K	=	equilibrium constant	$[m^3/kmol]$, $[m^6/kmol^2]$ and $[m^9/kmol^3]$
K^*	=	apparent interfacial adsorption equilibrium constant	$[m^3/kmol]$
k°	=	reaction rate constant	$[m/s]$, $[m^6/(kmol\cdot s)]$ and $[m^7/(kmol^2\cdot s)]$
$\bar{u}$	=	average linear velocity	$[m/s]$
R	=	interfacial reaction rate	$[kmol/(m^2\cdot s)]$
$\overline{Sh}$	=	Sherwood number $(=\Delta C_A \bar{u}_A h^2/D_A x_L C_{A0})$	[—]
x_L	=	constant length of both phases	[m]
α	=	(C_{A0}/C_{B0})	[—]
β	=	(D_A/D_B)	[—]
$\bar{\sigma}$	=	standard deviation	[—]
θ	=	fraction of area adsorbed by the species	[—]

⟨Subscripts⟩

A	=	acid
a	=	adsorption
B	=	amine
d	=	desorption
ij	=	A_iB_j species
s	=	surface reaction
$A_iB_j^*$	=	adsorbed species A_iB_j

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LETTER TO THE EDITOR

COMMENTS ON THE PAPER "PREDICTION AND STABILITY ANALYSIS OF CHOKING IN VERTICAL PNEUMATIC CONVEYING"

Dear Sir:

Recently, Matsumoto, Sato, Suzuki and Maeda[9] (hereafter referred to as MSSM) expressed their view on the necessity of global consideration of pressure drop characteristics of blower, air distribution piping system and of vertical pneumatic conveying line. This thesis changes essentially the previous point of view on the phenomenon of choking in vertical pneumatic conveying. *An identical thesis and conclusions* have been presented by us in ref. 1 and in an earlier Polish publication.[2] The method proposed by us is also mentioned by Leung.[8]

The results of our experiments, carried out in an installation equipped with a transport line of a diameter almost 3 times larger (0.0585 m) than in ref. 9 have confirmed the validity of the hypothesis that the critical velocity of the gas conveying a granular material corresponds to the point of tangency of the characteristic of the vertical transport and of the effective characteristic of the blower.

MSSM[9] did not mention that the pneumatic transport system is quite rarely as simple as presented in their Fig. 1; more often it is equipped with systems for separation of the granular material and—many a time—with an extended piping system for air (gas) after realization of the pneumatic conveying (e.g. system with closed gas circulation). Also, these elements have their own pressure drop characteristic, which must allowed for in the analysis of the stability of operation. Disregarding them may lead often to serious errors. Of course, the way of carrying out the analysis does not change, for one can abstractly, in an arbitrary manner, displace the elements, situated beyond transport, before the feeding point (since all the resistances on the air flow lines are connected in series). The pressure drop characteristics at the feeding point of granular material will evidently be different in the two cases (i.e. of taking into account or not taking into account the hydraulic resistance concerning the elements situated beyond the pneumatic conveying). Hence in both cases two different critical velocities of pneumatic transport can be determined. The velocity obtained in the case of the allowance for all the resistances will be, of course. correspondingly lower.

In the papers ref. 3, 4 we have presented, on the basis of obtained results, the practically important problems of selection of optimal parameters of operation of vertical pneumatic conveying of granular materials as well as an analysis of operation of vertical pneumatic conveying from the viewpoint of selection of the blower and of the elements of transport piping system.

In view of the great practical significance of pneumatic conveying we would like to make known our own observations, which to a higher extent render more practical the proposal concerning prediction of choking and which have not been allowed for by MSSM.[9]

These observations concern the following problems:

1) validity of the proposal as above in the case of polydisperse materials, which are more important from the point of view of technology.

Investigations corresponding to this case have been carried out by us and are discussed in ref. 11.

2) possibility of theoretical determination of the critical point on the basis of a correspondingly rigorous model of vertical pneumatic conveying.

The analysis of results for one-component,[2] binary and ternary mixtures[5] has shown that the most adepuate models for the description of vertical pneumatic conveying are those of Capes and Nakamura.[7,10] The second one,[10] valid for binary mixtures, yields—after introduction of some modifications and corrections—fairly good results for ternary systems.[5]

We turn to the problem of models, because the empirical relationship presented by MSSM[9] in the form

$$u_p = a \log(u_a) - b \qquad (1) \text{ eq. } 20$$

in no way corresponds to the solutions of equations describing the motion of particles in the gas stream.[6] Besides, lack of information concerning the constants a and b renders impossible its application or even comparison with other data. By the way, this equation is dimensionally incorrect (the constant a should be dimensionless).

We would like to treat the present communication as a supplement to the MSSM paper.[9] At the same time we wish to express our satisfaction that Japanese investigations have confirmed an initially controversial thesis concerning the necessity of determination of the critical point in vertical pneumatic conveying by the analysis of stability conditions of the operation.

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Dear Sir:

The comments by Prof. J. Bandrowski *et al.* on our paper[3] are very helpful and much appreciated. They point out that they have also proposed the prediction method of choking point in vertical pneumatic conveying system.[1,2] There is, however, a significant difference between their approach and ours. We analyzed the dynamic behavior of the system and derived the criterion of unstable operating condition, while they presented only a graphical explanation with the effective blower characteristic curve.[2] Although their final conclusion seems to be identical with ours, the essential point of their work is quite different from ours. The main objective of our work is to show how to perform the stability analysis of such a complicated system as a pneumatic conveyer. Theoretical analysis is emphasized in our paper, and thus the result is very comprehensive. Experiments were carried out only to show the validity of our result, and therefore the apparatus used was not necessarily so complicated, as pointed out in the comments.

The fact is that we completed this work in 1978 and reported it as the M. S. thesis of one of the authors (ref. 7) in (3), though the contribution for publication was delayed since then. We did indeed miss the two papers[1,2] of Bandrowski *et al.* mentioned in their comments.

It is a great pleasure that the same topic was also treated by J. Bandrowski *et al.* at almost the same time and that our result confirmed their work, in which a more practical apparatus than ours was used.

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