Supplementary Material

# Optimisation of iron oxide nanoparticles for agglomeration and blockage in aqueous flow systems

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## I. Synthesis of Iron Oxide Particles

Fe(acac)<sub>3</sub> 0.71 g 1.3 mL oleic acid 0.1 g 4-biphenylcarboxylic acid 30 mL benzyl ether,

total reaction time 35 min



oleic acid coated magnetite particles (Fe<sub>3</sub>O<sub>4</sub>-OA)

Scheme S1: Synthesis of iron oxide nanoparticles (Fe<sub>3</sub>O<sub>4</sub>-OA) detailed in the experimental section.



Scheme 2: Modification of  $Fe_3O_4$ -OA surface. Oxidative cleavage results in a hydrophilic system through the formation of azelaic acid coated particles ( $Fe_3O_4$ -AA); Further stability in water is achieved through the addition of PEG ( $Fe_3O_4$ -AA-PEG) to the surface.

Figure S1a: Reaction set up using a gas manifold where (a) illustrates a simple degassing procedure; (b) foiling/stoppering of flask prior to reaction; (c) end of reaction, foil has been removed for clarity; (d) flasks are totally removed from mantles for cooling.



Figure S1b: (left) A demonstration of how the magnet is removed, using a second externally placed magnet. As the magnet is sitting in a position similar to the one indicated above, a solution of toluene/hexane is squirted onto the magnet, to remove nanoparticles that adhere to the magnet. (right) Typical example of the appearance of nanoparticles after centrifugation following their second wash. The supernatant will be a straw yellow colour.



Table .	S1:	GC-MS	data d	of benz	vl ether
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Naturally aged         A         2.59         1.98         benzaldehyde         000100-52-7           16 months         B         3.18         0.66         benzyl alcohol         000100-51-6           (Aldrich 108014-1kg         C         11.12         100         benzyl ether         000120-51-4           Pristine (Aldrich 108014-         A         2.59         0.42         benzaldehyde         000120-51-4           D         12.47         0.10         benzyl ether         00013-50-4           D         12.47         0.10         benzyl ether         00010-52-7           Ikg Lot#SHBL6366)         B         3.19         0.07         benzyl ether         000103-50-4           D         12.47         0.10         benzyl ether         000100-51-6         lkg Lot#SHBL6366) with         C         11.12         100         benzyl alcohol         00010-52-7           Ikg Lot#SHBL6366) with         C         11.12         100         benzyl alcohol         00010-52-7           Ikg Lot#SHBL6366) with         C         11.12         100         benzyl alcohol         00010-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) fifer	benzyl ether	Peak	Retention time	Relative Abundance %	ID	CAS
16 months         B         3.18         0.66         benzyl alcohol         000100-51-6           (Aldrich 108014-1kg         C         11.12         100         benzyl benzoate         000120-51-4           Pristine (Aldrich 108014-         A         2.59         0.42         benzyl alcohol         000100-52-7           1kg Lot#SHBL6366)         B         3.19         0.07         benzyl alcohol         000100-52-7           1kg Lot#SHBL6366)         B         3.19         0.07         benzyl alcohol         000100-52-7           pristine (Aldrich 108014-         B         2.59         3.96         benzyl ether         000120-51-4           D         12.47         0.10         benzyl ether         000120-51-4           Ikg Lot#SHBL6366) with         C         11.12         100         benzyl ether         000120-51-4           Ikg Lot#SHBL6366) with         C         11.12         100         benzyl ether         000120-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl ether         000120-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl ether         00010-52-7           108014-1kg         B         3.19         0.08	Naturally aged	А	2.59	1.98	benzaldehvde	000100-52-7
(Aldrich 108014-1kg         C         11.12         100         benzyl ether         000103-50-4           Dristine (Aldrich 108014-         A         2.59         0.42         benzyl benzoate         00010-52-7           Ikg Lot#SHEL6366)         B         3.19         0.07         benzyl alcohol         000100-52-7           Ikg Lot#SHEL6366)         B         3.19         0.07         benzyl alcohol         000100-51-6           C         11.12         100         benzyl alcohol         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl ether         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl ether         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl ether         000100-52-7           additives         D         12.47         1.02         benzyl ether         000100-52-7           108014-1kg         B         3.19         0.08         benzyl ether         000100-52-7           108014-1kg         B         3.19         0.08         benzyl ether         000100-52-7           108014-1kg         B         3.19         0.08         benzyl eth	16 months	В	3.18	0.66	benzyl alcohol	000100-51-6
LotHMKCC9034)         D         12.46         0.83         benzyl benzoate         000120-51-4           Pristine (Aldrich 108014-         A         2.59         0.42         benzyl benzoate         000100-52-7           1kg Lot#SHBL6366)         B         3.19         0.07         benzyl alcohol         000100-51-6           C         11.12         100         benzyl benzoate         000120-51-4           Entry 11 (Table 2)         A         2.59         3.96         benzyl alcohol         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl alcohol         000100-52-7           1kg Lot#SHBL6366) with         C         11.12         100         benzyl alcohol         000100-51-6           1kg Lot#SHBL6366) with         C         11.12         100         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.63         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) ofter 1hr         C         11.17         100	(Aldrich 108014-1kg	c	11.12	100	benzvl ether	000103-50-4
Pristine (Aldrich 108014- Ikg Lot#SHBL6366)         A         2.59         0.42         benzaldehyde         000100-52-7           1kg Lot#SHBL6366)         B         3.19         0.07         benzyl alcohol         000100-52-7           0         12.47         0.10         benzyl ether         000100-52-7           pristine (Aldrich 108014- B         B         3.19         0.62         benzyl benzoate         000120-51-4           Ikg Lot#SHBL6366) with         C         11.12         100         benzyl benzoate         000120-51-4           additives         D         12.47         1.02         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl benzoate         000120-51-4           Lot#SHBL6366) giter 1hr         C         11.17         100         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl benzoate         000120-51-4           Lot#SHBL6366) giter	Lot#MKCC9034)	D	12.46	0.83	benzyl benzoate	000120-51-4
Ikg Lot#SHBL6366)         B         3.19         0.07         benzyl alcohol         000100-51-6           C         11.12         100         benzyl ether         000130-50-4           D         12.47         0.10         benzyl ether         000130-51-4           Entry 11 (Table 2)         A         2.59         3.96         benzyl ether         000120-51-4           pristine (Aldrich 108014-         B         3.19         0.62         benzyl ether         000130-52-7           pristine (Aldrich         A         2.59         0.53         benzyl ether         000120-51-6 <i>additives</i> D         12.47         1.02         benzyl ether         000120-51-7 <i>additives</i> D         12.47         1.02         benzyl ether         000120-51-6 <i>additives</i> D         12.47         1.02         benzyl ether         000120-51-6 <i>lot#SHBL6366) after 1hr</i> C         11.17         100         benzyl ether         000120-51-4 <i>compressed air</i> D         12.49         0.08         benzyl ether         000120-51-6 <i>lot#SHBL6366) after 7hr</i> C         11.12         100         benzyl ether         000120-51-6	Pristine (Aldrich 108014-	А	2.59	0.42	, benzaldehyde	000100-52-7
C         11.12         100         benzyl ether         000103-50-4           D         12.47         0.10         benzyl benzate         000120-51-4           Entry 11 (Table 2)         A         2.59         3.96         benzyl alcohol         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl alcohol         000100-52-7           additives         D         12.47         1.02         benzyl ether         000100-52-7           Artificially aged (Aldrich         A         2.59         0.53         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lott#SHBL6366) after 1hr         C         11.17         100         benzyl ether         000100-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl etholo         000100-52-7           108014-1kg         B         3.19         0.08         benzyl ether         000100-51-6           Lott#SHBL6366) after 7hr         C         11.12         100         benzyl ether         00	1kg Lot#SHBL6366)	В	3.19	0.07	, benzyl alcohol	000100-51-6
D         12.47         0.10         benzyl benzoate         000120-51-4           Entry 11 (Table 2)         A         2.59         3.96         benzyl benzoate         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl alcohol         000100-51-6           1kg Lot#SHBL6366) with         C         11.12         100         benzyl ether         000103-50-4           additives         D         12.47         1.02         benzyl benzoate         000102-51-4           Artificially aged (Aldrich         A         2.59         0.53         benzyl benzoate         000100-52-7           108014-1kg         B         3.19         0.08         benzyl benzoate         000100-52-7           108014-1kg         B         3.19         0.08         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl benzoate         000120-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         000120-51-6           Lot#SHBL6366) after 7hr         C         11.12 <th>2</th> <th>С</th> <th>11.12</th> <th>100</th> <th>benzyl ether</th> <th>000103-50-4</th>	2	С	11.12	100	benzyl ether	000103-50-4
Entry 11 (Table 2)         A         2.59         3.96         benzaldehyde         000100-52-7           pristine (Aldrich 108014-         B         3.19         0.62         benzyl alcohol         000100-51-6           1kg Lot#SHBL6366) with         C         11.12         100         benzyl entro 00103-50-4           additives         D         12.47         1.02         benzyl benzoate         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.08         benzyl entro 000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl benzoat		D	12.47	0.10	benzyl benzoate	000120-51-4
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Artificially aged (Aldrich         A         2.59         0.53         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1hr         C         11.17         100         benzyl ether         000103-50-4           compressed air         D         12.49         0.08         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl benzoate         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl benzoate         000100-52-7           108014-1kg         B         3.18         0.10         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzyl benzoate         000120-51-4           Artificially aged (Aldrich <th>additives</th> <th>D</th> <th>12.47</th> <th>1.02</th> <th>benzyl benzoate</th> <th>000120-51-4</th>	additives	D	12.47	1.02	benzyl benzoate	000120-51-4
108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1hr         C         11.17         100         benzyl ether         000103-50-4           compressed air         D         12.49         0.08         benzyl benzoate         000100-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl benzoate         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         00013-50-4           compressed air         D         12.46         0.23         benzyl ether         000100-51-7           108014-1kg         B         3.18         0.10         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.10         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.10         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.40         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.40         benzyl ether	Artificially aged (Aldrich	А	2.59	0.53	benzaldehyde	000100-52-7
Lot#SHBL6366) after 1hr         C         11.17         100         benzyl ether         000103-50-4           compressed air         D         12.49         0.08         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzyl benzoate         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         00013-50-4           compressed air         D         12.46         0.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl benzoate         000100-52-7           108014-1kg         B         3.18         0.10         benzyl ether         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl ether         000103-50-4           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B	108014-1kg	В	3.19	0.08	benzyl alcohol	000100-51-6
compressed air         D         12.49         0.08         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.47         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl benzoate         000120-51-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.40         benzyl ether         00013-50-4           hr compressed air         D         12.46         0.38         benzyl ether         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40 <th>Lot#SHBL6366) after 1hr</th> <th>С</th> <th>11.17</th> <th>100</th> <th>benzyl ether</th> <th>000103-50-4</th>	Lot#SHBL6366) after 1hr	С	11.17	100	benzyl ether	000103-50-4
Artificially aged (Aldrich         A         2.59         0.47         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         000103-50-4           compressed air         D         12.46         0.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl benzoate         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl benzoate         000120-51-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000120-51-7           108014-1kg         B         3.18         0.40         benzyl benzoate         000120-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C	compressed air	D	12.49	0.08	benzyl benzoate	000120-51-4
108014-1kg         B         3.19         0.08         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         000103-50-4           compressed air         D         12.46         0.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         00013-50-4           hr compressed air         D <th< th=""><th>Artificially aged (Aldrich</th><th>А</th><th>2.59</th><th>0.47</th><th>benzaldehyde</th><th>000100-52-7</th></th<>	Artificially aged (Aldrich	А	2.59	0.47	benzaldehyde	000100-52-7
Lot#SHBL6366) after 7hr         C         11.12         100         benzyl ether         000103-50-4           compressed air         D         12.46         0.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000103-50-4           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl ether         000103-50-4           Artificially aged (Aldrich         A         2.59         1.91         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.40         benzyl ether         000100-52-7           108014-1kg         B         3.18         0.40         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46	108014-1kg	В	3.19	0.08	benzyl alcohol	000100-51-6
compressed air         D         12.46         0.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         0.52         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000100-52-7           108014-1kg         B         3.18         0.40         benzyl benzoate         000100-52-7           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-7           108014-1kg         B         3.19         <	Lot#SHBL6366) after 7hr	С	11.12	100	benzyl ether	000103-50-4
Artificially aged (Aldrich         A         2.59         0.52         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.10         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000120-51-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzyl alcohol         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzyl benzoate         000100-52-7           108014-1kg	compressed air	D	12.46	0.23	benzyl benzoate	000120-51-4
108014-1kg         B         3.18         0.10         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000102-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11 <th>Artificially aged (Aldrich</th> <th>А</th> <th>2.59</th> <th>0.52</th> <th>benzaldehyde</th> <th>000100-52-7</th>	Artificially aged (Aldrich	А	2.59	0.52	benzaldehyde	000100-52-7
Lot#SHBL6366) after 24         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         0.38         benzyl benzoate         000100-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	108014-1kg	В	3.18	0.10	benzyl alcohol	000100-51-6
hr compressed air         D         12.46         0.38         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl benzoate         000100-51-6           Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	Lot#SHBL6366) after 24	С	11.12	100	benzyl ether	000103-50-4
Artificially aged (Aldrich         A         2.59         1.91         benzaldehyde         000100-52-7           108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	hr compressed air	D	12.46	0.38	benzyl benzoate	000120-51-4
108014-1kg         B         3.18         0.40         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl ether         000120-51-4	Artificially aged (Aldrich	А	2.59	1.91	benzaldehyde	000100-52-7
Lot#SHBL6366) after 96         C         11.12         100         benzyl ether         000103-50-4           hr compressed air         D         12.46         1.42         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzyl alcohol         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	108014-1kg	В	3.18	0.40	benzyl alcohol	000100-51-6
hr compressed air         D         12.46         1.42         benzyl benzoate         000120-51-4           Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	Lot#SHBL6366) after 96	С	11.12	100	benzyl ether	000103-50-4
Artificially aged (Aldrich         A         2.59         3.23         benzaldehyde         000100-52-7           108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	hr compressed air	D	12.46	1.42	benzyl benzoate	000120-51-4
108014-1kg         B         3.19         0.62         benzyl alcohol         000100-51-6           Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	Artificially aged (Aldrich	А	2.59	3.23	benzaldehyde	000100-52-7
Lot#SHBL6366) after 1         C         11.11         100         benzyl ether         000103-50-4           week compressed air         D         12.44         2.19         benzyl benzoate         000120-51-4	108014-1kg	В	3.19	0.62	benzyl alcohol	000100-51-6
week compressed air D 12.44 2.19 benzvl benzoate 000120-51-4	Lot#SHBL6366) after 1	С	11.11	100	benzyl ether	000103-50-4
	week compressed air	D	12.44	2.19	benzyl benzoate	000120-51-4

Figure S2: <sup>1</sup>H NMR for benzyl ether aged 16 months (blue), pristine benzyl ether (red), pristine benzyl ether with additives entry 11 (green).



## II. Characterisation of Iron Oxide Particles

Figure S3: Characterisation of **1b**; (a) Bright Field TEM image; (b) XRD pattern; (c) Raman Spectrum.



Table S2: Comparison of d-spacings for 1b from powder XRD for **1b** with JCPDS cards #75-0033 and #39-1346.

entry	hkl	Measured XRD d-spacings (nm)	Fe₃O₄ (JCPDS 75-0033) (nm)	γ-Fe₂O₃ (JCPDS 39- 1346) (nm)
а	111	0.486	0.484	0.482
b	220	0.297	0.296	0.295
С	311	0.253	0.253	0.252
d	222	0.242	0.242	0.241
е	400	0.210	0.210	0.209
f	422	0.172	0.171	0.170
g	511	0.162	0.161	0.161
h	440	0.149	0.148	0.148

Figure S4: Characterisation of **6a**; (a) Bright Field TEM image; (b) XRD pattern; (c) Raman Spectrum.



Table S3: Comparison of d-spacings for **6a** from powder XRD for 1a with JCPDS cards #75-0033 and #39-1346.

entry	hkl	Measured XRD d-spacings (nm)	Fe₃O₄ (JCPDS 75-0033) (nm)	γ-Fe2O3 (JCPDS 39- 1346) (nm)
а	111	0.481	0.484	0.482
b	220	0.294	0.296	0.295
С	311	0.251	0.253	0.252
d	222	-	0.242	0.241
е	400	0.201	0.210	0.209
f	422	0.171	0.171	0.170
g	511	0.161	0.161	0.161
h	440	0.148	0.148	0.148

entry	Diameter of particles (nm)	TEM	Size Distribution
1a	$131\pm30$		$\begin{bmatrix} 120 \\ 100 \\ 80 \\ 40 \\ 20 \\ 0 \\ 50 \\ 50 \\ 100 \\ 150 \\ 200 \\ 250 \\ Length (nm) \\ \end{bmatrix}$
1b	$146\pm36$		100 80 40 20 0 50 100 150 200 250 Length (nm)
1c	$158\pm42$	O D D D D D D D D D D D D D D D D D D D	100 60 60 60 60 60 60 60 60 60
2	$107\pm18$	100 pm	60 50 40 50 20 10 0 20 40 50 40 50 40 50 40 50 40 50 50 40 50 50 50 50 50 50 50 50 50 50 50 50 50
За	72 ± 17		50 40 40 50 20 10 0 20 40 60 80 100 120 140 Length (nm)

Table S4: A representative bright field TEM image of as-synthesised (Table 1 and 2) iron oxide nanocrystals. Histogram of the size distribution obtained from measurements is included.



# Supporting Information



\*Four repeat reactions were performed; reactions were combined prior to work up;

Figure S5: FTIR(ATR) used to observe the oxidative cleavage of magnetite particles from **6a**. The upper trace contains as-synthesised  $Fe_3O_4$ -OA with the lower trace for particles after oxidative cleavage ( $Fe_3O_4$ -AA).



*Figure S6: FTIR(nujol) of Fe*<sub>3</sub>O<sub>4</sub>-AA-PEG (**5**) *and PEG, a strong C-O str is evident in the particles.* 



#### **III.** Flow experiments

Figure S7: (left) a schematic representation and (right) image of the in-house flow system used in the experiments.



Figure S8: Flow experiments for **1b** (Fe<sub>3</sub>O<sub>4</sub>-AA-PEG). Distance between the magnet and capillary tubing = 0 mm.



Figure S9: Flow experiments for **5** (Fe<sub>3</sub>O<sub>4</sub>-AA-PEG). Distance between the magnet and capillary tubing = 0 mm.



nanoparticles

Figure S10: Flow experiments for **5** (Fe<sub>3</sub>O<sub>4</sub>-AA-PEG). Distance between the magnet and capillary tubing = 1 mm.



Figure S11: Flow experiments for **3b** (Fe<sub>3</sub>O<sub>4</sub>-AA-PEG). Distance between the magnet and capillary tubing = 1 mm.

