reaches 1600 K before the end of the ignition window, as it ordinarily does, then the special energy deposition is terminated at that point. The ignition cell(s) are specified in the input data as the DO-loop range defined by IIGNL(1) to IIGNR(1), JIGNF(1) to JIGND(1), and KIGNB(1) to KIGNT(1). This allows the choice of a single cell or a block of cells. If JIGNF(1) = 1 and JIGND(1) = NY, ring ignition will result in a 3-D cylindrical run. Dual ignition is an optional feature, as a second ignition region may be specified by setting IIGNL(2), IIGNR(2), JIGNF(2), JIGND(2), KIGNB(2), and KIGNT(2) to nonzero values.

Spark ignition in our UPS-292-SC engine calculations[7] was accomplished in a unique manner. In the UPS engine, a pencil spray of fuel impinges on a spark plug which commences firing when the spray starts and continues firing for 35 crank angle degrees. Our procedure was to not allow fuel and oxygen to coexist in the cells containing the spark plug tip during the 35° period. Each cycle, any available fuel or oxygen was consumed through direct conversion to CO_2 and H_2O in accordance with the oxidation reaction, with appropriate heat release. While quite satisfactory, this procedure is applicable only in such specialized circumstances and would be totally inappropriate in more general applications in which the fuel has experienced significant evaporation and premixing prior to ignition.

I. Initial Bessel Function Swirl Profile

Internal combustion engines are designed to impart a significant amount of swirl in the incoming air, to aid in turbulent mixing and enhance combustion efficiency. The simplest model assumes that the swirl velocity has a wheel-flow profile, but this is not usually a realistic assumption, as the turbulent wall boundary layer forces the swirl velocity to decrease in the wall region. From experimental observation, modelers have determined that a Bessel function profile more accurately represents the flow.

Figure 27 illustrates the Bessel function velocity profile provided in KIVA-II and compares it with wheel flow for the same swirl number. The quantity α (input as SWIPRO) is a dimensionless constant that defines the initial azimuthal velocity profile and lies between 0.0 (the wheel flow limit) and 3.83 (zero velocity at the wall). A value suggested by Wahiduzzaman and Ferguson[58] for typical engine applications is about 3.11. We define our Bessel function profile to give the same angular momentum as wheel flow with the same swirl number. Thus the initial slope of the $\alpha = 3.11$ curve is necessarily higher than the corresponding slope for wheel flow.

A second input quantity, SWIRL, is the initial swirl ratio of air r.p.m. to crankshaft r.p.m. When viewed from above, the swirl is clockwise if SWIRL > 0 and counterclockwise if SWIRL < 0.

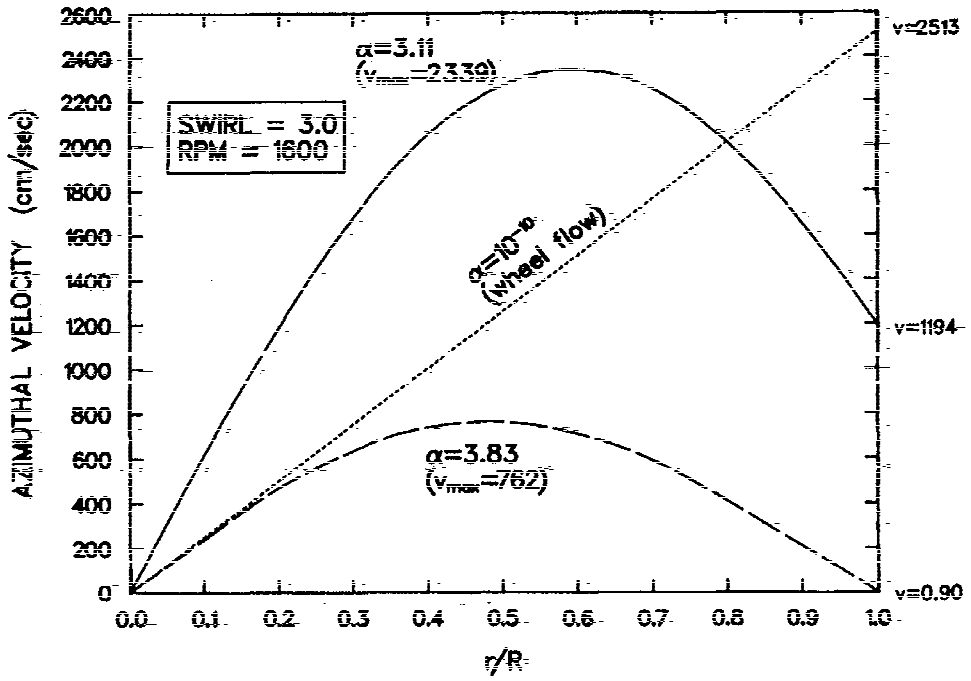

Fig. 27. Bessel function swirl velocity profile provided in KIVA-II setup.

J. Fuel Library

The release version of KIVA-II assumes that 12 chemical species are present, although this number can be increased or decreased as needed. The 12 species, appropriate for a variety of combustion applications, are 1 = fuel, 2 = O_2, 3 = N_2, 4 = CO_2, 5 = H_2O, 6 = H, 7 = H_2, 8 = O, 9 = N, 10 = OH, 11 = CO, and 12 = NO. The sample input data deck contains kinetic and equilibrium chemistry data that correspond to these 12 species. Enthalpy tables are required for all species, and because species 2-12 have been defined, enthalpies for them are provided in DATA statements in subroutine RINPUT.

What remains is to define the fuel, species 1, which requires a number of other properties in addition to its enthalpy. For this purpose, KIVA-II contains a library of the thermophysical properties of 12 common hydrocarbon fuels, embodied in BLOCK DATA FUELIB. At present, the 12 fuel choices are

methane	(CH_4),
propane	(C_3H_8),
n-heptane	(C_7H_{16}),
n-octane	(C_8H_{18}),
n-dodecane	($C_{12}H_{26}$),
n-tridecane	($C_{13}H_{28}$),
n-tetradecane	($C_{14}H_{30}$),
n-hexadecane	($C_{16}H_{34}$),