STABILIZED ABSOLUTE OPEN FLOW
POTENTIAL OF A GAS WELL

PURPOSE
The program is designed to calculate stabilized absolute open flow potential (AOFP) for a gas well, utilizing modified isochronal test data in conjunction with extended flow (short time variation) data. The radius of drainage for the gas well should either be known or assumed (half the distance between the wells). This calculated stabilized AOFP is quite a reliable estimate and should be used for a low-permeability (relatively tight) reservoir. Stabilization, in this context, is referred to as the condition when the pressure transient or disturbance has reached the outer drainage boundary. Computation and theoretical considerations are based on Poettmann and Schilson's (1959) technical paper.

METHOD

\[ Q_S = C_S (P_R^2 - P_f^2)^n \]

\[ Q_{SAOF} = C_S P_R^{2n} \]

\[ C_S = C_1 \left( \frac{A + 1/2 \ln t_1}{A + 1/2 \ln t_s} \right) \]

\[ A = \frac{C_2^{1/n}}{2(C_1^{1/n} - C_2^{1/n})} \ln t_2 - \frac{C_1^{1/n}}{2(C_1^{1/n} - C_2^{1/n})} \ln t_1 \]

\[ t_s = \frac{50 \phi \mu C \gamma_c}{k} \]
where

\[ Q_S = \text{Stabilized flow rate, MCFD}; \]
\[ C_S = \text{Stabilized performance coefficient}; \]
\[ P_R = \text{Reservoir pressure, psi}; \]
\[ P_F = \text{Flowing bottomhole pressure, psi}; \]
\[ n = \text{Performance exponent}; \]
\[ Q_{\text{SAOF}} = \text{Stabilized absolute open flow, MCFD}; \]
\[ C_1 = \text{Performance coefficient for flow duration of } t_1, \text{ hr}; \]
\[ t_1 = \text{Isochronal flow period, hr}; \]
\[ t_s = \text{Stabilization time, day}; \]
\[ C_2 = \text{Performance coefficient for flow duration of } t_2, \text{ hr (extended flow time)}; \]
\[ t_2 = \text{Extended flow period, hr}; \]
\[ \phi = \text{Porosity, fraction}; \]
\[ \mu = \text{Gas viscosity, cp}; \]
\[ C = \text{Gas compressibility, vol/vol/psi}; \]
\[ \gamma_e = \text{Radius of drainage, ft}; \]
\[ k = \text{Reservoir permeability, md}. \]

The modified isochronal test is conducted with the shut-in period (after each flow rate), about equal to the flow period. The associated unstabilized shut-in pressure is used for shut-in pressure \((P_{\text{sh}})\) in calculating the difference of pressures squared for the next flow period. The modified method does not yield a true isochronal curve but is completely satisfactory for determining the exponent \((n)\) of the flow equation. To determine the position of the stabilized back-pressure curve, the well is produced at one rate for an extended period of time. Satisfactory results may be obtained with the modified isochronal test for determining the exponent \((n)\) with flow test period of 1 to 2 hr. However, a much longer time period may be required for an extremely tight reservoir. Most of these considerations are applicable for radial flow geometry and are not applicable for hydraulically fractured tight gas wells, since the flow geometry (initially) is linear for such wells.

**PROGRAM DESCRIPTION**

The program consists of a FORTRAN main program and two subprograms. Subprogram COMFAC is used to determine gas compressibility factors, which in turn yield gas compressibility values. Subprogram VISCO is used to estimate reservoir gas viscosity. Most of the computations are performed in the main program. Isochronal test data are used to determine the slope (exponent) of the performance curve and the coefficient \(C\) by assuming a least-squares straight line fit through these points on a log-log basis. Restrictions are placed on the computed slope, such that \(0.5 \leq n \leq 1\). Since these values are determined by least-