 + \gamma^2]^2 + 4x^2y^2\}^{1/4}, \quad \lambda_2 = \frac{1}{2}\,\mathrm{arctg}\,\frac{2xy}{x^2 - y^2 + \gamma^2}. \tag{14}$$

For $\gamma = 0$ the formula (13) simplifies considerably:

$$u_x = \frac{Q}{\pi h}\,\frac{\cos\lambda_1}{r_1}\bigg|_{\gamma=0}, \quad u_y = \frac{Q}{\pi h}\,\frac{\sin\lambda_1}{r_1}\bigg|_{\gamma=0}. \tag{15}$$

Let us emphasize that the angles λ, λ_1, and λ_2 can vary in the range $(0, \pi/2)$ and their evaluation requires some attention. For instance, for $\gamma = 0$ it follows from (14) that $\tan 2\lambda_1 = 0$ for $x = 0$ and any y, but for $y < 1$ and $y > 1$ we have, respectively, $\lambda_1 = 0$ and $\lambda_1 = \pi/2$.

A conception of the nature of the velocity fields in the neighborhood of the jet and about the influence of the parameter γ thereon can be obtained from the curves in Fig. 2.

The vertical component of the gas filtration velocity increases without limit upon approaching the point $x = 0$, $y = 1 + \gamma$, which is certainly related to the representation of the real jet tongue by using an infinitely thin slit. However, in any case it can be expected that this component will become sufficiently large in some domain near the upper part of the jet so as to exceed the quantity u_*. Within the limits of such a region the particle weight is less than the upwardly directed vertical component of the hydraulic force; i.e., there is a potential possibility for the occurrence of ascending particle motion. Such an ascending motion should be compensated by the slipping of particles of friable material in the beds directly abutting the mentioned region from outside the boundary, by the appearance of a specific disperse phase circulation in the neighborhood of the jet, which is repeatedly observed in test. The boundary of the domain mentioned, which actually separates the zones of ascending and descending particle motion, can be estimated from the relationship

$$\frac{1}{\pi}\cdot\frac{r}{r_1 r_2}\sin(\lambda_1 + \lambda_2 - \lambda) = \frac{hu_*}{Q} = \Gamma, \tag{16}$$

which implicitly defines the two-parameter equation of the boundary. Here the quantities γ and Γ, characterizing the location of the jet base in the granular bed and the relationship between the minimal fluidization velocity and the gas discharge in the jet referred to its height, respectively, are the parameters. The shape of this domain corresponding to $\gamma = 0$ and different Γ is shown in Fig. 3.

Injection of a Jet through a Hole in a Gas-Distributing Grid ($\gamma = 0$). In this case the integral in (6), which is of interest for both a fixed infiltrative ($u^\circ < u_*$) and a fluidized ($u^\circ > u_*$) granular layer, is easily calculated, so that from (6) and (7) we have

$$F(\zeta) = \frac{C}{\sqrt{\zeta(\zeta-1)}} - \frac{u^\circ}{2\pi\sqrt{\zeta-1}}\,\mathrm{Ln}\,\frac{\sqrt{\zeta}+1}{\sqrt{\zeta}-1},$$

$$U(z) = \frac{2C}{\sqrt{z^2+1}} - \frac{u^\circ}{\pi}\,\mathrm{Ln}\,\frac{\sqrt{z^2+1}+1}{\sqrt{z^2+1}-1}. \tag{17}$$

For $x = 0$, $0 < y < 1$ we obtain from the second relationship in (17)

$$u_x = v_x = \frac{2C}{\sqrt{1-y^2}} - \frac{u^\circ}{\pi}\ln\frac{1+\sqrt{1-y^2}}{1-\sqrt{1-y^2}} \tag{18}$$

and we furthermore find from condition (9)

$$C = \frac{Q}{2\pi h} + \frac{u^\circ}{\pi^2}I, \quad I = \int_0^1 \ln\frac{1+\sqrt{1-y^2}}{1-\sqrt{1-y^2}}\,dy. \tag{19}$$

It is seen from (18) and (19) that as $y \to 0$ or $y \to 1$ the quantity u_x is, respectively, negative or positive and its absolute value grows without limit. The sign of u_x changes at the value $y = y_0$, where y_0 is the single root of the equation

$$G(y)=\sqrt{1-y^2}\ln\frac{1+\sqrt{1-y^2}}{1-\sqrt{1-y^2}}=\frac{2I}{\pi}+\beta,\quad \beta=\frac{Q}{u^\circ h},\quad \frac{2I}{\pi}\approx 1.6. \tag{20}$$

This root is easily found graphically from Fig. 4a, on which the function G(y) is shown. The profiles $u_x(y)$ on the jet boundary corresponding to different β are shown in Fig. 4b.

The critical value of the coordinate $y_0(\beta)$ separates the lower and upper part of the jet at which gas injection and ejection hold, respectively. The ejection domain evidently increases with the growth of β (i.e., with the diminution in u° and the increase in Q/h), being propagated in the whole jet as $\beta \to \infty$. This latter corresponds to jet injection into the fixed and uninjected bed considered above. Let us note that according to [4] the value $y_0(\beta)$ actually determines the level at which contraction of the jet tongue is formed, the "redrawing" separating the bubble being developed from the lower part of the tongue. Therefore, the quantity $y_0(\beta)$ can be used to estimate the size of the bubbles being formed during jet injection into a granular injectable bed.

We again obtain expressions for the gas filtration velocity components by separating U(z) into real and imaginary parts and by using (19). We have

$$u_x=v_x=\left(\frac{Q}{\pi h}+\frac{2I}{\pi^2}u^\circ\right)\frac{\cos\lambda_1}{r_1}-\frac{u^\circ}{\pi}\ln\left|\frac{\sqrt{1+z^2}+1}{\sqrt{1+z^2}-1}\right|,$$

$$u_y=u^\circ+v_y=u^\circ+\left(\frac{Q}{\pi h}+\frac{2I}{\pi^2}u^\circ\right)\frac{\sin\lambda_1}{r_1}+\frac{u^\circ}{\pi}\arg\left(\frac{\sqrt{1+z^2}+1}{\sqrt{1+z^2}-1}\right), \tag{21}$$

where r_1 and λ_1 are defined in (14). As it should be, these formulas go over into (15) for $u^\circ = 0$. As $|z| \to \infty$ it follows from (12) that $u_x \to 0$, $u_y \to u^\circ$.

Let us formulate an equation to determine the boundary $u_y = u_*$, which is analogous to (16). We obtain from (21)

$$\frac{1}{\pi}\left(1+\frac{2I}{\pi\beta}\right)\frac{\sin\lambda_1}{r_1}+\frac{1}{\beta}\arg\left(\frac{\sqrt{1+z^2}+1}{\sqrt{1+z^2}-1}\right)+\frac{1}{\beta}=\Gamma. \tag{22}$$

As $\beta \to \infty$ this equation agrees with that obtained from (16) for $\gamma = 0$.

Using (22), the boundaries on which the vertical gas-velocity component agrees exactly with the minimum fluidization rate corresponding to different β and Γ can be constructed. The boundaries shown in Fig. 3 hence correspond to $\beta \to \infty$. Let Γ, and therefore, the ratio Q/h as well, be fixed. With the diminution of β (i.e., with the increase of u°) the domain in which $u_y > u_*$ and there is the possibility of the appearance of ascending particle motion, expands. When the value $u^\circ = u_*$ is reached (i.e., for a fluidization number one), the lowest point of the mentioned boundary emerges on the plane of the gas distribution grid at a point infinitely remote from the jet base; the outer and upper parts of the boundary hence also tend toward infinity. In this case $u_y \leqslant u_*$ everywhere with the exception of a region directly abutting the jet, where the horizontal dimension of this region increases monotonically from zero to infinity with the diminution in y from one to zero. As the fluidization number increases further in the domain where the particle weight is not compensated completely by the hydraulic forces, the formation of dead zones is possible and slipping of the layers of friable material is reduced monotonically up to the achievement of the limit configuration calculated from (22) in the case $\beta = 0$. An investigation of the size and shape of this region may turn out to be useful in estimating the magnitude and configuration of the dead zones occurring during jet gas injection in a prefluidized granular bed.

In conclusion, let us note that a method completely analogous to that elucidated is also applicable in the consideration of other plane problems about jet flows in granular beds. The main difficulty in the practical realization of this method is in finding an analytic function which will map the representative domain of the flow plane conformally onto the upper half-plane, after which the Keldysh—Sedov formulas can be applied directly to the variant of the Hilbert problem obtained. For instance, let us speak about the injection of a collection of equidistantly arranged (at spacings 2Lh) identical plane jets into a granular bed of the finite height Hh. In this case it is sufficient to examine the situation in the square $0 < x < L$, $0 < y < H$ of the z plane shown by dashes in Fig. 1a. It follows from symmetry considerations that the normal derivative of φ vanishes for x = L and the condition φ = const at y = H results from the condition of constancy of the pressure above the bed. The conformal mapping of the domain mentioned into the domain of Fig. 1b is not accomplished by the simple function (1) in this case but by using Jacobi and Weierstrass elliptic functions [6], or by using trigonometric functions in the particular case $H \to \infty$. The Keldysh–Sedov formula again yields the solution of the problem in principle, but calculations and numerical computations may turn out to be quite awkward.

NOTATION

C, C', arbitrary constants; F, complex velocity in the ζ plane; G, a quantity introduced in Eq. (20); H, dimensionless height of the bed; h, height of the jet; I, integral in Eq. (19); L, half the dimensionless spacing between adjacent jets; p, pressure; Q, gas discharge into the jet; r, r_1, r_2, functions defined in Eq. (14); U, complex velocity; **u**, gas filtration velocity; u_*, minimal fluidization rate; **v**, excess velocity due to jet gas injection; x, y, dimensionless coordinates; $z = x + iy$; α, hydraulic drag coefficient; β, a parameter introduced in Eq. (20); Γ, a parameter introduced in Eq. (16); γ, dimensionless height of the jet base above the gas distributing grid; $\xi = \xi + i\eta$; ξ, η, coordinates in the ζ plane; λ, λ_1, λ_2, angle functions introduced in Eq. (14); Φ, complex potential; φ, potential; ψ, harmonic conjugate function to ϕ; the degree superscript refers to quantities characterizing the unperturbed state of the bed.

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SECTIONALIZED FLUIDIZED-BED EQUIPMENT FOR SOLUTION GRANULATION

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A mathematical model is presented for solution granulation; the model has been tested by experiment. The model indicates that sectionalized equipment is suitable.

We have previously [1] examined the advantages of two-stage (countercurrent and crossflow) sectioning in a fluidized-bed system in which heat of reaction is released and this heat is removed by evaporation of input water. The sectionalization in that case gives a considerable improvement in the specific throughput. This system has now been introduced in a commercial equipment designed by the Urals Chemical-Research Institute and intended for treating sodium sulfate.

However, the heat- and mass-transfer processes occurring in solution granulation are very different from those occurring in many fluidized beds. Here we employ mathematical simulation to examine the effects of sectioning on the performance parameters of a fluidized bed intended to handle solutions. The results show that sectioning improves the throughput without increasing the energy consumption.

The model presupposes ideal mixing in the fluidized bed, so the temperature and effective water content of the granules are taken as identical throughout the height of the bed.

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