**Piezo-Pumps for Clean Sustainable Buildings.**

**Piezoelectric pumps – are a type of displacement pump that use the piezoelectric effect to move fluids. They consist of key components such as chambers, valves, and a piezoelectric element (usually a ceramic disc). When the electrical voltage is applied to the piezo-material, it deforms and creates a mechanical strain, which moves the fluid through the pump.**

 Recent development on cement-based [piezoelectric](https://www.sciencedirect.com/topics/materials-science/piezoelectricity) functional composites was introduced. Two internal connectivity patterns relating to the [functional ceramic](https://www.sciencedirect.com/topics/materials-science/functional-ceramics) phase, 0-3 and 2-2 types, were adopted in the development. 0-3 Cement-based piezoelectric composites were produced by incorporating different types of piezoelectric [ceramic powders](https://www.sciencedirect.com/topics/engineering/ceramic-powder) into [Portland cement](https://www.sciencedirect.com/topics/engineering/portland-cement) matrix( Portland cement is the basic ingredient of concrete mortar and plaster which consists of a mixture of oxygen of calcium, silicon and aluminum. When first made and used in the early 19th century in England, it was termed portland cement because its hydration product resembled a building stone from the Isle of Portland off the British coast. The first patent for portland cement was obtained in 1824 by Joseph Aspdin, an English mason). In order to explore the advantages of combining cement with piezoelectric ceramic, 2-2 cement-based piezoelectric ceramic composite was fabricated and studied, where both the ceramic and cement phases are two dimensions. The 2-2 piezoelectric composite exhibits a desirable direct piezoelectric effect and converse piezoelectric effect, so it can be used both as sensor and actuator in intelligent structures. A self-sensing actuator can be fabricated based on this kind of composite. A self-sensing actuator, by using a simple bridge circuitry, can sense the information of mechanical status in the structure by itself, which not only reduces the number of sensors needed in the structures, but can also yield theoretically perfect collocation between sensing and actuating performances

HVAC Systems: Piezo Pumps can be used for in heating, ventilation and air conditioning systems to control the flow of refrigerants or other fluids with high precision.

Water Supply Systems: They can be employed in water distribution system to ensure a constant and precise flow of water.

Fire protection System: Piezo pumps can be used in fire suppression systems to delivery fire retardant chemicals accurately.

Laboratory equipment: In buildings facilities, piezo pumps can be used for precise flued handling in experiments and processers

Benefits: High precision: -They offer precise control over fluid flow rates.

-Low power consumption: They are energy efficient, making them suitable for applications where power conservation is important.

-Compact and Lightweight: Their small size and light weight make them easy to integrate into various systems.

Balance: Ensure that all cells are well-matched in terms of performance to avoid losses due to mismatched cells.

Also- PM particles can indeed be generated in buildings. Indoor PM concentrations can be influence by both indoor activities and outdoor air pollution that enters the building. Common indoor sources of PM include:

Cooking: activities as frying, grilling and baking can release fine particle into the air

Heating: Using wood stoves, fireplaces, or even some types of central heating systems can generate PM1

Cleaning: Vacuuming, sweeping, and dusting can stir up dust and other particles.

Construction and renovation: Activities like sanding, cutting, and drilling can release significant amount of PM2

 personal care products can emit volatile organic compounds (VOCs) that contribute to indoor PM levels.

To manage indoor PM levels, it’s important to ensure proper ventilation, use air purifiers, and minimize activities that generate high levels of PM. -link.springer.com

For sensors crucially important Single structure of piezo crystal inside the sensor, which means -only one required orientation of generated electrical field with advanced manufacturing.

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