**S1 Preparation of carbon nanospheres**

Firstly, 10 g of glucose and 100 ml of deionised water were mixed well. Then the glucose solution was poured into a reaction kettle. The solution was heated at 180 °C for 12 h. After the reaction, a brown-black solution was obtained. After the reaction, a brown-black solution was obtained, which was washed three times with deionised water and anhydrous ethanol and dried at 60 °C. The final brown-black carbon nanospheres were obtained.

**S2 Preparation of fluorinated polyether**

Firstly, quantitative hexafluorobisphenol A and tetraethylenepentamine were added to the four-port bottle, heated to 45 °C to completely dissolve, and kept for 20 min. Then, a quantitative formaldehyde solution was slowly added to the four-necked bottle. In order to make the reaction complete, the reaction was continued for 1 h after the addition. A certain amount of xylene was added to the bottle, heated to 100 °C, refluxed and dehydrated for 2 h, and then heated to 190 °C, so that xylene was completely removed. After the reaction, the phenolic amine resin initiator was obtained. After that, the quantitative phenolic amine resin initiator and KOH were added to the high-pressure reactor, and the reactor was sealed. N2 was used to purge and replace the air in the reactor, and then the vacuum pump was used to vacuum the reactor to a gauge pressure of -0.09 MPa. Next, the reactor was heated to 110 °C -130 °C, the feed valve was opened, the quantitative propylene oxide (PO) was slowly introduced and the reactor pressure gauge reading was between 0.2±0.01 MPa. Then the feed valve was closed, the reaction continued until the reactor pressure was -0.09 MPa when the reaction was complete, to obtain intermediate products. Finally, the quantitative intermediate product and KOH were added to the high-pressure reactor, and ethylene oxide (EO) was introduced in the same way.

**S3 Preparation of Fe3O4@C**

Firstly, 0.001 mol of iron acetylacetonate, 0.003 mol of oleic acid, 0.003 mol of oleylamine, and 0.1 g of carbon nanospheres were added to the beaker, and then the solvent dibenzyl ether was added. The material in the beaker was stirred evenly and ultrasonically dispersed for 30 min. Next, the reagent in the beaker was poured into the reactor, and the air in the reactor was removed by nitrogen. The reactor was placed in a muffle furnace at 230 °C for 5 h. After the heat preservation experiment, take out the reactor and place in the air to cool naturally. After that, the product in the reactor was taken out, and the magnetic demulsifier product was separated by a magnet, and a 1:1 volume mixture of ethanol and n-hexane was added to the product to clean the magnetic demulsifier product for 3-5 times. Finally, the product was dried at 60 °C for 12 h to obtain magnetic demulsifier.

**S4 Preparation of Fe3O4-F**

Firstly, 0.001 mol iron acetylacetonate, 0.003 mol oleic acid, 0.003 mol oleylamine and 5 g fluorine-containing polyether were added to the beaker, and the solvent dibenzyl ether was added. Then the materials in the beaker were stirred evenly and ultrasonically dispersed for 30 min. Next, the reagent in the beaker was poured into the reactor, and the air in the reactor was removed by nitrogen. The reactor was then placed in a muffle furnace at 230 °C for 5 h. After the heat preservation experiment, take out the reactor and place in the air to cool naturally. Then, the product in the reaction kettle was taken out, and the magnetic demulsifier product was separated by a magnet, and a 1:1 volume mixture of ethanol and n-hexane was added to the product to clean the magnetic demulsifier product for 3-5 times. Finally, the product was dried at 60 °C for 12 h to obtain magnetic demulsifier.