[This is a 2005 message by Dave Nelson to the FMES Yahoo Group which was active from 2005 to 2007.. https://groups.yahoo.com/neo/groups/fmes/info
This is good background, but should not be considered to be the last word on the design. Since then he had made numerous changes and improvements as he continued building and testing, Some of the changes I have indicated in annotations. BMN 2018]

I thought it might be useful to provide the group with the thinking that lead me to the current Fluid Mass Electrolytic Seismometer (FMES) concept and a description of the instruments units that I have built. The FMES is a work in progress . I have built over 10 instruments of various configurations. The configurations differed in overall physical size and configuration of the damping restriction but were based on the same overall concept . I will describe some of the variants in a later message. To keep this message as brief as possible it will include provide only an introduction and a top level description .

My personal background in seismology is limited . I became interested seriously only a couple of years ago .The system I have put together has grown with time . One of the instruments I obtained is MET seismometer from CME in Russia http://www.cme-tech.ru/products.html. It employs a liquid seismic mass and a unique and mostly proprietary methodology . I have been intrigued by the idea of a non-mechanical fluid mass seismometer since my introduction to the MET instruments . I therefore set out on home project to explore concepts for a fluid mass seismometer. I did not attempt to duplicate the MET instrument as it has many unique characteristics in its implementation that were beyond my reach. I have an extensive background in instrumentation for space systems but have become a little rusty in the mathematical side of things from too many years in program management, My work therefore lacks mathematical rigor.

My objective was to design and build an instrument for the amateur that would have good performance for local and teleseismic events. It was to be simple to build without any complex mechanisms . I believe I have accomplished my objective and will be documenting the design for the amateur to explore .

A new objective has been proposed by Angel which I find very interesting. Extending the instrument to long periods is possible and is the impetus for this forum in addition to the original objective.

After several "learning experiences" that provided poor results but good direction I developed the idea that has led to the FMES. It has its origins in both large and very small tiltmeters but it is NOT a tiltmeter . The instrument discards the static tilt information retaining only the dynamic tilt and horizontal acceleration information. There has been no attempt (so far ) to control long term tilt stability that is not relevant to a seismometer application. Tilt information is used only to level the instrument in initial setup.

The instrument design is based on two parallel tubes or pipes connected by short vertical sections at both ends. The lower tube is filled with a water based fluid which forms a water column seismic mass. The upper tube is filled with air to balance the pressure on the fluid . The entire instrument is made of PVC pipe except for a short section in the vertical section that is metallic (currently brass) The metallic section is part of the transducer which I will describe later.
[In later designs, the metallic tube was replaced by a deep vertical reference wire.]

The key element in the FMES is a restriction in the water column that makes the dynamic response highly overdamped. The restriction acts as the integrator that makes the volume of fluid transferred through the restriction the integral of acceleration or velocity for seismic motions at frequencies above the hydraulic pole of the integrator.

The transducer is a coaxial conductivity cell consisting of the short section of metallic pipe [now a deep reference wire] as one electrode. The second electrode is a coaxial pipe or rod that extends half way through the metallic pipe section from above [now a shallow sensor wire] . The fluid level is adjusted such that the tip of the inner electrode is immersed in the fluid a few [one] mm. When the instrument is level and static the inner electrode at both ends will be immersed in the fluid equally. When acceleration produces a flow through the restriction , the fluid level will rise and fall on the electrodes.

The obvious question is the effect of surface tension. That is addressed by the addition of surfactants that both make the water slightly electrically conductive and reduce the surface tension. The result is a positive meniscus that moves over the surfaces of the electrodes with no evidence of sticking. The fluid currently in use consists of deionized water with 5ml/l of ethylene glycol based automobile antifreeze and 20 drops per liter of a silicone emulsion defoaming agent. [Later experiments show that the defoamer/surfactant is neither needed nor helpful.]

The transducers are conductivity cells that respond to the area of the center electrode that is immersed in the fluid . They become the legs of a conductivity bridge that measures the difference in the level between the two ends That difference is proportional to the velocity of the seismic motions within the bandwidth of the integrator and to acceleration below the cutoff of the integrator . The hydraulic time constant of the integrator is set at about 4 seconds making the low frequency cutoff about 25 seconds.

The electronics consist of only 3 ic's . The core of the system is the LTC1043 acting as the bridge driver at about 80 KHz square wave and a switched capacitor sampler.
Two dual op amps complete the electronics.

Sensitivity is limited by the seismic background both at my home and in rural Panama where Angel has one set up. The response is very comparable with USGS seismometers available on the web. Microseisms are the dominant background. Two FMES instruments set side by side will give almost exactly the same response to the seismic background in any selected band within the passband of the instrument .

I have built instruments ranging in length from 1/3 meters to 1 meter . The instruments I operate continuously and for development are 1/ 2 meter.

I chose the conductivity bridge rather than a capacitance bridge for simplicity. I was very pleased and surprised at how well it works . I have quit a lot of experience with capacitance bridges and was prepared to go that route if the conductivity bridge had not worked so well.