Velocity Calculation

The basic formula is as follows:

$$V = K \times C \times \sqrt{\Delta P} \times \frac{\sqrt{Tstack + 273}}{\sqrt{M \times P}}$$

where

V = stack gas velocity (m/s)
K = pitot tube velocity constant (34.97)
C = velocity pressure coefficient (for S-type pitot=0.84) (dimensionless)
$\sqrt{\Delta P}$ = square root of differential pressure of stack gas (mmH_20)
Tstack = stack temperature (ºC)
M = molecular weight of stack gas, wet basis (g/g mole)
P = absolute stack gas pressure (mm.Hg)

K
K is the velocity constant for pitot tubes and is set to 34.97.

C
C is the velocity pressure coefficient and for S type pitot tubes is around 0.84. This parameter should be adjusted for the individual pitot tubes used in the specific application.

Molecular Weight
M is the molecular weight of the stack gas on a wet basis in g/g mole. To calculate this value the component of the stack gas must be known. In general the main components are CO_2, O_2 and N_2 plus water. The dry weight is calculated by:

$$Mdry = 44\frac{\%CO_2}{100} + 32\frac{\%O_2}{100} + 28\frac{\%CO}{100} + 28\frac{\%N_2}{100}$$

When
Mdry = dry molecular weight of stack gas (g/g mole)
$\%CO_2$ = percentage CO_2 in gas stream
$\%O_2$ = percentage O2 in gas stream
%CO = percentage CO in gas stream
$\%N_2$ = percentage N_2 in gas stream
44 = molecular weight of carbon dioxide (g/g mole)
32 = molecular weight of oxygen (g/g mole)
28 = molecular weight of carbon monoxide and nitrogen (g/g mole)

This can then be converted to a wet basis by:

$$Mwet = Mdry(1 - B_{wo}) + 18(B_{wo})$$

When
Mwet = wet molecular weight of stack gas (g/g mole)
Mdry = dry molecular weight of stack gas (g/g mole)
B_{wo} = proportional of water vapor in the gas stream by volume
18 = molecular weight of water in (g/g mole)