Discussion and Summary

The long slender channel approximation used in the entrance region analysis requires that the axial diffusion term $\partial u / \partial z^2$ be neglected. While this approximation is quite valid over most of the channel, it is inappropriate for calculating the details of the velocity profiles very near the end wall ($\xi = 1$) and may lead to error right at the inlet ($\xi = 0$). There is evidence, however, that the effects of this approximation on the calculation of the overall pressure variations $\{P(1) - P(0)\}$ and entrance length are negligible. Quaile and Levy [1] obtained solutions for flow in a closed porous circular tube with mass suction, using the same approximation and technique used in the present analysis. Their analytical results for axial pressure variation are in excellent agreement with the results from a numerical finite difference solution of the complete flow equations (3) and also agree well with the available experimental data.

Gupta and Levy [15] also used this approximation and analytical technique for flow in a channel with suction at one wall and obtained excellent agreement with measured pressure variations. Finally where comparisons are possible, the hydrodynamic entrance lengths obtained from the present study are in agreement with the finite difference solutions of [14]. Both analyses yield a ratio of entrance length to channel length of 18 percent at the value $Re_w = 1$.

In summary it is concluded that the behavior of the laminar flow in a channel with uniform suction at the walls is highly sensitive to both the shape of the inlet velocity profile and the value of the suction Reynolds number $Re_w$. A flow with a parabolic inlet velocity profile does not become fully developed for $Re_w > 7$ except very near $\xi = 1$; and, except for small values of $Re_w$, the similarity analysis should not be used to predict the overall pressure variations. A flow with a uniform inlet velocity profile does not develop fully for $Re_w > 7$ and $Re_w < 13$, except very near $\xi = 1$. With this type of inlet flow, the similarity theory does not accurately predict the overall pressure variations except at very large values of $Re_w$.

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References

**Authors' Closure**

Professor Smith is very kind; we are grateful for his comments. We agree with his statement that there may be other series formulations which are more efficient at large $Re$; however, we attempted several different expansions; and of these, the form presented in the paper is the only one which works. His final observation on the validity of the similarity solutions is correct.