Supporting Information for Publication Prediction and characterization of flooding in pulsed sieve plate extraction columns using data-driven models

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Table S1: List of dimensionless numbers used for the physically motivated feature engineering

Dimensionless number	Abbreviation	Definition
Reynolds number	Re_{d}	$\frac{d_{32}\rho_{\mathrm{d}}v_{0,\mathrm{char}}}{\eta_{\mathrm{c}}}$
	$Re_{\mathrm{d/c}}$	$\frac{\rho_{\mathrm{d}}v_{0,\mathrm{char}}d_{32}\mu_{\mathrm{c}}}{\rho_{\mathrm{c}}v_{\mathrm{c}}D\mu_{\mathrm{d}}}$
Weber number	We_{d}	$\frac{\rho_{\mathrm{d}}v_{v_{0,\mathrm{char}}}^{2}d_{32}}{\sigma}$
Froude number	Fr_{d}	$\frac{v_{0,\mathrm{char}}^{2}}{gd_{32}}$
	$Fr_{\mathrm{d/c}}$	$\frac{v_{0,\mathrm{char}}^{2}D}{v_{\mathrm{c}}^{2}d_{32}}$
Ohnsorg number	Oh_{d}	$\frac{\eta_{\mathrm{d}}}{\sqrt{d_{32}\rho_{\mathrm{d}}\sigma}}$
Morton number	Mo	$\frac{g\eta^{4}\Delta\rho}{\rho_{\mathrm{c}}^{2}\sigma^{3}}$
Eötvös number	Eo_{d}	$\frac{\Delta\rho g d_{32}}{\sigma}$
Capillary number	Ca_{d}	$\frac{\eta_{\mathrm{d}}v_{0,\mathrm{char}}^{2}}{\sigma}$
Atwood number	At	$\frac{\Delta\rho}{\rho_{\mathrm{c}}+\rho_{\mathrm{d}}}$
Galilei number	Ga_{c}	$\frac{gd_{32}^{3}}{\upsilon_{\mathrm{c}}^{2}}$
Galilei number	Ga_{d}	$\frac{gd_{32}^{3}}{\upsilon_{\mathrm{d}}^{2}}$
Density ratio	-	$\frac{\rho_{\mathrm{c}}}{\rho_{\mathrm{d}}}$
	-	$\frac{\Delta\rho}{\rho_{\mathrm{c}}}$
Viscosity ratio	-	$\frac{\eta_{\mathrm{d}}}{\eta_{\mathrm{c}}}$
Density ratio	-	$\frac{\rho_{\mathrm{d}}}{\rho_{\mathrm{c}}}$
Relative density ratio	-	$\frac{\Delta\rho}{\rho_{\mathrm{c}}}$
Geometric ratio	-	$\frac{d}{D}$
Hub ratio	-	$\frac{A}{S}$

Table S2: General information of the flooding database for pulsed sieve plate extraction column

Author	**Correlation**
Miller[1]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} = 2\cdot f\cdot A$
Thornton[2]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} =$
	$0.6\cdot\sigma^{-0.17}\cdot\eta_\mathrm{c}^{-0.26}\cdot K^{-0.24}\cdot f^{-0.72}\cdot A^{0.72}\cdot S^{0.24}\cdot\rho_\mathrm{c}^{-0.66}\cdot d^{0.9}$
	$\cdot(\Delta\rho)^{0.79}\cdot g^{1.01}\cdot\eta_\mathrm{d}^{0.3}\cdot((1-2\phi_\mathrm{f})\cdot(1-\phi_\mathrm{f})^2+\phi_\mathrm{f}^2\cdot(1-\phi_\mathrm{f}))$
	$K = \frac{\pi^2}{2\cdot C_0^2}\cdot\frac{1-\epsilon^2}{\epsilon^2}$
	$\phi_\mathrm{f} = \frac{\sqrt{PV^2+8PV}-3PV}{4(1-PV)}$
Smoot[3]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} =$
	$0.527\cdot(\Delta\rho)^{0.63}\cdot\rho_\mathrm{c}^{-0.775}\cdot\eta_\mathrm{c}^{0.489}\cdot\eta_\mathrm{d}^{-0.2}\cdot g^{0.81}\cdot PV^{0.014}\cdot S^{0.207}\cdot d^{0.458}\cdot K^{-0.207}\cdot(Af)^{-0.621}$
Kagan[4]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} = 2.5\cdot10^{-2}\cdot g\cdot D\cdot PV^{1.1}\cdot(f^2\cdot\frac{D}{g})^{1.1}\cdot\sqrt{\frac{S}{D}}\cdot(1+\frac{1}{PV})$ (ascending)
	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} = 3\cdot10^{-9}\cdot g\cdot D\cdot PV^{1.1}\cdot(\frac{A}{D})^{-1.75}\cdot(f^2\cdot\frac{D}{g})^{-1.3}\cdot\sqrt{\frac{S}{D}}\cdot(1+\frac{1}{PV})$ (descending)
McAllister[5]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} =$
	$(\Delta_\mathrm{c}+\Delta_\mathrm{d})$
	$\cdot\exp[-3.741+0.2568\ln X-0.07194(\ln X)^2+0.006191(\ln X)^3$
	$-1.034\ln Y-0.09096(\ln Y)^2-0.0008898(\ln Y)^3$
	$+0.1424\ln\frac{1}{PV}-0.1807\ln\frac{A}{S}$
	$+0.07198\cdot\frac{\ln X}{\ln Y}]$
	$X = \frac{\Delta\rho\ d\ \epsilon^2\ g}{\rho_\mathrm{c}\ \pi_M^2}$
	$Y = \frac{\eta_\mathrm{c}\ \pi_V}{\epsilon\ \sigma}$
	$\pi_M^2 = \frac{1}{2}(\pi_\mathrm{c}^2+\pi_\mathrm{d}^2)$
	$\pi_V = \frac{1}{2}(\pi_\mathrm{c}+\pi_\mathrm{d})$
	$\pi_\mathrm{c} = \pi\cdot A\cdot f\cdot\frac{\sqrt{1-\lambda^2}}{\pi/2-\arcsin(\lambda)}-\lambda$
	$\pi_\mathrm{d} = \pi\cdot A\cdot f\cdot\frac{\sqrt{1-\lambda^2}}{\pi/2+\arcsin(\lambda)}+\lambda$
	$(\Delta_\mathrm{c}+\Delta_\mathrm{d}) = 2\cdot A\cdot f(\sqrt{1-\lambda^2}+\lambda\cdot\arcsin(\lambda))$
	$\lambda = \frac{V_\mathrm{c}-V_\mathrm{d}}{\pi\ A\ f}$
Berger[6]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f,m} =$
	$(6.81\cdot10^{-3}+0.7047\sigma-15.222\sigma^2)\cdot(1-4.55\epsilon+3.247\epsilon^2)+0.1778\cdot\ln\frac{1}{PV}+0.0437\cdot\ln\frac{1}{PV}^2)$
Tribess[7]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f,m} =$
	$(6.81\cdot10^{-3}+0.7047\sigma-15.222\sigma^2)\cdot(1-4.55\epsilon+3.247\epsilon^2)+0.1778\cdot\ln\frac{1}{PV}+0.0437\cdot\ln\frac{1}{PV}^2)$
	$\cdot(0.2115\cdot D^{0.2}\cdot S^{0.18})$
Amani[8]	$(V_\mathrm{c}+V_\mathrm{d})_\mathrm{f} =$
	$(2.086\cdot10^{-8}\cdot\frac{\sigma}{\eta_\mathrm{c}}\cdot\frac{A\ f}{1-PV/(1+PV)}^{-0.109}\cdot\frac{A\ f}{PV/(1+PV)}^{-0.095}\cdot\frac{\Delta\rho}{\rho_\mathrm{c}}^{-6.586}\cdot\frac{\eta_\mathrm{d}}{\eta_\mathrm{c}}^{2.582}\cdot\frac{\sigma}{A\ f\ \eta_\mathrm{c}}^{0.404})^{1.256}$

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