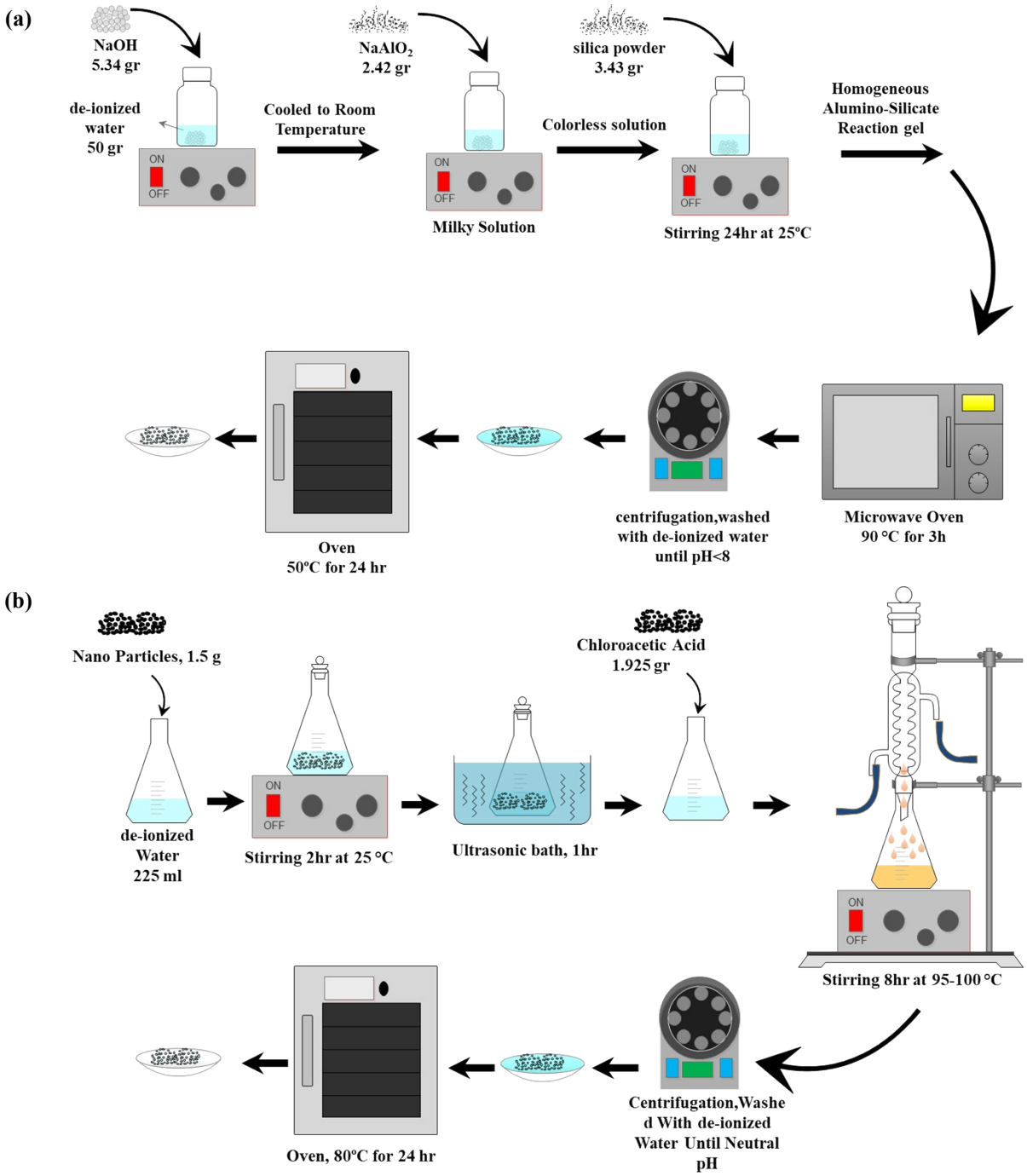
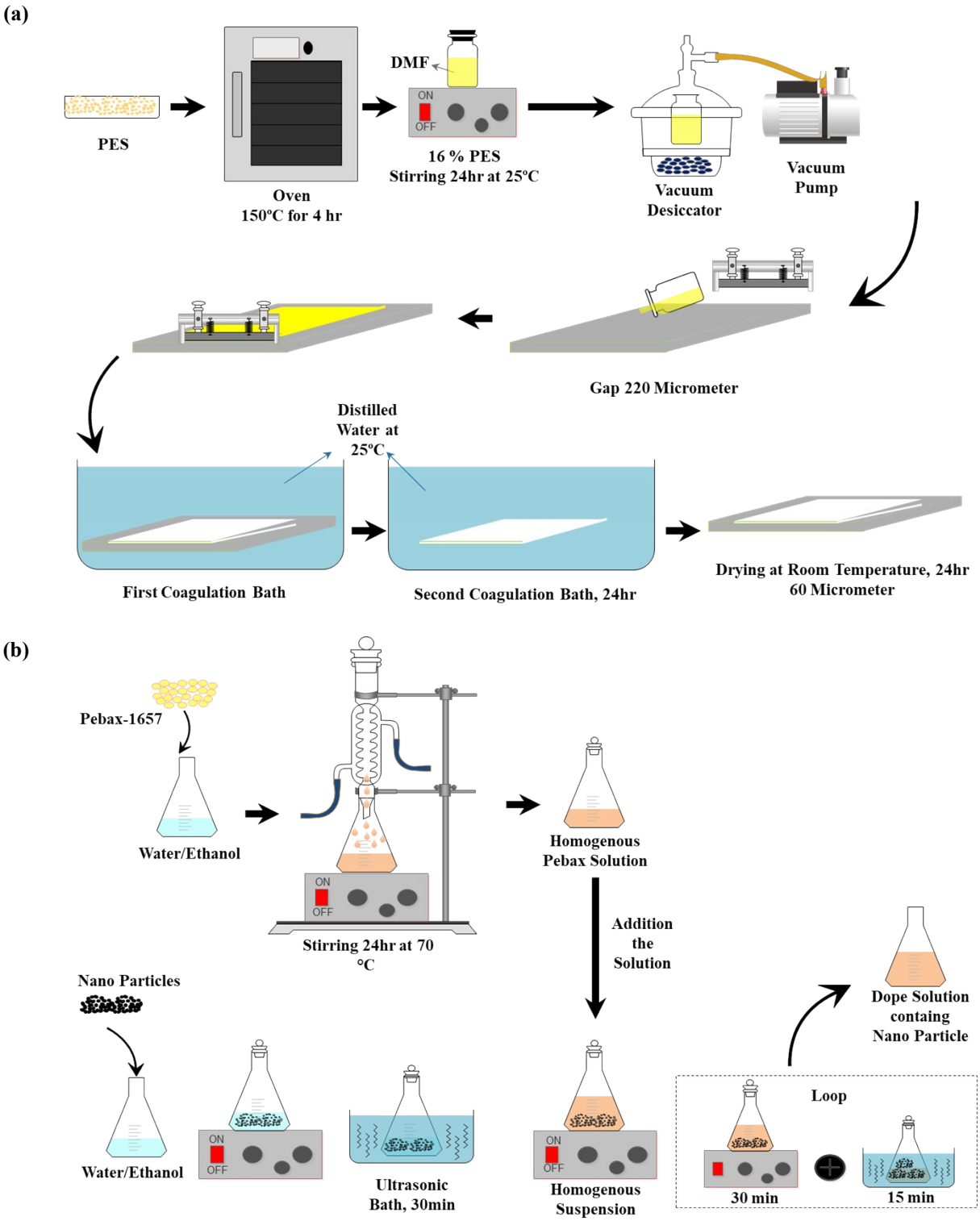


Fig. S1: The schematic of steps in the synthesis (a) and functionalization (b) of NaX nano-zeolite.


(a)
PES
Oven
150°C for 4 hr
DMF
ON
OFF
16 % PES
Stirring 24hr at 25°C
Vacuum
Desiccator
Vacuum
Pump
Gap 220 Micrometer
Distilled
Water at
25°C
First Coagulation Bath
Second Coagulation Bath, 24hr
Drying at Room Temperature, 24hr
60 Micrometer
(b)
Pebax-1657
Water/Ethanol
Stirring 24hr at 70
°C
Homogenous
Pebax Solution
Addition
the
Solution
Nano Particles
Water/Ethanol
Ultrasonic
Bath, 30min
Homogenous
Suspension
Loop
30 min
15 min
Dope Solution
containg
Nano Particle

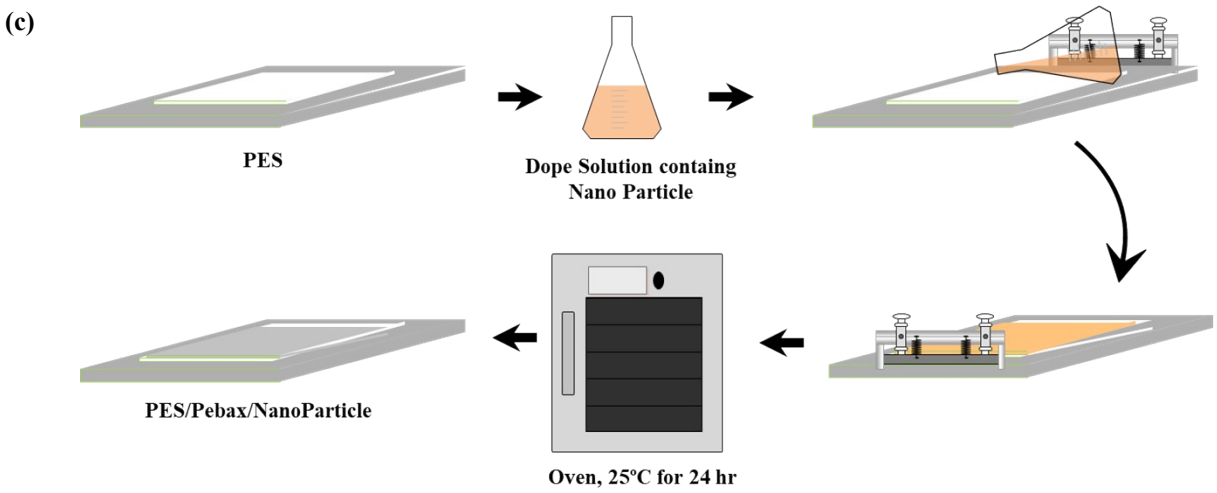


Fig. S2: The schematic of the preparation process of PES support layer (a), casting dope solution (b) and MSL-MMMs (c).

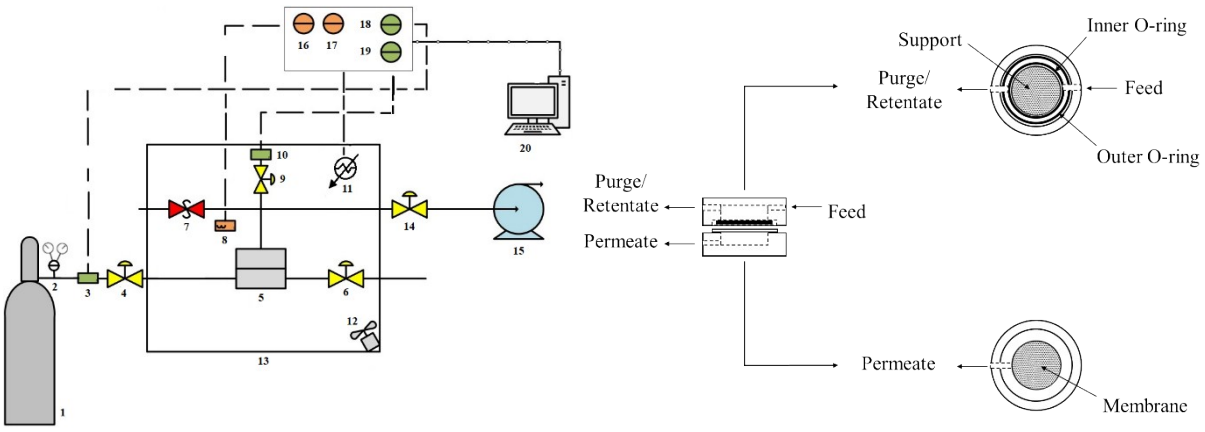


Fig. S3: The experimental set-up and membrane module scheme used for single gas permeation process (1. Gas cylinder, 2. Feed pressure regulator, 3. Feed pressure transmitter (accuracy ± 0.1 bar), 4. Control valve, 5. Membrane module, 6. Control valve (purge flow pressure), 7. Safety valve, 8. Thermometer, 9. Control valve (pressure sensor), 10. Permeate pressure transmitter (accuracy ± 0.01 mbar), 11. Heater, 12. Fan, 13. Constant temperature chamber, 14. Control valve, 15. Vacuum pump, 16. Temperature indicator, 17. Heater controller, 18. Feed pressure indicator, 19. Permeate pressure indicator and 20. Data recording computer).

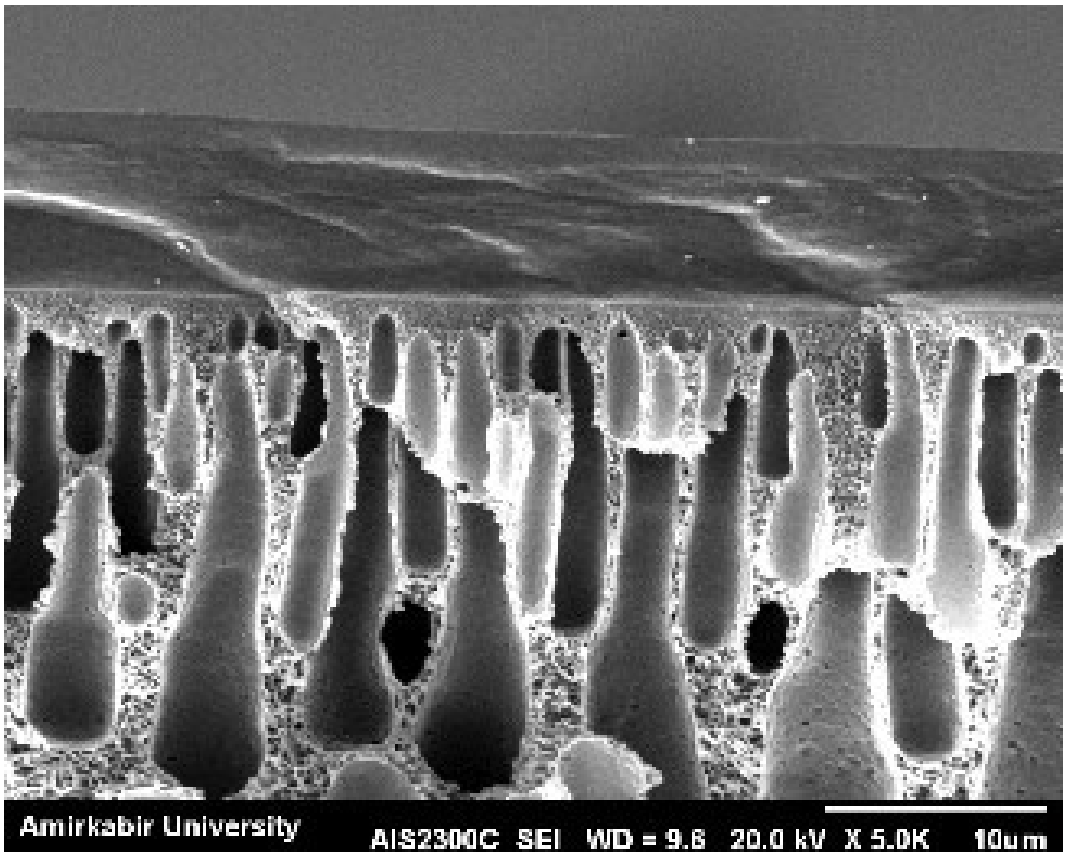


Fig. S4: The SEM cross sectional images of the of PP.

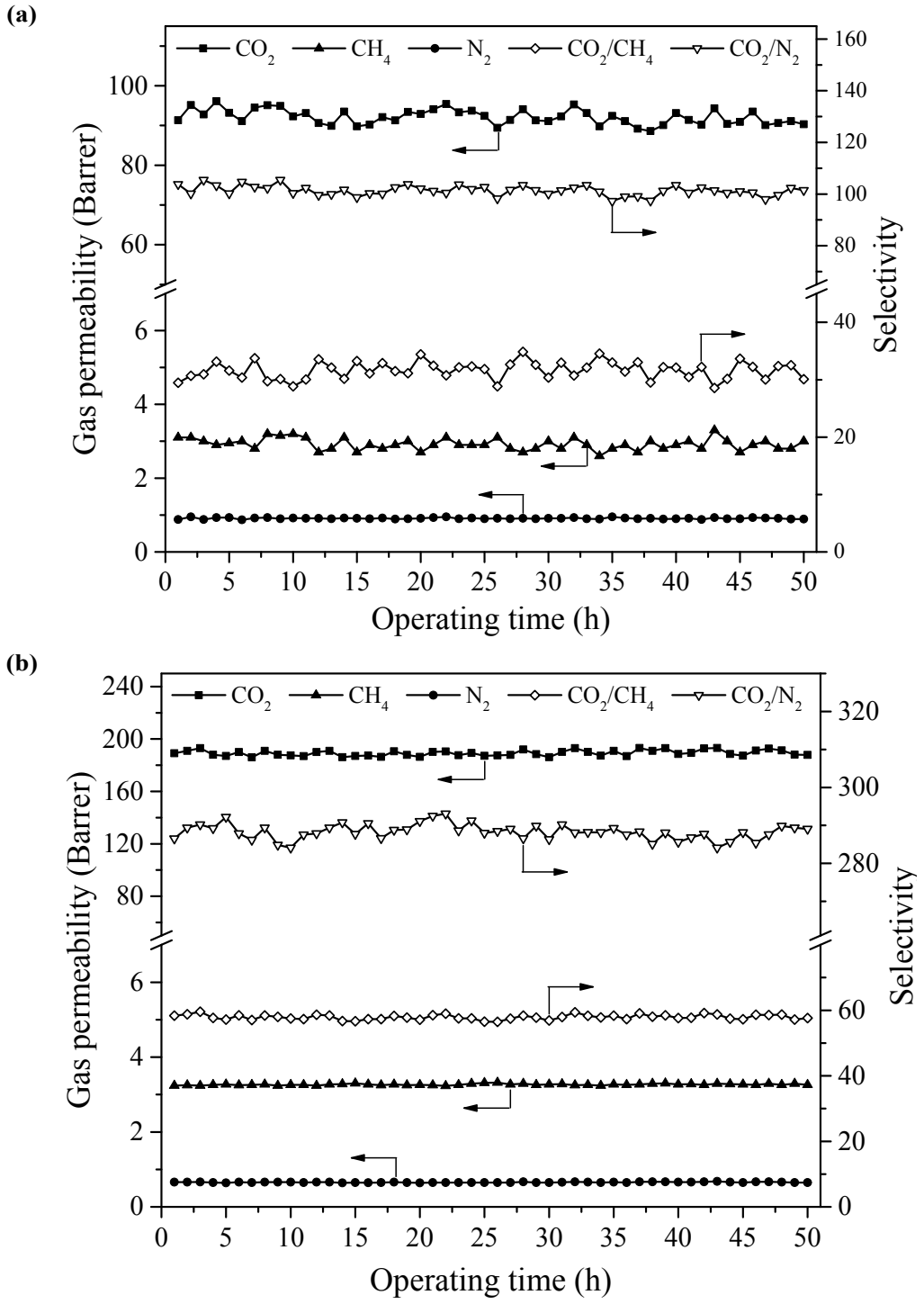


Fig. S5: The long-term operation stability for the PPN1.5 (a) and PPNC1.5 (b) at 6 bar and 25 °C.