Electronic Supplementary Material (ESI) for Reaction Chemistry & Engineering.

Electronic Supplementary Information

Hydrous pyrolysis of glucose using a rapid pulsed reaction technique

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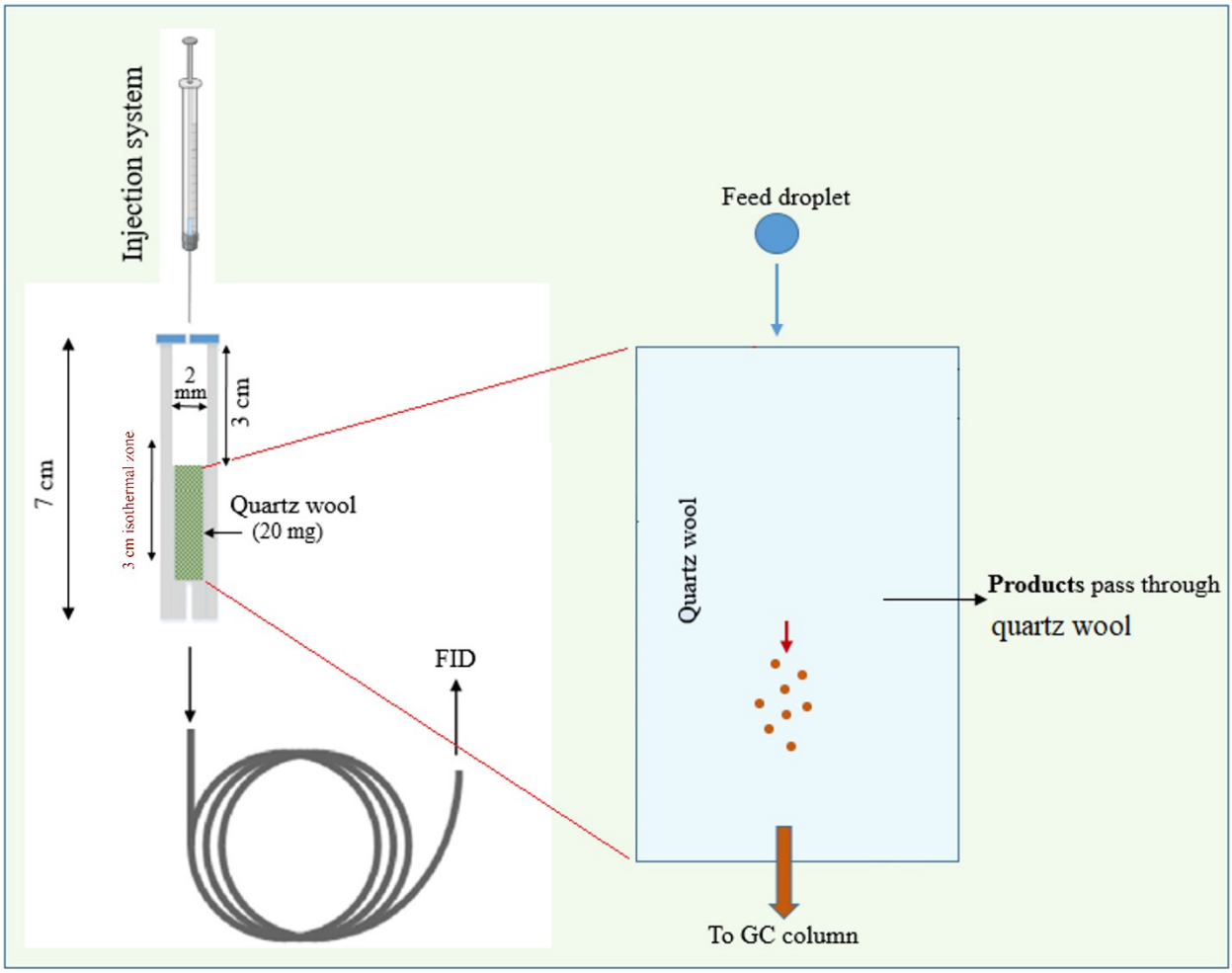
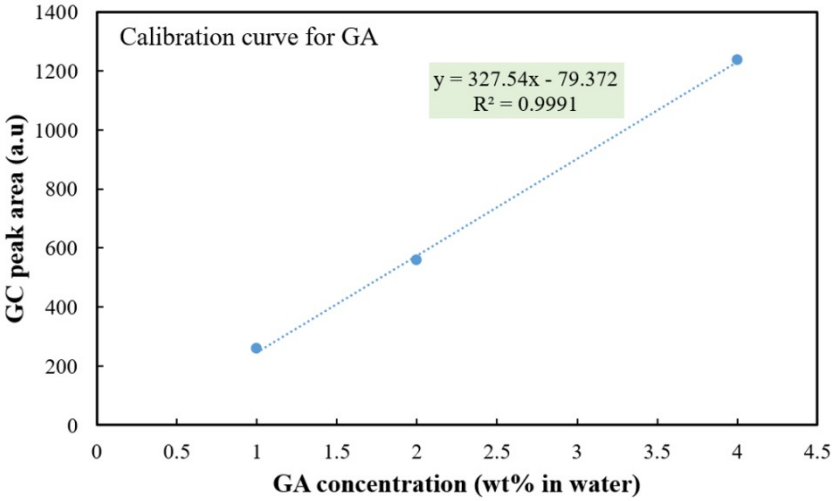
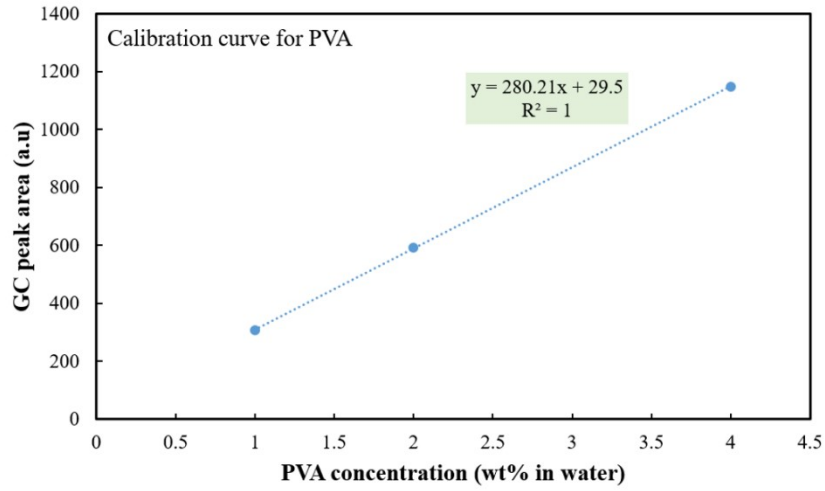


Figure S1: Schematic of the GC inlet liner used as reactor and experimental set-up.





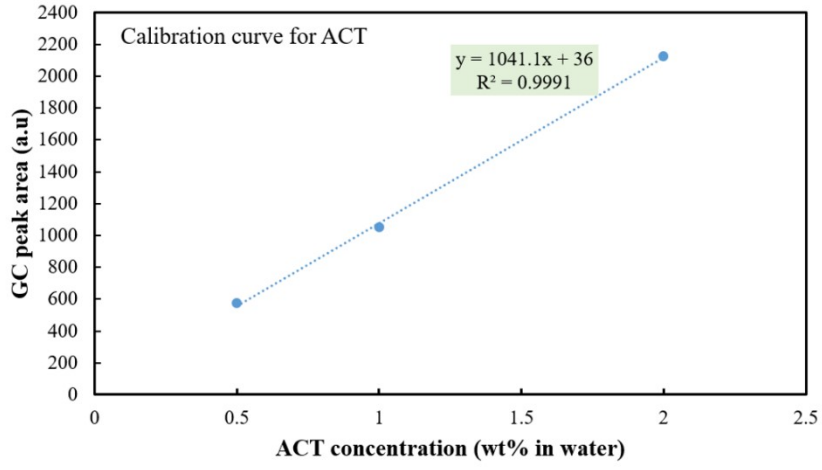


Figure S2: GC-FID calibration curve for glycolaldehyde (GA), pyruvaldehyde (PVA), and acetol (ACT) at liner temperature of 180 °C.

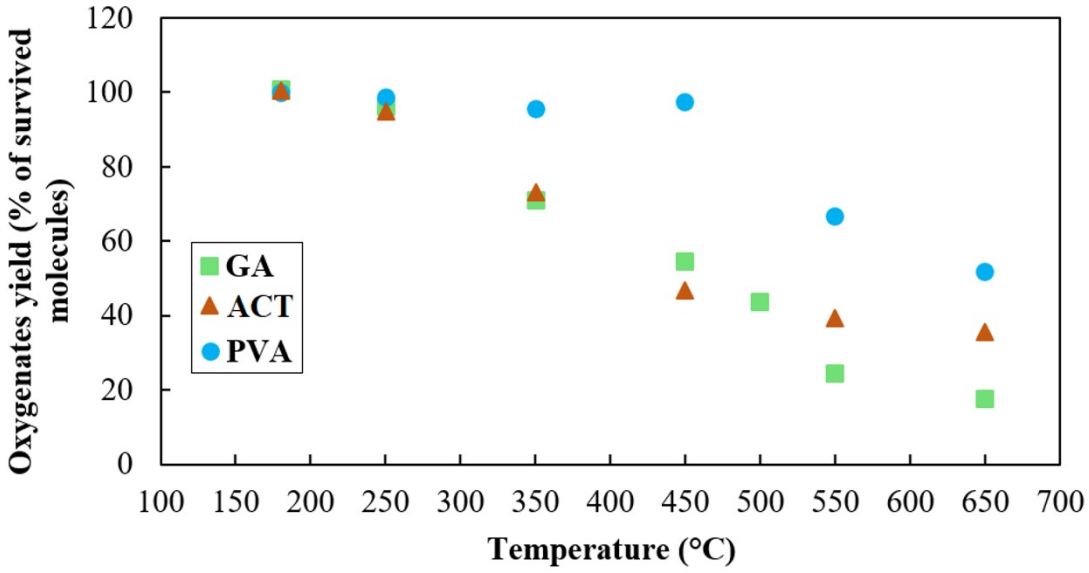


Figure S3: Oxygenates yields for experiments injecting 4% GA, 4% PVA, and 2% ACT at different temperatures (decomposition correction factor at different temperatures).

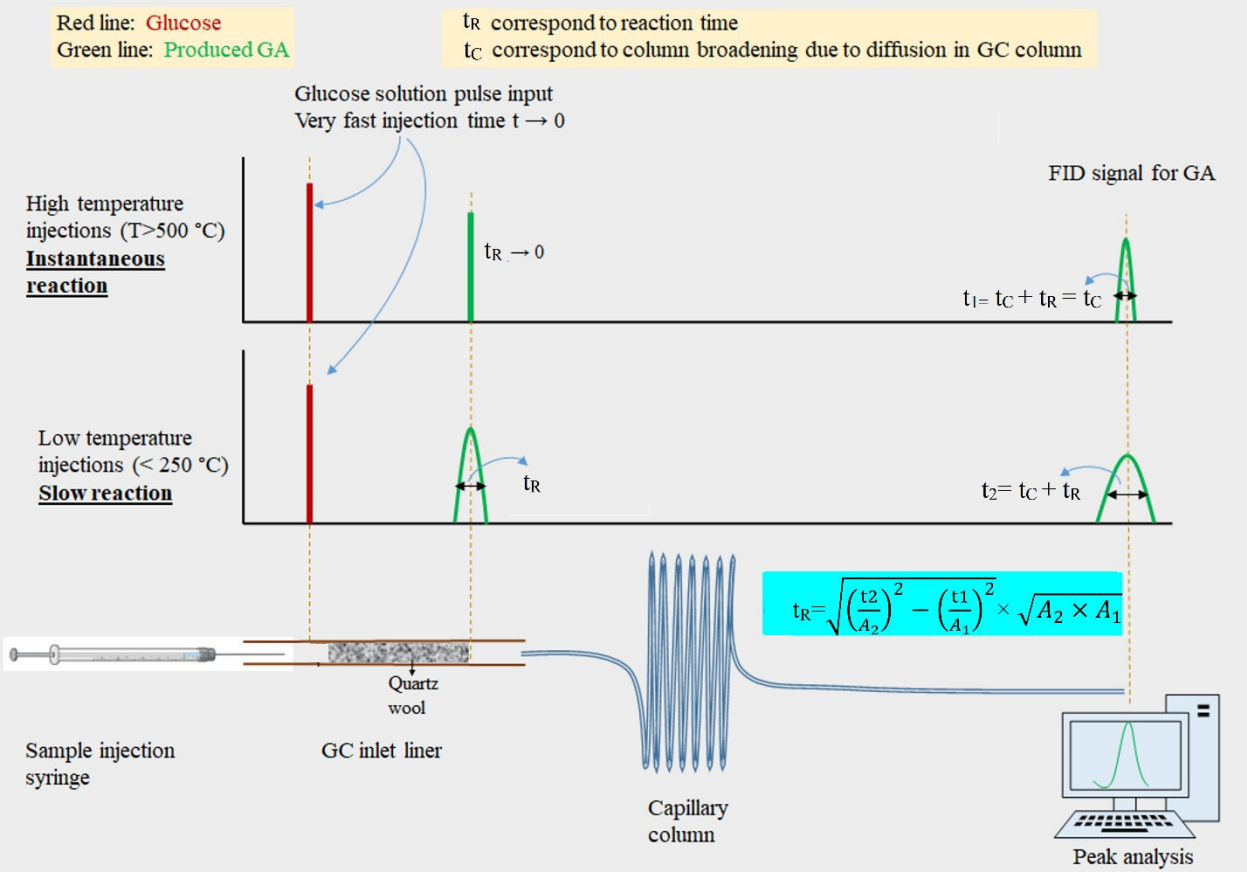


Figure S4: Analysis of GC peak width and reaction time.

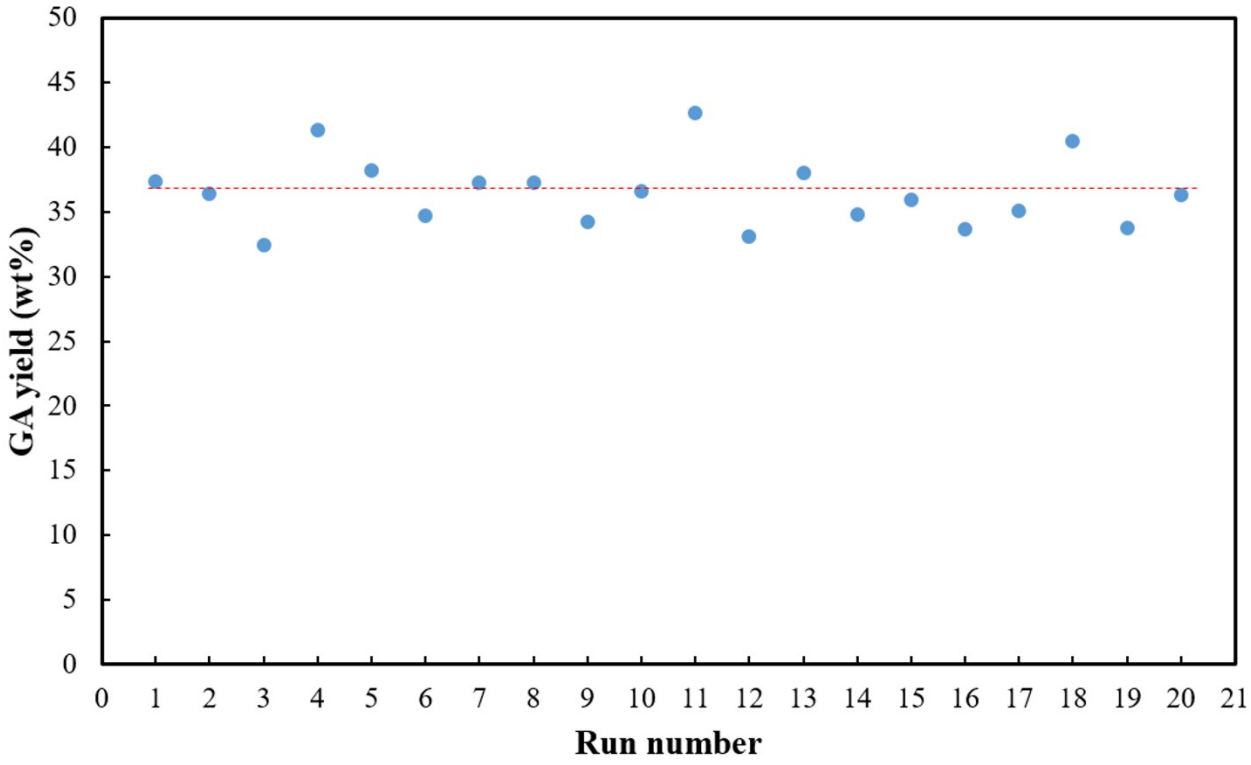


Figure S5: Corrected yield of GA from consecutive pulse pyrolysis of 20 wt.% aqueous glucose (T=350 °C, 20 mg quartz wool as bed material).

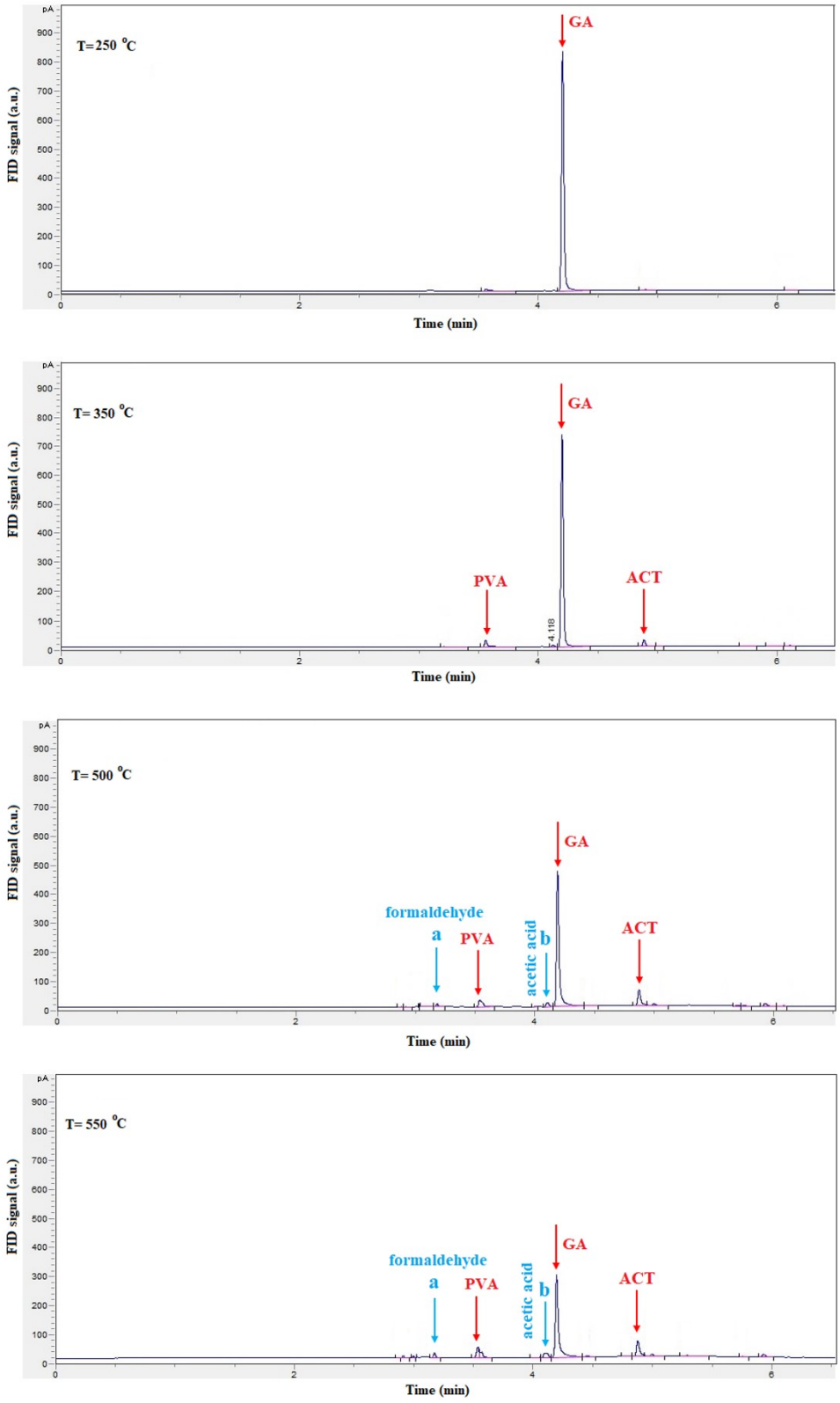


Figure S6: Detected peaks after GA injection at different liner temperatures; 20 mg quartz wool as bed material.

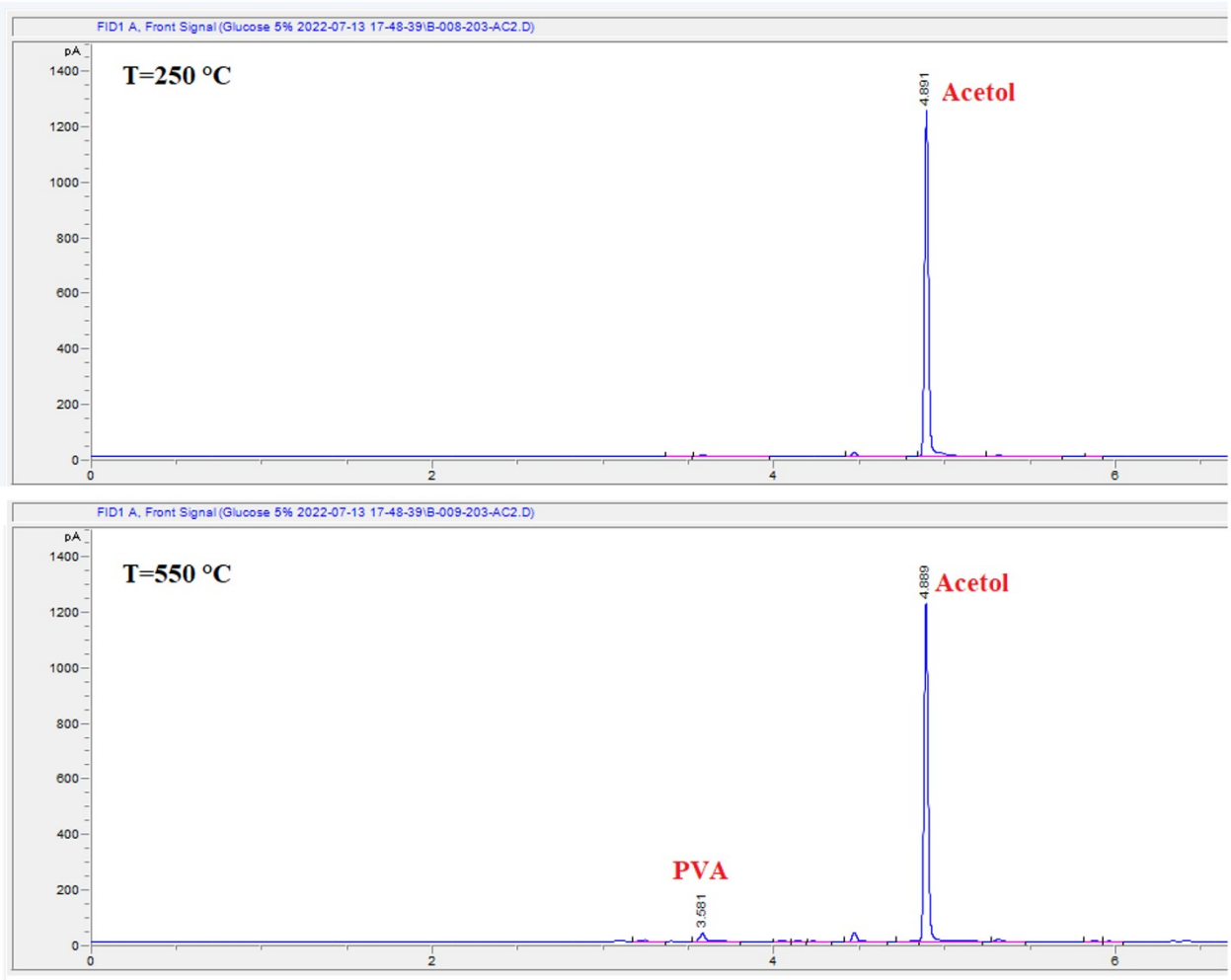


Figure S7: Detected peaks after acetol injection at different liner temperatures; 20 mg quartz wool as bed material.

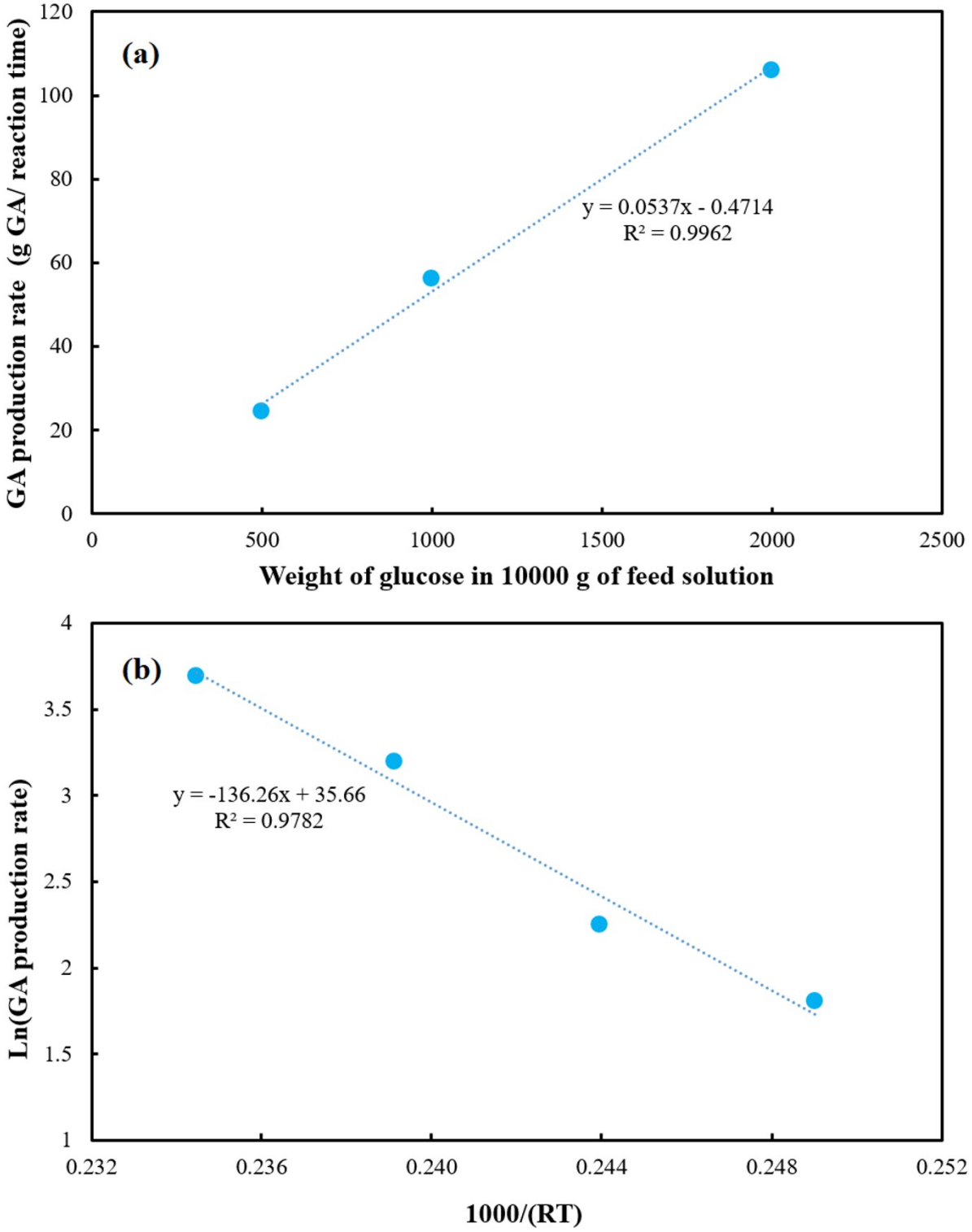


Figure S8: (a) GA production rate at 230 °C from different weights of glucose; (b) Temperature dependence of GA production rate at 210–240 °C from using 5 wt.% aqueous glucose solution.

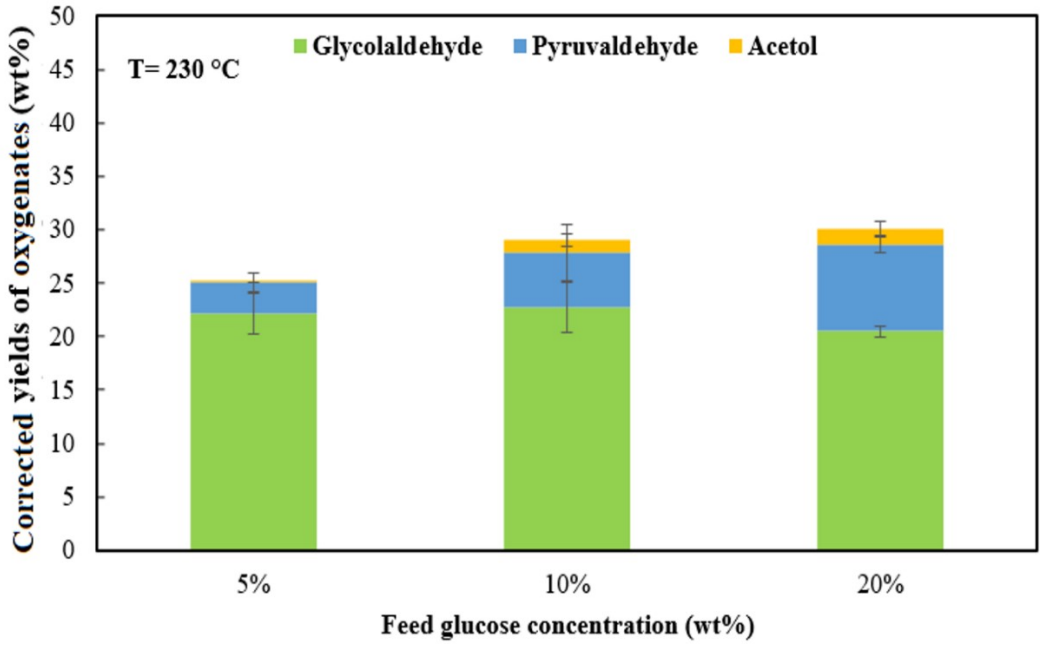


Figure S9: Corrected oxygenates yields at low temperature (230 °C) with different glucose concentration; 20 mg quartz wool as bed material.

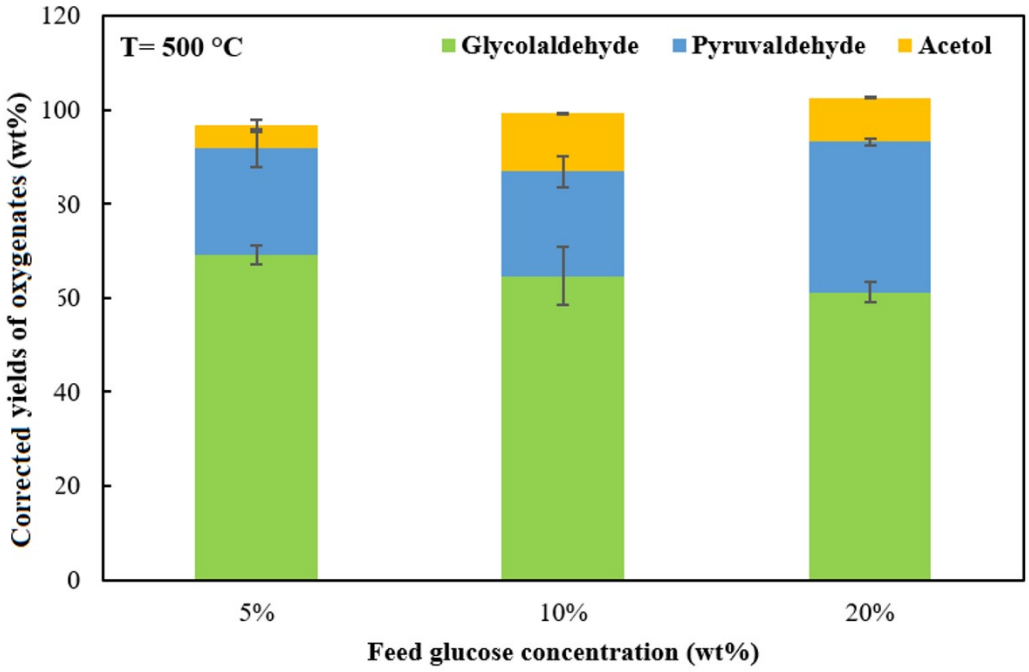


Figure S10: Corrected oxygenates yields at 500 °C with different glucose concentrations; 20 mg quartz wool as bed material.

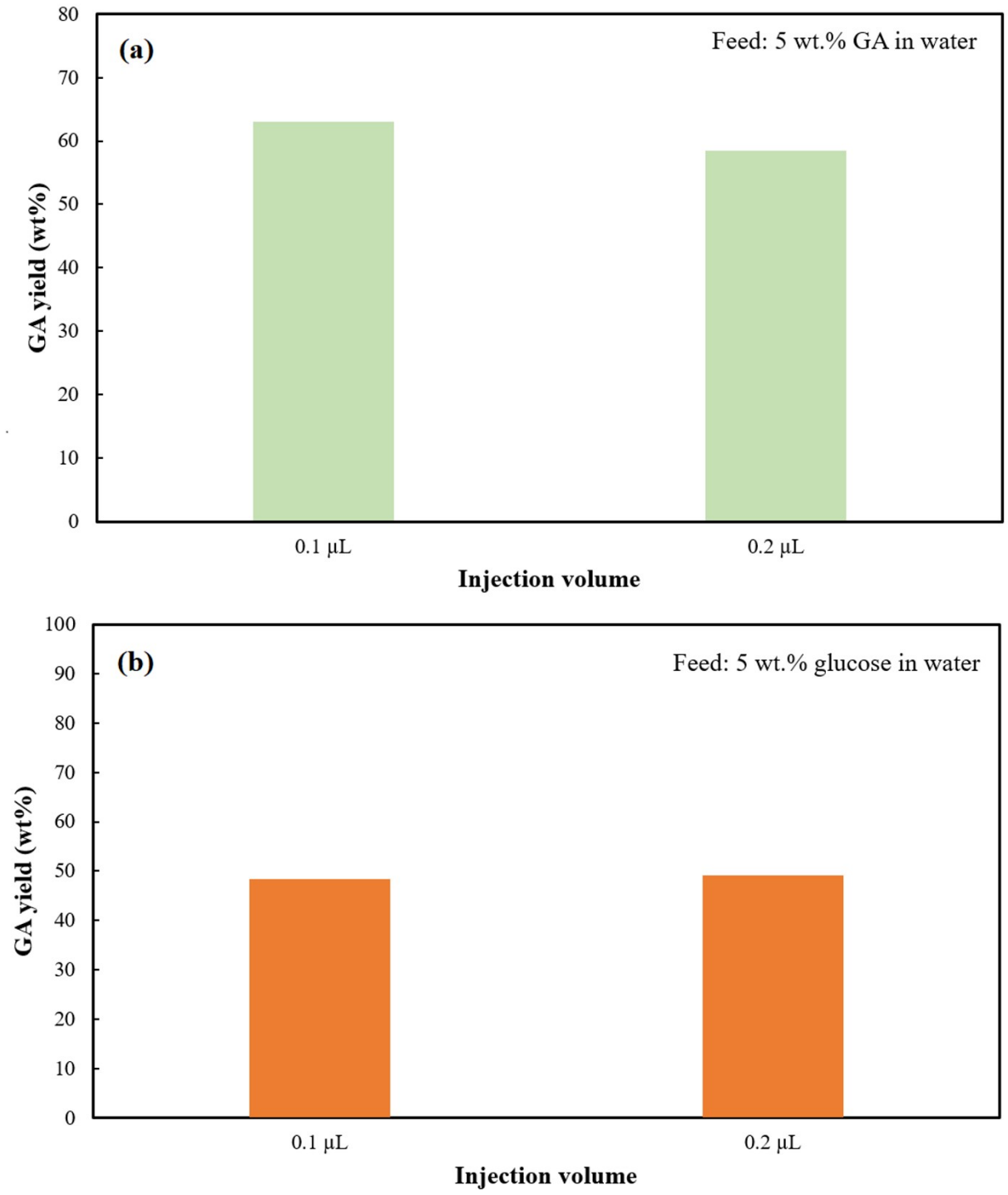


Figure S11: Yield of unconverted GA from 5 wt% GA aqueous solution (a) and corrected GA yields from 5 wt% glucose aqueous solution (b) at 400 °C and two different injection volumes.

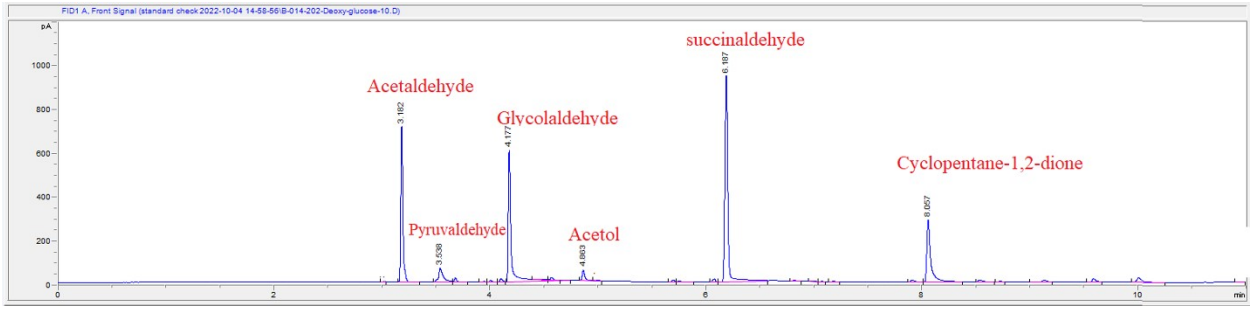


Figure S12: Detected GC-FID peaks after 2-deoxy-d-glucose injection into the inlet liner at 400 °C.

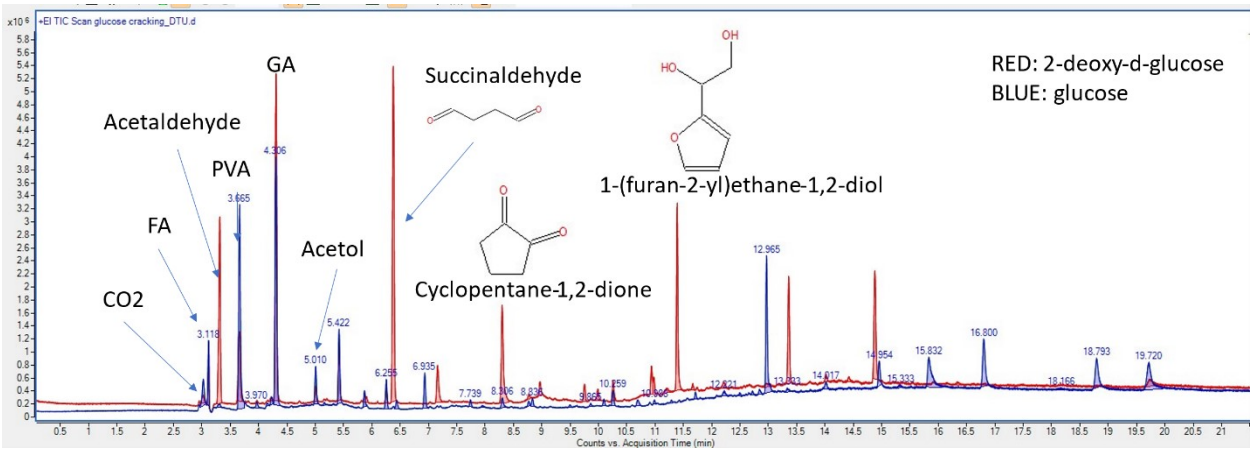


Figure S13: GC-MS spectra for glucose (blue) and 2-deoxy-d-glucose (red) hydrous cracking at 400 °C. Molecules represent hits from NIST database.

Table S1: Corrected yields of GA, acetaldehyde, PVA, and ACT from hydrous cracking of 10 wt% of glucose and 2-deoxy-d-glucose in water at different temperatures.

	Oxygenates yields (wt%) from glucose				Oxygenates yields (wt%) from 2-deoxy-d-glucose			
Temperature (°C)	**GA**	**acetaldehyde**	**PVA**	**ACT**	**GA**	**acetaldehyde**	**PVA**	**ACT**
300	24.05	0	10.43	0.18	55.28	15.72	5.98	0.068
350	32.62	0	13.68	0.14	65.15	13.14	5.56	0.19
400	41.92	0	15.34	0.42	62.62	13.20	6.36	0.80
450	41.22	0	18.94	1.83	26.75	25.22	5.79	1.94
500	60.98	0	22.27	2.39	25.50	26.05	6.96	2.40
550	59.47	0	17.96	4.51	30.62	21.94	10.33	2.95

A1: Estimated temperature drop at the moment of 0.2 µL (0.0002 g) water injection:

Required energy for heating water from 25 to 500°C:

A: From 25 to 100°C = 0.0002 g · 4.184 J/(g·K) · 75 K = 0.06276 J

B: heat of vaporization = 0.0002 g · 2260 J/g = 0.452 J

C: from 100 to 500°C = 0.0002 g · 1.9 J/(g·K) · 400 K = 0.152 J

Required energy for heating water from 25 to 500°C = A + B + C = 0.6667 J

Approximate temperature drop of quartz wool:

Quartz wool weight = 20 mg = 0.002 g

Heat capacity of quartz wool ~ 741 J/(g·K)

0.002 g · 741 J/(g·K) · (ΔT) = 0.6667 J

ΔT = 0.45 K

Therefore, the temperature drop is less than 1°C at the moment of liquid injection. In the calculation, it was assumed that all of the quartz wool contributes to the evaporation. Even if only 10% of the quartz wool are wetted, the temperature drop will still be less than 10 °C.