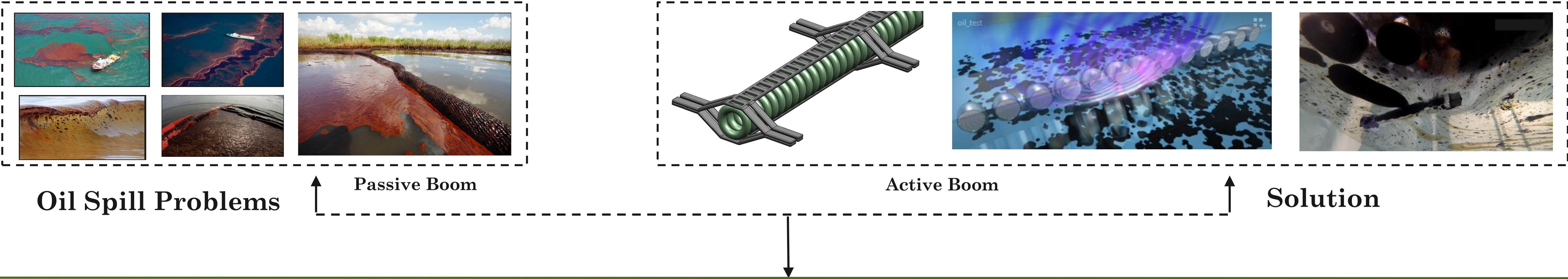


Electromagnetic Boom Technology and Applications

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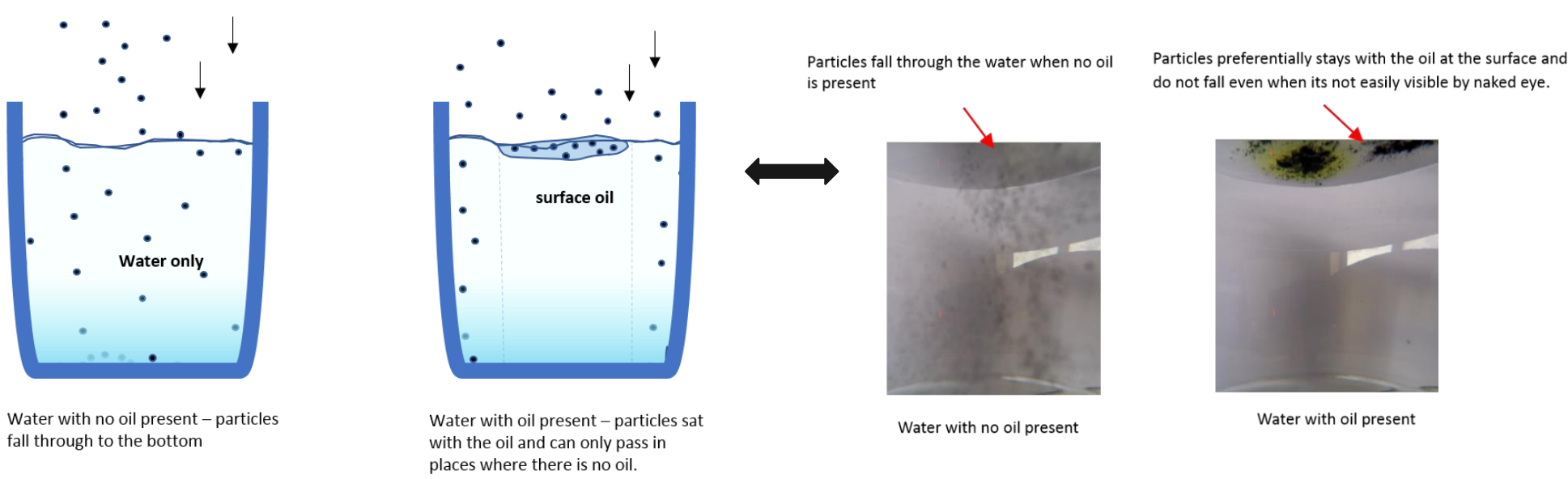
A system for electromagnetically removing oil from water, reducing the diffusion rate of oil on water (spread rate), magnetically lifting oil from water and nonporous surfaces, as well as separating the magnetic material from the oil for reuse

Standard booms are passive devices that are typically used in conjunction with skimmers and other methods to remove oil from water. The skimmers rely primarily on surface tension forces and mechanical action to collect the oil. These methods are inefficient and also collect large volumes of oily water in the process. An innovative, electromagnetic-based approach for oil-spill remediation has been developed that uses micron-sized magnetite (Fe_3O_4) particles which are reusable, recoverable, and environmentally safe.



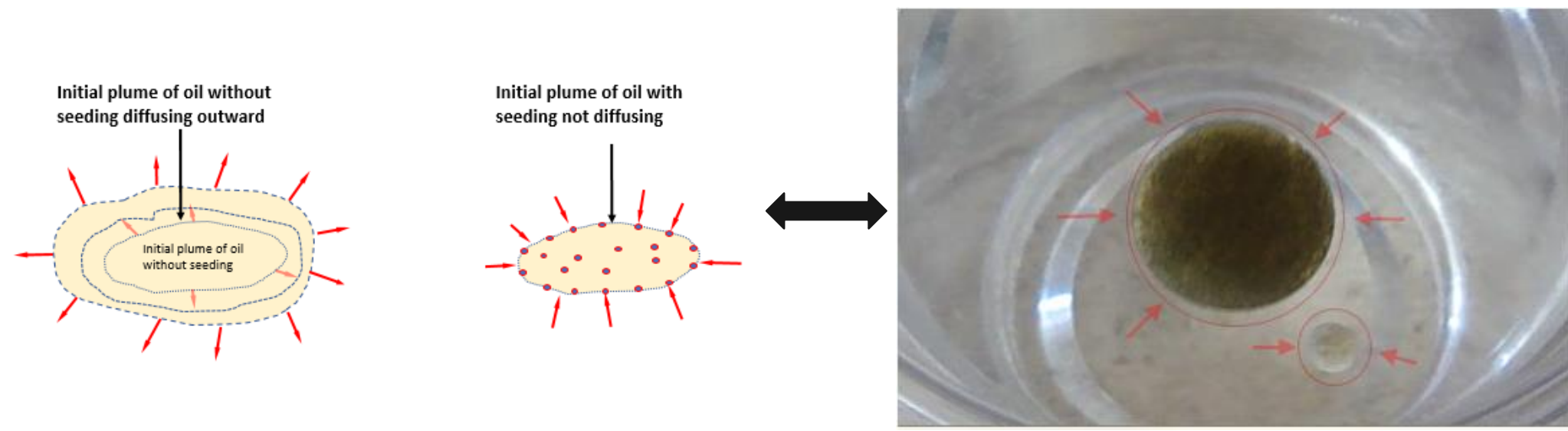
How it works

The Fundamental Concepts 1 - Seeding



Concept Illustration – Particles preferentially stay with the oil

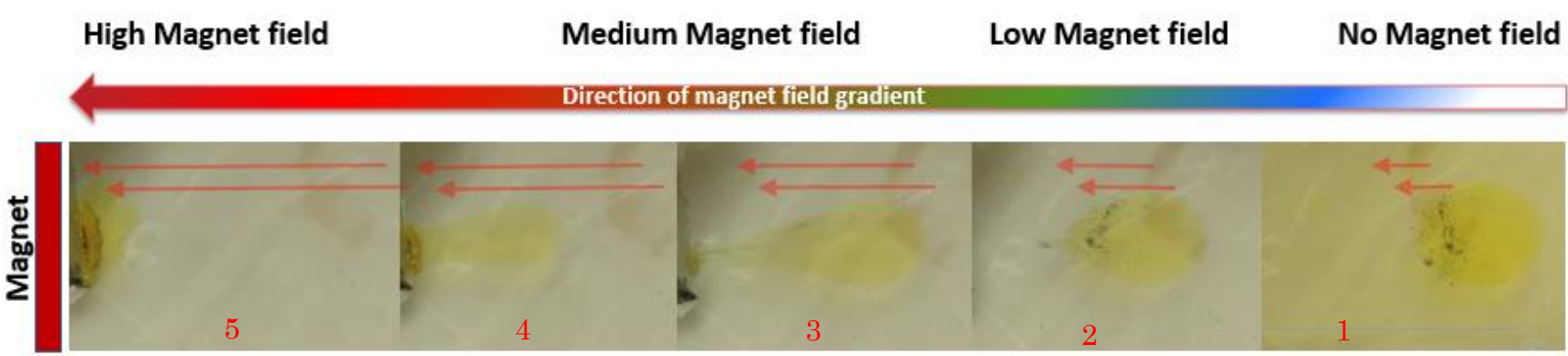
- Preferentially target oil on water by trapping micron sized magnetite (Fe_3O_4) or iron oxide particles in the oil/water combination.
- Process dominated by the Van der Waals force in the aqueous phase.
- Particles preferentially bond with oil while passing through water.
- Provides a method to determine where the oil is located at the micron scale.
- The limiting scale is of the order of the size of the magnetite particles used.



Concept Illustration – parcel of oil diffuse outward before seeding (left). Same parcel oil does not diffuse at same rate if seeded (right)

Magnetically Confine oil plume

The Fundamental Concepts 2 Control and Separation



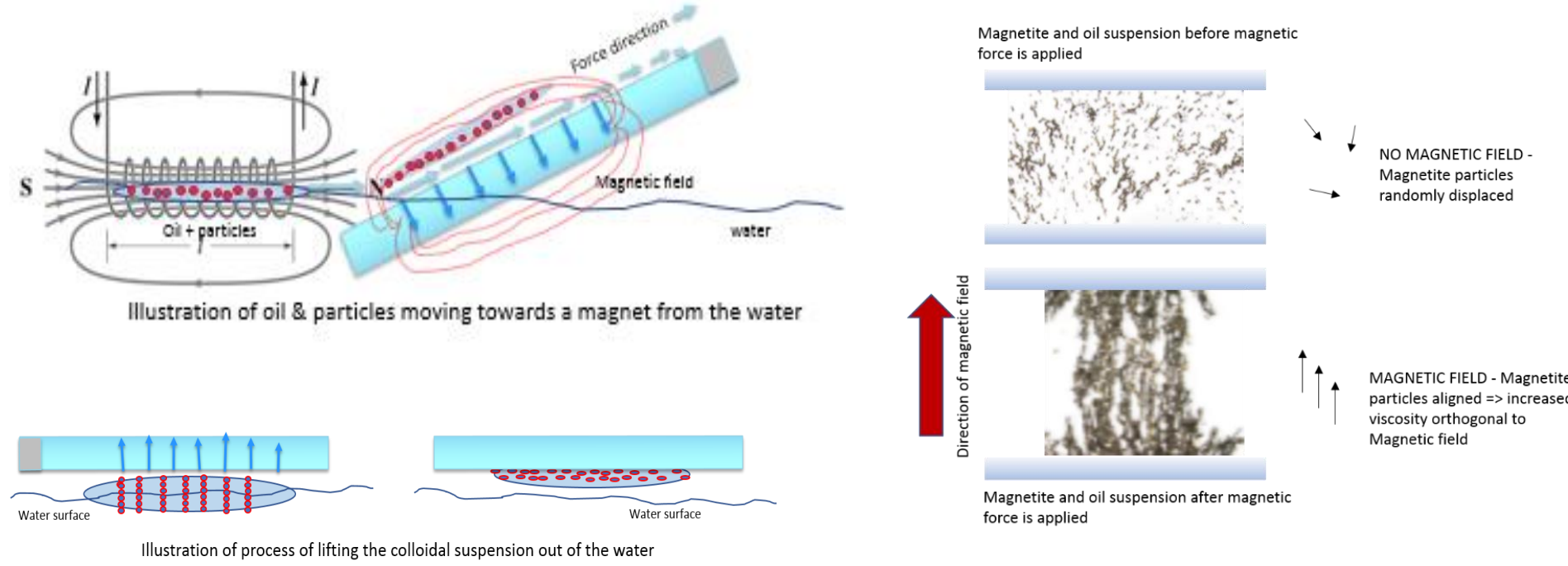
Snapshot of oil with a small amount of magnetite moving on water in the presence of a magnetic field. The arrows show the direction of the field gradient and the force direction.



Sequence of images illustrating the magnetic separation of the magnetite particles from the oil using a permanent magnet.

- A non-uniform distribution of magnetizable particles confined to oil will bond and move the oil when magnetic forces are applied. The water serves as the transport medium and the flow rate is proportional to the gradient of the magnetic field (Newtonian flow)

- 100% removal of magnetic particles from the oil after separation from water

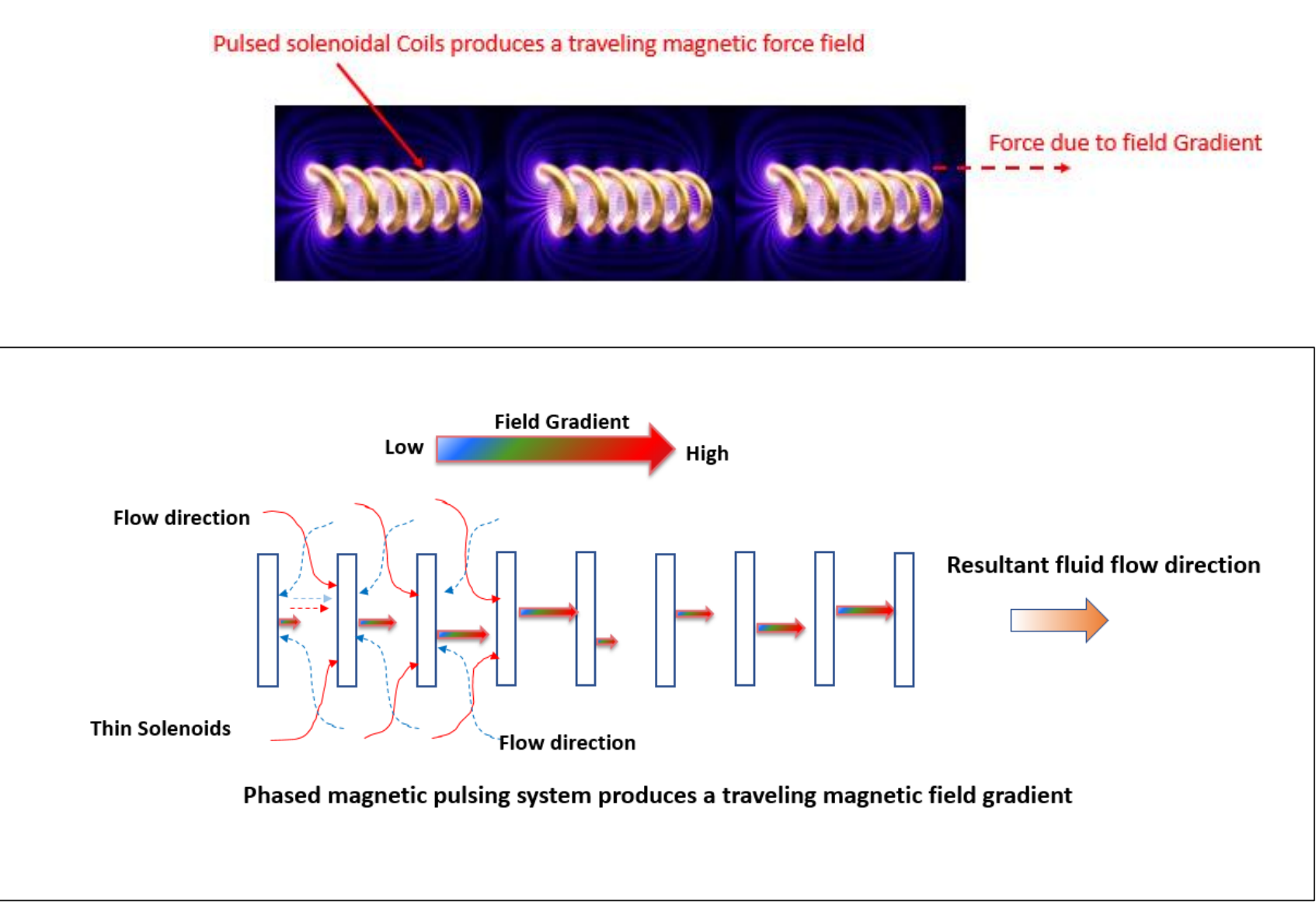


Microscopic view of magnetically enhanced viscosity – Magneto-rheological effects

- Magneto-rheological effects are used to lift oil from the water and other surfaces

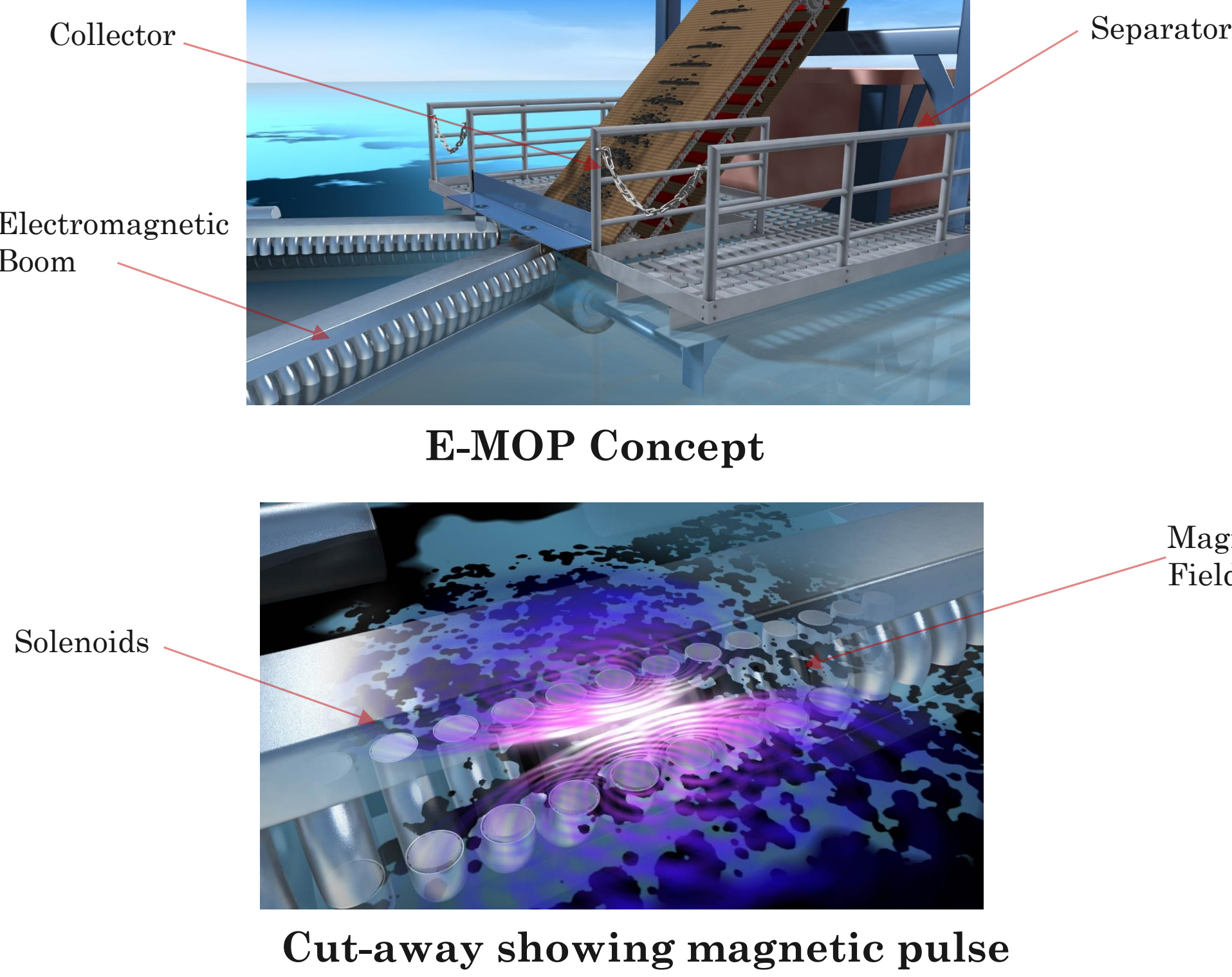
E-MOP – Electromagnetic Boom System

Principle

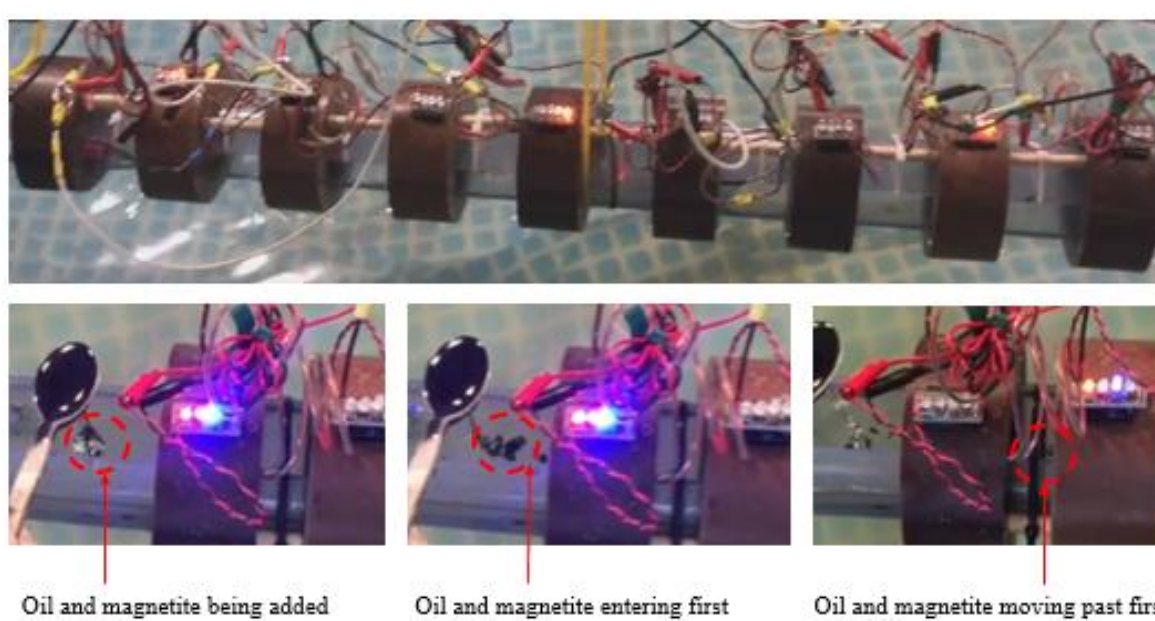


Concept Illustration – magnets combined to form an electromagnetic boom which will drive oil along its axis towards a collector and separator

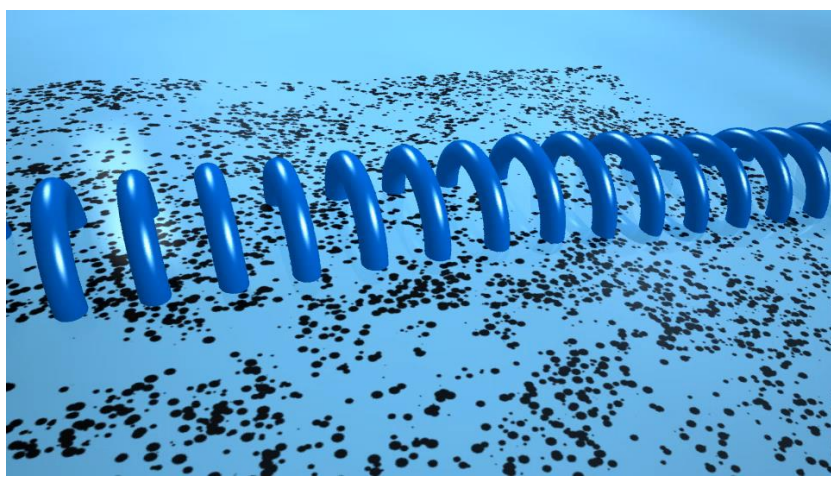
Design Concept



Engineering Test with oil



Engineering Demonstration of Electromagnetic Boom Moving oil on water along with the fluid dynamics model of the same



Simulation Model of fluid dynamics

Applications and Features

Main Application

- Recover and separate oil from water
- Remove oil from non porous surfaces
- Magnetically confine and manipulate oil
- Oil spill response
- Environmental Research
- Engineering application

Main Features

- Recapture oil at the micron scale and above
- Efficient- preferentially targets oil
- Remove oil at cold temperatures
- Work with low to high viscosity oil
- No saturation limit of materials
- Recoverable materials
- Flow rates proportional to magnetic field properties
- Scalable



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