Supplementary Material

Table 1. Parameter values used in this paper.

Parameter		Formula
ΔG^{EL}	Electrostatic interaction	Eqs. 1
ΔG^{LW}	Van der Waals interaction	Eqs. 2
ΔG^{AB}	Acid-base interaction	Eqs. 3
h	The actual separation distance between the two interacting planes	Eqs. 1
h_0	The minimum separation distance	Eqs. 2
κ	Reciprocal of Debye length	Eqs. 1
ζ_m	The surface potentials of membranes	Eqs. 1
ζ_f	The surface potentials of foulants	Eqs. 1
$\varepsilon_r \varepsilon_0$	Solution permittivity	Eqs. 1
λ	The acid-base interaction decay length	Eqs. 3
γ^{LW}	Surface tension of LW	Eqs. 5
γ^{+}	Electron acceptor surface tension	Eqs. 6
γ^{-}	Electron donor surface tension	Eqs. 6
L	The length of sample	Eqs. 11
G	fractal roughness	Eqs. 11
D_f,	fractal dimension	Eqs. 11
η	frequency density of a surface	Eqs. 11
M	superposed ridges number	Eqs. 11
m	The number of vertical iterations	Eqs. 11
n	The number of horizontal iterations	Eqs. 11
n_{max}	highest frequency	Eqs. 11
$\phi_{m,n}$	random phase	Eqs. 11
σ	the root mean square roughness	Eqs. 12
l	the length in *x* and *y* axis directions	Eqs. 12
N (0,1)	the random number obeying standard Gaussian distribution	Eqs. 12

$n \bullet \overline{P_1 P}$	the vector between points P_1 and P	Eqs. 13
$n(P_1, P_2, P_3)$	the normal vector perpendicular to the triangle face	Eqs. 13
θ and φ	the angle coordinates in a spherical coordinate system	Eqs. 14
λ	the scaled amplitude of the ripples along the angle coordinates	Eqs. 14
n	the scaled frequency of the ripples along the angle coordinates	Eqs. 14
R	the radius of coarse particles	Eqs. 15
r	the radius of smooth particles	Eqs. 15
(m, n, z)	Cartesian coordinates	Eqs. 16
$\Delta G(h)$	By summation of differential individual interaction per unit area at different vertical distances *(h)*	Eqs. 19
$U(h)$	individual interaction among the foulant and the membrane surface	Eqs. 19
d_A	the projected area of the differential arc on the sphere	Eqs. 19
r	the radius of the ring	Eqs. 20
d_r	the radius of the differential ring	Eqs. 20
d_θ	the differential angle of the differential circular arc	Eqs. 20
U^{EL}_{fwm}	Electrostatic interaction among the foulant and the membrane surface	Eqs. 21
U^{LW}_{fwm}	Van der Waals interaction among the foulant and the membrane surface	Eqs. 22
U^{AB}_{fwm}	Acid-base interaction among the foulant and the membrane surface	Eqs. 23
ΔS_m	the combined entropy of the gel layer	Eqs. 24
R	the universal gas constant	Eqs. 24
n	the molar constant of the substance	Eqs. 24
φ	the volume fraction of the substance	Eqs. 24
ΔH_{m}	Enthalpy change of the gel layer	Eqs. 25
T	the absolute temperature	Eqs. 25
χ	the interaction parameter of Flory-Huggins	Eqs. 25
z	the number of coordination	Eqs. 26
$\Delta \mathcal{E}_{12}$	the binding energy of different segments of the polymer chain between adjacent lattice sites	Eqs. 26
$\Delta \mu_m$	the change value of the chemical potential during the mixing process	Eqs. 28
N	the degree of the material polymerization	Eqs. 28

V_B	the solvent's molar volume	Eqs. 29
$\Delta\mu$	The chemical potential difference existing in the gel layer filtration process	Eqs. 32
$\Delta\mu_{mix}$	the mixed chemical potential change	Eqs. 32
$\Delta\mu_{ela}$	the elastic chemical potential change	Eqs. 32
$\Delta\mu_{ion}$	the ion chemical potential change	Eqs. 32
ΔG_{ela}	Elastic potential energy of the deformation of the gel network	Eqs. 33
v_e	the number of moles per unit volume of the elastic network chain of the dry polymer	Eqs. 33
A	The constants associated with v_e and swelling	Eqs. 33
B	The constants associated with v_e and swelling	Eqs. 33
λ	the rate of deformation	Eqs. 33
ϕ_0	the polymer volume fraction in the initial state	Eqs. 34
ϕ	the polymer volume fraction in the swelling network	Eqs. 34
Z	Constants has a relationship of $Z=\Delta G_{ela}/RT$	Eqs. 35
Z_φ	Constants has a relationship of $Z_\varphi=\partial_Z/\partial_\varphi$	Eqs. 35
N	per mole of lattice site	Eqs. 35
m_c	the average number of lattices occupied by the polymer segment	Eqs. 36
f	the cross-linking function parameter	Eqs. 37
SFR_{mix}	The filtration resistance contributed by the change in the mixing chemical potential	Eqs. 39
SFR_{ela}	The filtration resistance contributed by the change in the elastic chemical potential:	Eqs. 40
ΔG	the total free energy of the gel layer filtration process	Eqs. 41
ΔG_{mix}	the mixing free energy	Eqs. 41
ΔG_H	hydrogen bonds free energy	Eqs. 41
K_A	the constants describing the correlation equilibrium	Eqs. 44
K_B	the constants describing the self-association equilibrium	Eqs. 42
φ_{A_1}	the volume fractions of non-hydrogen-bonded solvent	Eqs. 42
φ_{B_1}	the volume fractions of non-hydrogen-bonded polymer segments	Eqs. 42

$\varphi_{B_1}^0$	the volume fraction of polymer segments	Eqs. 42
r	the molar volume ratio V_A/V_B of A to B	Eqs. 42
SFR_H	the SFR of gel caused by the hydrogen bond free energy change	Eqs. 48