

# A Review of Experimental Investigation for Enhancing Acoustic Emission Control in Muffler Using Magneto Rheological Fluid

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**Abstract:** Exhaust noise of engine is key source of automotive noise. This noise is a serious challenge for the natural environment. Automotive mufflers reduce noise slowly in an actual manner. The transmission loss (TL) is mostly 0 (zero) dB pass at 1100 Hz frequency. This review paper of acoustic emission control in mufflers using magneto rheological fluid (MRF) used in automobile devices for reducing engine exhaust noise. In this review paper key feature is to reduce transmission loss using newcomer magneto rheological fluid sound absorption material.

**Key words:** Acoustic, muffler, noise, transmission loss (TL), Absorption material, magneto rheological fluid (MRF)

## INTRODUCTION

Automobile engine exhaust noise is a key factor of noise pollution of the natural environment. From the last decade people's density of automobiles on road has increased, so it's an important area of research and development[1]. Number of limits are define the acoustic performance of muffler and its allied piping consideration with noise reduction (NR), transmission loss (TL)/insertion loss (IL) [2].By using piezoelectric transducer sensors this acoustic emission can be recorded and a material deformation process is possible to monitor the acoustic emission released. Weak matrix properties are affected by the performance of laminates with material, so that internal properties have to be enhanced to avoid premature crack beginning and propagation[3].Balance of acoustic characteristics, pollutant emission of automotive engines constitutes the subject of muffler over the year. The exhaust system of an internal combustion engine is a key factor of noise from automobiles[4]. material is a ability to absorbing energy of sound and same waves duration minimize for transmitting and reflection energy[5]. Muffler is part of engine exhaust system to reduce noise (below 500 Hz), sound attenuation is require at low frequency [6].

The mixed finite boundary elements theory and finite element method are maximum commonly used in acoustic frequency response function [7]. Porous material has a good acoustic property, this porous structure is allowed to sound enter in their matrix. after entering sound wave in structure of porous material its transfer in viscous heat [8]. Frequency range of acoustic muffler is 100Hz to 1000Hz. Transmission loss is ratio between inlet and outlet acoustic energy. 3D analysis is give well thoughtful of wave spread within the muffler[9]. Back pressure to source due to sudden expansion area in muffler.The advanced command momentary modes produced at these area breaks significantly affect the acoustic field inside the muffler chamber. As an outcome, the transmission loss (TL) presentation predicted by the predictable 1D axial plane wave theory departs from investigational results uniform in the short-frequency series[10]. From last years, three-dimensional analytical method, finite element method and transfer matrix method more use on acoustic concert on the muffler for a huge number of studies[11].For the muffler design the key parameter is transmission loss and insertion loss. For the performance of engine, the TL is mostly favored and broadly used. Analysis and design of muffler is multifaceted task that affected sound qualities [12].

Magnetorheological fluids properties are subject to change when electromagnetic field is applied. Due to MRF physical characteristic modified in different situation so it's considered as "smart material". Material of MRFs can be use in live sound barriers to manage noise transmission loss and also use in noise modification characteristics absorption of sound material[13].

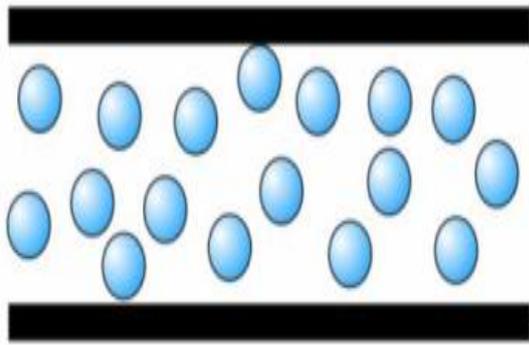


Figure 1 without magnetic field

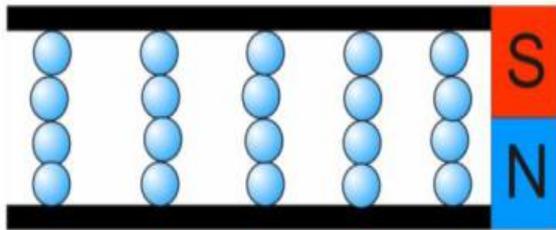


Figure 2 with magnetic field

The silicon oil and mineral oil has micron size of permeable particles floating in a transport liquid. From inner structure view the particles are spread randomly in fluid without applying magnetic field as shown in Figure 1, after applying magnetic field the particles arrange in chain like structures as shown in Figure 2. It's reversible when removing of magnetic field and deferment to a Newtonian fluid, its provide exclusive feature of electromagnetic field manage acoustic impedance of MRFs. This characteristics is inspire to plan manage transmission loss in absence of dynamic bulk modulus of acoustic material[13].

#### CLASSIFICATION OF MUFFLER

Muffler are classified in two different types, one is dissipative and second is reflective[14]. Parts of dissipative muffler are duct and chamber, acoustic absorbing material is lined in these parts for absorb acoustic energy and transmit into heat. Advantage of this muffler is that pressure drop entire the absorbing system is quietly low. The disadvantages of this muffler is deficient at low frequencies compare to large wavelength[15]. Reflective muffler is a second type. It has more than one chamber with different volume and size. They replicate energy of sound back to source and filters. At fixed frequencies its use for noise reduction. Merits for this muffler are quite inexpensive and less preservation. Demerits are

frequency range interest in some area for less reduction of back pressure[14].

#### Absorption materials

Sound absorbing material in wide range. It absorbs most of sound energy striking and very useful to controlling noise, in old decade use synthetic fibers instead of new fibers. New fibers are safe for health, easily available, no issue related to global warming compare to natural fibers. Using nanotechnology, advance material science and chemistry are enhancing properties of absorbing materials[14].

#### Porous Absorbing Materials

Cellular, fibrous, granular are types of porous absorbing material. Sound wave enters from small holes. Three dimensional nanofibrous network shown in Figure 3. After experimental work measure sound absorbing coefficient for 3D nanofibrous network in standing wave tube[16].

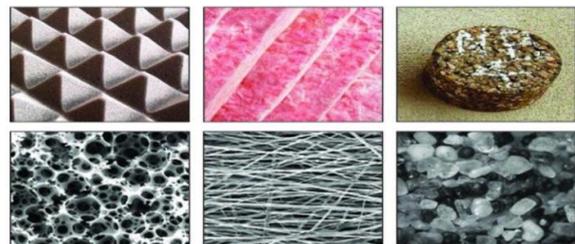


Figure 3 cellular, fibrous and granular porous absorbing material

#### Magnetorheological fluid

Now a day's Magnetorheological Fluid is smart material which use in actuators, sensors in several research field. MRFs are broadly useful in frequent application devices or systems like as automotive brakes actuators and suspension, in the presence if magnetic field MRF is capable to convert liquid state to semi-solid state, this is quickly and reversible[17]. The carbonyl iron (CI) particles have soft magnetic properties and high magnetic permeability, due to this reason it's broadly use in magnetic phase in MRF, for greater MR effect its fabricated with CI particles. Several amorphous magnetic materials have easy magnetic properties and lower density related to the CI, newly MRF made up by amorphous micro-particles, as Fe<sub>76</sub>Cr<sub>2</sub>Mo<sub>2</sub>Sn<sub>2</sub>P<sub>10</sub>B<sub>2</sub>C<sub>2</sub>Si<sub>4</sub>. Their MRF microstructure, properties and sedimentation stability associated with CI based MRF with the same[18]. MRF is collected of Ferroparticles and silicon oil with diameter not more than 10µm. After

properly mixing this suspension get long time stability. This commercial MRF selling by Feisifurui Company labeled by F13140 is working with porous material contain as black nontoxic suspension with density  $2.5 \text{ g/cm}^3$ [19].

#### MRFs application

MRFs are family member of rheological fluid materials. Within microsecond its change phase from liquid to semi solid. Some application of MRFs is MR Damper, MR valves, orifices in hydraulic circuit, MR Brakes, and Vibration isolation[20].

#### CONCLUSION

Unwanted sound is day dream of every human. Automobile is one of the sources of unwanted sound. New sound absorbing material is safer, fast technologically and lighter than old absorbing material produced in last two decade (1996-2016). Magnetorheological fluid is choice of newcomers due to its smart controlling sound level at different frequencies. It's promising for semi active sound control material. Major effect of change in magnetic field is varying with properties and characterization of MRFs. Controlling of noise by using MRFs still is new thought for future research.

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