

Supplementary material for:

Jams and cakes: a closer look on well clogging mechanisms in microscale PWRI experiments

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Material and methods

All salts used in brine solution are purchased from Sigma-Aldrich.

The synthetic produced water is formulated with 200 ppm of crude oil from a field in Africa and 100 ppm of quartz particles BCR066 from Sigma-Aldrich ($\langle d_{50} \rangle = 1.8 \mu\text{m}$) dispersed in the brine solution.

The synthetic porous media are fabricated from a quartz square capillary in which borosilicate beads are lightly sintered to obtain a 3D consolidated porous medium. The quartz capillaries are from CM Scientific, have a square geometry with an internal section of 2 mm x 2 mm, a length of 30 mm (in the double wall setup we used longer capillaries, about 60mm, to account for the additional injection system, however the length of the porous medium remained the same) and a wall thickness of 0.75 mm. The borosilicate glass beads are from Mo-Sci (38-45 μm).

The setup is monitored by the commercial ESI software supplied with all the devices from Elveflow. The material setup references are listed here:

- A double wall reactor from Optimus Instrument (autoclave 0,75 type 1B 0.5Lt)
- A pressure controller OB1 from Elveflow coupled with a BFS Coriolis flow sensor from Bronkhorst
- Two microfluidic pressure sensors MPS from Elveflow
- A set of lights and a camera GO-5100-PGE from Jai
- A dry microscope objective 4X Olympus Plan Achromat Objective purchased from Thorlabs
- A white light with a condenser lens "LED Warm White" from Thorlabs
- A diffusing light ring LDR-176SW2-LA-1 from CCS Inc.
- A heating bath Julabo F12
- A rheometer Anton Paar (cylindrical Couette cell)

Movie 2M. Typical video of damage formation during produced water reinjection.

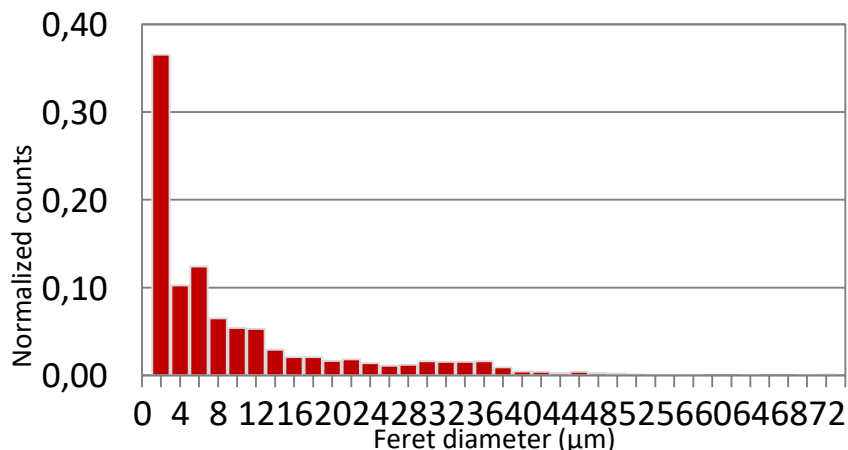


Fig 1S. Diagram of diameter distribution of oil droplet contained in the synthetic produced water. The mean diameter is approximately 10.7 μm .

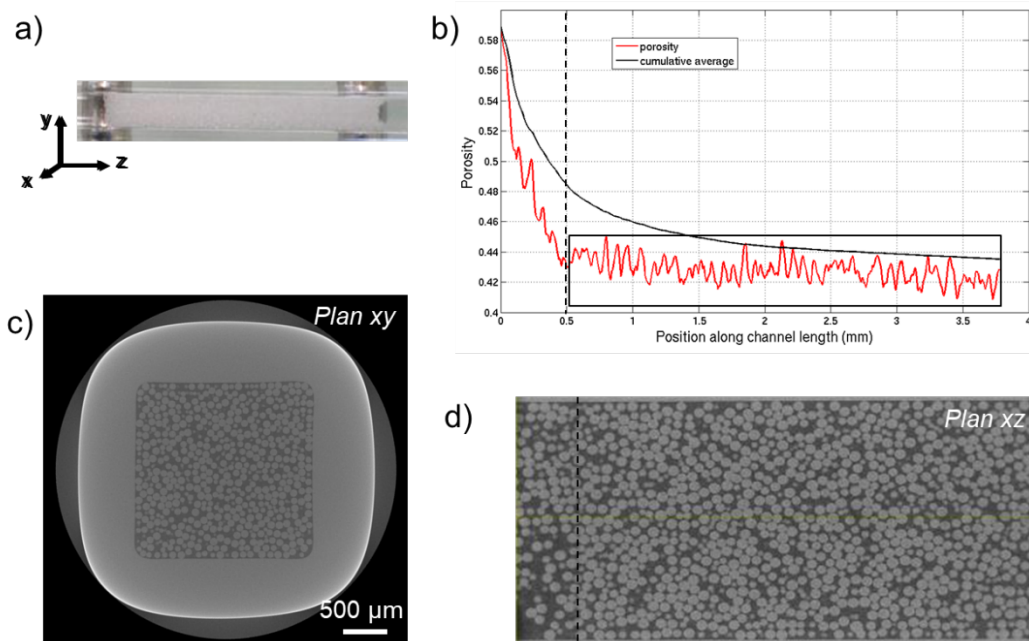


Fig 2S a) Picture of a porous medium obtained after sintering 38-45 μ m borosilicate beads in a square quartz capillary; **b)** Porosity curve obtained along the Z axis on the first 4 millimeters of the porous media; Microtomography images of **c)** the XY plan and **d)** the Z axis of the porous media

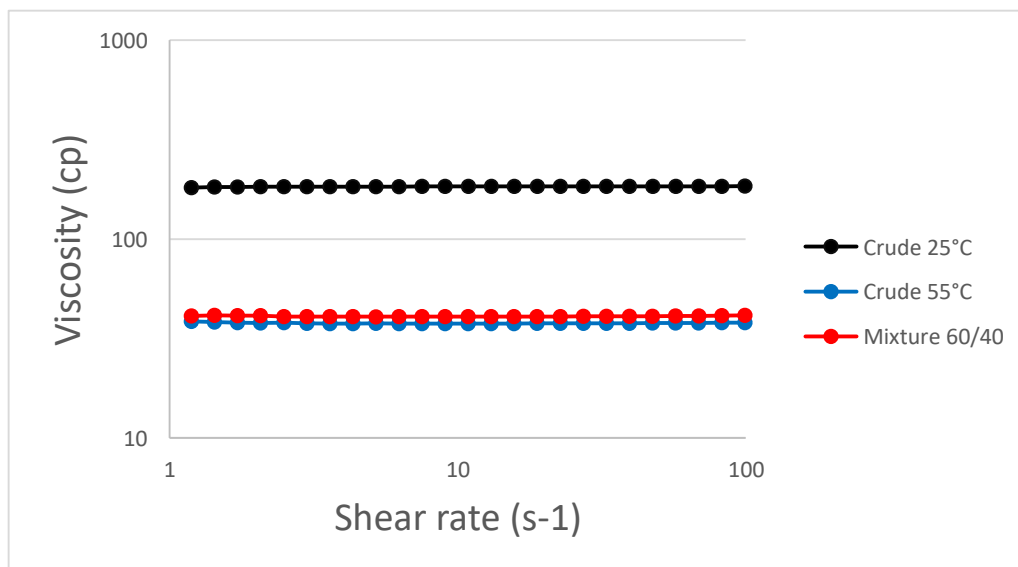


Fig 3S. Viscosity measurements on the crude diluted with Finavestan oil compared to the viscosity of the crude oil at different temperatures.

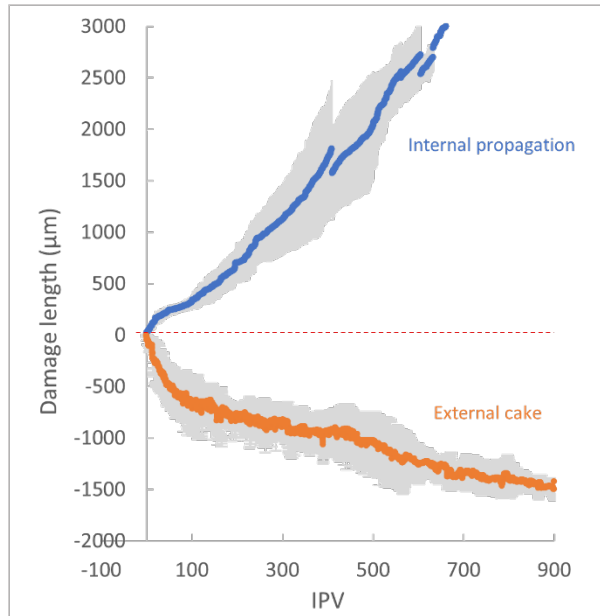


Fig 4S. Damage length mean curve of the 5 representatives experiments, with standard deviation at each IPV.

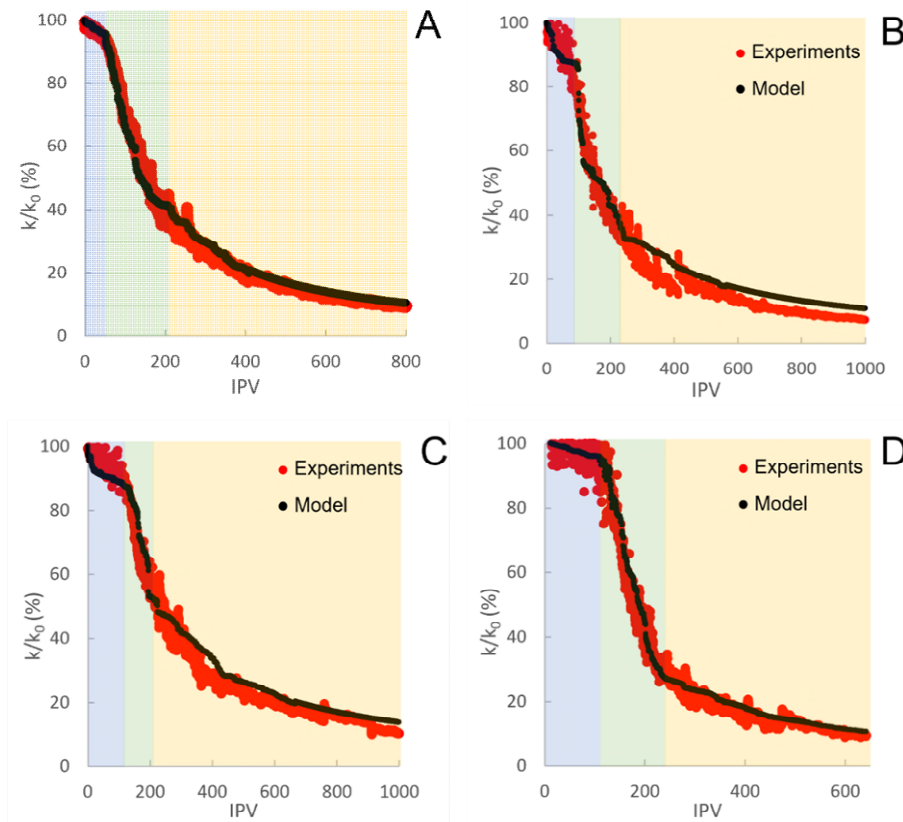


Fig 5S. Theoretical and experimental injectivity loss curves versus injected pore volume, for the four experiments of the datasets in Fig. 2. The colors on the diagram correspond to the different regimes. The extrapolated part is from about 600 IPV (see Fig. 5). The labels correspond to Table 1S.

Table 3S. Summary of the characteristics of the three regimes of the model applied for each experiment from the datasets in Fig.2. The labels correspond to Fig. 4S, except for experiment A that is presented in Fig.5 in the main text. The size of each regime in percentage of the total size of the porous media is indicated, as well as the relative reduction of the mean permeability of the porous media in each regime.

	INITIAL		REGIME 1					REGIME 2					REGIME 3					FINAL		
	k_0 (mD)	L (μm)	k_{d1} (mD)	k_1 (mD)	%	L_{d1} (μm)	%	k_{d2} (mD)	k_2 (mD)	%	$L_{d2}-L_{d1}$ (μm)	%	k_{d3} (mD)	k_3 (mD)	%	$L_{d3}-L_{d2}$ (μm)	%	k_f (mD)	k_0-k_f (mD)	L_{df} (μm)
A	2667,5	18000	491,3	2486,7	7,5	190,7	3,1	69,1	937,8	64,2	651,3	10,5	103,7	255,0	28,3	5362,5	86,4	255,0	2412,5	6204,5
B	2706,3	15000	352,6	2431,1	11,1	330,5	6,0	55,9	1037,3	56,2	438,2	8,0	110,9	224,7	32,7	4704,5	86,0	224,7	2481,6	5473,2
C	2454,1	18000	319,1	2295,8	7,3	400,2	8,2	73	1499,1	36,6	269	5,5	89,8	278,1	56,1	4221,6	86,3	278,1	2176,0	4890,8
D	3053,3	16500	664	2754,4	10,8	236,5	7,0	35,1	803	70,5	615,3	18,2	63,4	286,0	18,7	2538,2	74,9	286,0	2767,3	3390