For the suggested revised coefficient values ($\phi_1 = 0.16$, $\phi_2 = 0.56$),

$$\frac{\overline{u^2}}{k} = 0.88, \quad \frac{\overline{v^2}}{k} = \frac{\overline{w^2}}{k} = 0.56, \quad \frac{-\overline{uv}}{k} = 0.30$$

which agree reasonably well with the normalized stress levels measured by Champagne, Harris, and Corrsin ($\overline{u^2}/k = 0.93$, $\overline{v^2}/k = 0.48$, $\overline{w^2}/k = 0.59$, $-\overline{uv}/k = 0.33$).

Finally, it should be noted that if the suggested alternate value for $\phi_1$ is adopted, then $\beta$ will be lower by a factor 2.5 than the value of $\beta$ specified by the authors. In reference to Eq. (4), this change will diminish the effect of swirl on the eddy viscosity and, in turn, will alter predictions in comparison to those shown in Figs. 1-3 of Ref. 1. It would be informative if the authors were to repeat their calculations in order to demonstrate the performance of their model when referred to a value of $\beta$ that is internally consistent with the overall model.

### References

[1]Kim, K. Y. and Chung, M. K., "New Eddy Viscosity Model for Computation of Swirling Turbulent Flows," *AIAA Journal*, Vol. 25, July 1987, pp. 1020-1022.

[2]Rodi, W., "A New Algebraic Relation for Calculating the Reynolds Stresses," *ZAMM*, Vol. 56, 1976, pp. T219-T221.

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# Comment on "New Eddy Viscosity Model for Computation of Swirling Turbulent Flows"

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WHILE the authors may be right that $c_1$ and $c_2$ vary greatly in the literature, these constants are not independent but should obey

$$\frac{1 - c_2}{c_1} = \phi_1 \approx 0.22$$

when $P/\epsilon = 1$. Note that this gives $\beta = 4\phi_1^2 = 4(0.22)^2 = 0.19$, so you are not at liberty to take $\beta = 0.25$, otherwise you implicitly modify $c_1$ and/or $c_2$ in an arbitrary ad hoc fashion.

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# Reply by Authors to F. B. Gessner and M. A. Leschziner

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WE very much appreciate Drs. Gessner and Leschziner for their comments and private advice about our $k$-$\epsilon$ model for weakly swirling turbulent flows.[1]

They seem to assert that the ratio $P/\epsilon$ must be taken to be an equilibrium value of unity in order to determine the model constant $\beta$ in Eq. (5) of Dr. Gessner's comment. Such practice, however, is permitted only for convenience and simplicity in determining unknown model constants. Rather, we believe that it is more desirable and accurate to use a representative value of $P/\epsilon$, if available, in the flowfield under consideration.

In reality, $P/\epsilon$ vanishes at both the center and near free boundary of the swirling jet, and $0 < P/\epsilon \leq 1$ in the rest of the flowfield. This means that $P/\epsilon = 1$ is not a good selection to represent the total flowfield.

Our model constant $\beta = 0.25$ implicitly assumes that $P/\epsilon$ is about 0.8 for $c_1 = 1.8$ and $c_2 = 0.6$[2] or $c_1 = 3.$ and $c_2 = 0.3$.[3] And if $c_1 = 2.2$ and $c_2 = 0.55$,[4] $\beta = 0.25$ implies that $P/\epsilon = 0.6$. In this respect, since $(1 - P/\epsilon) \geq 0$, the constant value of $(1 - c_2)/c_1$ as, say, 0.22 in Leschziner's comment constrains the lower asymptote of $\beta$ [note that $\beta = 4\phi_1^2$ where $\phi_1$ is in Eq. (2) of Gessner's comment]. The accompanying figure shows comparison of model performances with varying $\beta$, which suggests that $\beta = 0.25$ is a best choice.

As a conclusion, we would like to mention that it is usual practice to select the best model constant with reference to available data after theoretical derivation of a physical model.

### References

[1]Kim, K. Y. and Chung, M. K., "New Eddy Viscosity Model for Computation of Swirling Turbulent Flows," *AIAA Journal*, Vol. 25, July 1987, pp. 1020-1022.

[2]Gibson, M. M. and Launder, B. E., "Ground Effects on Pressure Fluctuations in the Atmospheric Boundary Layer," *Journal of Fluid Mechanics*, Vol. 86, 1978, pp. 491-511.

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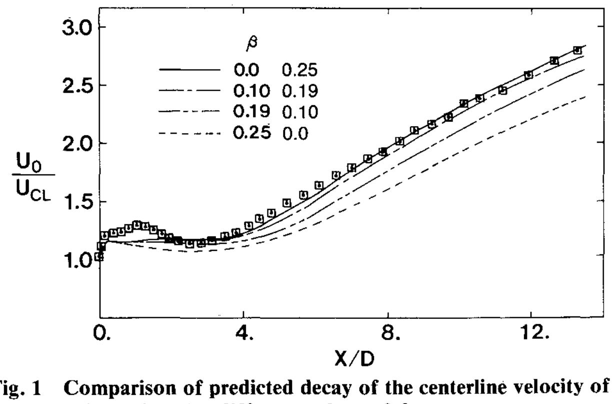


**Fig. 1 Comparison of predicted decay of the centerline velocity of a coaxial swirling jet with different values of $\beta$.**

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