

# SMART FLUID PROPERTIES AND APPLICATIONS

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## Abstract

The materials which have the ability to change shape or size simply by adding a little heat or to change from a liquid to a solid almost instantly when placed near a magnet; these materials are commonly called Smart materials/fluids. Most everyday materials have physical properties, which cannot be significantly altered; for example if oil is heated it will become a little thinner, whereas a smart material with variable viscosity may turn from a liquid state which flows easily to a solid. Each individual type of smart material has a different property which can be significantly altered, such as viscosity, volume or conductivity. The development of smart fluids will undoubtedly be an essential task in many fields of science and technology such as medical treatment, energy, transportation, safety engineering, vibration control and military technologies.

**Keywords:** MR Fluid , ER Fluid ,Viscosity, Dampers

# 1.INTRODUCTION

Science and technology have made marvelous developments in the design of electronics and machinery using standard materials, which do not have particularly special properties. The range of applications is still wider for special materials whose properties scientists, engineers can manipulate. Some of these materials have the ability to change shape or size simply by adding a little heat or to change from a liquid to a solid almost instantly when placed near a magnet; these materials are commonly called Smart materials/fluids. These materials have multiple properties (chemical, electrical, magnetic, mechanical and thermal) or can transform energy which can be altered or tuned using external fields.

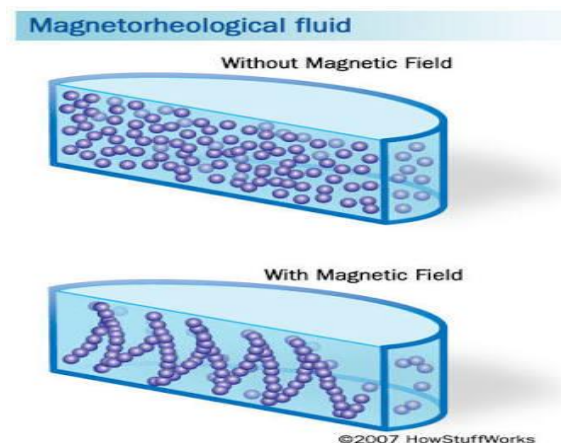
## 1.1 DISCOVERY OF SMART FLUID

ERFs were discovered by accident. Researchers using marble and oil to construct a high-voltage switch in the **1940s**.. Jacob Rainbow then with the National Bureau of Standards, independently invented MRFs in 1947.MRFs proved useful in magnetic power clutches in automotive

transmissions in the 1950s. They were commercialized in 1997.

## 1.2 WHAT IS SMART FLUID?

A **Smart Fluid** is a fluid whose properties (for example viscosity) can be changed by applying electric field or magnetic field.



## 2. TYPES OF SMART FLUID

As each smart material has a different properties which can significantly be altered. Thus there are three types of smart fluids

### 1. Magneto-rheological Fluid

### 2. Electro-rheological Fluid

### 3. Ferro-fluids

## 2.1 MAGNETO-RHEOLOGICAL FLUID & ITS PROPERTIES

Magneto-rheological (MR) fluids are one of the smart fluids that exhibit dramatic reversible change in its rheological properties (elasticity, plasticity or viscosity) either in solid-like state or free-flowing liquid state depending on the presence or absence of a magnetic field.

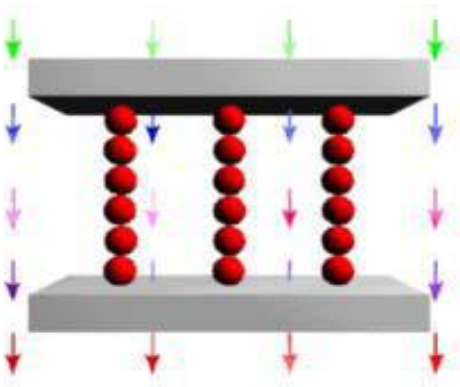


Fig: showing the MR particles under strong magnetic field.

The MR fluids consist of magnetically permeable micron-sized particles dispersed throughout the carrier medium either a polar or non-polar fluid, which influence the viscosity of the fluids under no external magnetic field.

## 2.2 ELECTRO-RHEOLOGICAL FLUID & ITS PROPERTIES

Another attractive field-responsive fluid, similar to MR fluid, is Electro-rheological (ER) fluid which also exhibits its rheological change or ability to alter their flow characteristics under the influence of an applied electric field. In the earlier era, the ER fluids have long been known as electro-viscous fluids

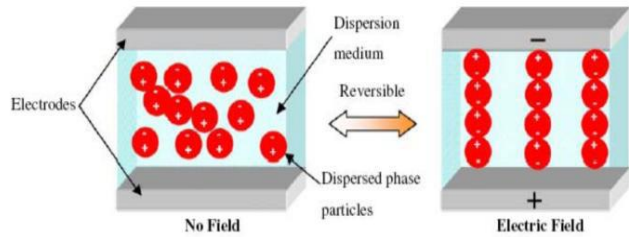


Fig:ER FLUID

The normal application of ER fluids is in fast acting hydraulic valves and clutches, with the separation between plates being in the order of 1 mm while the applied potential being in the order of 1 kV.

## 2.3 FERRO FLUID AND ITS PROPERTIES

A magnetic colloid, also known as a Ferro-fluid, is a colloidal suspension of single-domain magnetic particles, with typical dimensions of about 10nm, dispersed in a liquid carrier [17]. Ferro-fluids were discovered in the 1960s at the NASA.

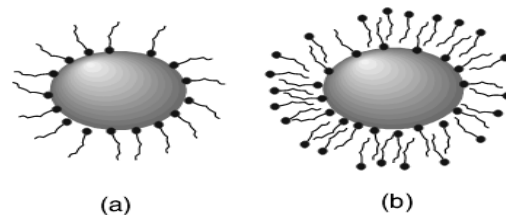


Fig : Ferro- Fluid

## 4. ADVANTAGES & DISADVANTAGES

### 4.1 ADVANTAGES

- Flow Mode Can Be Use in the Dampers and Shock Absorbers.
- Shear Mode is particular useful in clutches and brakes and in place where rotational motion is to be control.
- Switch flow mode is suitable for controlling small order movements.
- Can be used in flow channels.

### 4.2 DISADVANTEGES

Although are rightly seen as having many potential application, they are limited in commercial feasibility for the following reason

- High density due to presence of iron, makes them heavy. However operating volumes are small.
- High quality fluids are expensive.
- Fluids are subjected to thickening after prolonged use and need to replace.
- Setting of Ferro-particles can be a problem for some application.

## 5. APPLICATION OfSMART FLUID

### 5.1 MR Damper

The MR Dampers can be used as Seismic dampers which will

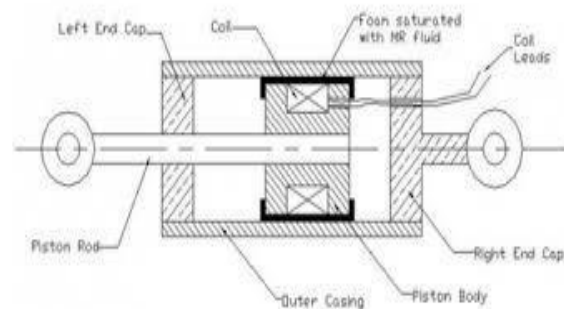


Fig: MR DAMPER

operate under the resonance frequency of the building by absorbing shock waves and oscillations that can cause harm, within the structure. This makes the dampers able to make any building earthquake proof.

### 5.2 Electro-rheological clutch

An **electro-rheological clutch** (ER clutch) comprises drive and driven members, generally parallel to each other, that can be selectively engaged by the application of a voltage to an ER fluid. The ER fluid is used as the coupling between the input and the output. The clutch acts as a power

amplifier and the effect is fast (of the order of milliseconds) and reversible.

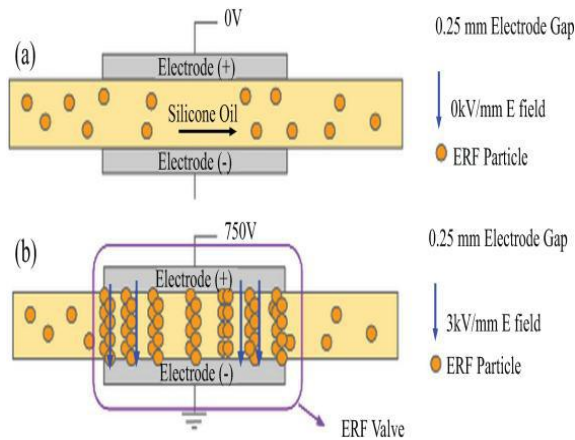


Fig: ER CLUTCH

## 6. COCLUSION

The development of smart fluids will undoubtedly be an essential task in many fields of science and technology such as medical treatment, energy, transportation, safety engineering, vibration control and military technologies. In future the materials development, therefore, should be directed toward creation of hyper-functional materials which surpass even biological organ in some aspects.

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