Supplementary Material S2. Liquid fraction and effective equivalence ratio calculation

The amount of acetone vapor was estimated by the liquid flux method[1], i.e., subtracting the measured liquid flux in the gas mixture (by PDA) from the injected liquid flux. In turn, this led to an estimate of the liquid fraction (α_{liq}) and the effective equivalence ratio (ϕ_{e}).

Oxidation of acetone in air follows:

$$\mathrm{CH_3COCH_3} + \frac{4}{\phi_0}\left(\mathrm{O_2} + 3.76\mathrm{N_2}\right) \tag{1}$$

where ϕ_0 is the nominal equivalence ratio. The injected liquid molar flux $\dot{X}_{\mathrm{inj}}$ is

$$\dot{X}_{\mathrm{inj}} = \frac{\dot{Q}_{\mathrm{gas}}}{V_{\mathrm{m}}(1+19.04/\phi_0)} \tag{2}$$

where $\dot{Q}_{\mathrm{gas}}$ is the volumetric flow rate of the gas mixture and V_{m} is the molar volume for an ideal gas at 298 K and 1 atm (24.5 L). Note that from Eq. (2), at the richest condition ($\phi_0 = 1.4$), the acetone molar fraction is still less than 7% of the total gas mixture, and its liquid fraction is even smaller. Hence, $\dot{Q}_{\mathrm{gas}}$ is assumed to be constant during evaporation.

At the burner outlet, for a droplet size histogram and droplet concentration measured by PDA, the liquid molar flux is calculated as

$$\dot{X}_{\mathrm{liq}} = \frac{1}{M}\sum_{i=1}^{N_{\mathrm{b}}} \rho_{\mathrm{liq}} n_i' \frac{\pi D_i^2}{6}\dot{Q}_{\mathrm{gas}} = \frac{\rho_{\mathrm{liq}}\varepsilon\dot{Q}_{\mathrm{gas}}}{M} \tag{3}$$

where M is the molecular mass of acetone (58.08 g/mol), i represents the i th bin in the size histogram (Fig. S1.1), N_{b} is the total number of bins, ρ_{liq} is the liquid density (784 kg/m^3), D_i is the droplet diameter, n_i' is the droplet concentration for that diameter, and ε is the void factor, defined as the droplet volume per unit volume of gas mixture (m^3/m^3). Therefore, the vapor molar flux is

$$\dot{X}_{\mathrm{vap}} = \dot{X}_{\mathrm{inj}} - \dot{X}_{\mathrm{liq}} \tag{4}$$

The acetone vapor fraction α_{gas} is then

$$\alpha_{\mathrm{gas}} = \frac{\dot{X}_{\mathrm{vap}}}{\dot{X}_{\mathrm{inj}}} \tag{5}$$

and the acetone liquid fraction α_{liq} is

$$\alpha_{\mathrm{liq}} = 1 - \alpha_{\mathrm{gas}} \tag{6}$$

Therefore, the effective equivalence ratio (ϕ_{e}) is

$$\phi_{\mathrm{e}} = \alpha_{\mathrm{gas}}\phi_0 \tag{7}$$

The key values in the above analysis for each test condition are summarized in Table S2.1.

[1] Gounder, J. D., Kourmatzis, A., Masri, A. R., Turbulent piloted dilute spray flames: Flow fields and droplet dynamics, Combustion and Flame 159 (11) (2012) 3372-3397.

Table S2.1
Estimates of acetone liquid fraction (α_{liq}) and effective equivalence ratio (ϕ_{e}), calculated using the measurements of mean non-reacting droplet concentration (n_{d}) and the void factor (ε) for each nominal equivalence ratio (ϕ_0) at $z = 6$ mm.

ϕ_0 (–)	n_{d} (#/cm^3)	ε $\left(10^{-6}\ \mathrm{m}^3/\mathrm{m}^3\right)$	α_{liq} (%)	α_{gas} (%)	ϕ_{e} (–)
0.8	153	7.27	6.0	94.0	0.75
0.9	245	8.63	6.3	93.7	0.84
1.0	328	11.22	7.4	92.6	0.93
1.1	481	19.61	11.9	88.1	0.97
1.2	662	27.48	15.3	84.7	1.02
1.3	865	32.19	16.7	83.3	1.08
1.4	1196	45.50	22.0	78.0	1.09