

**Industrial Consultancy & Sponsored Research (IC&SR)**

**CONCEPT AND DEVELOPMENT OF A FLOW SWITCHING  
SUDDENLY EXPANDING MIXING (FSSEM) NOZZLE**

**IITM Technology Available for Licensing**

**Problem Statement**

- Flow geometries has immense importance in fundamental and applied fluid mechanics studies, such as analysis of **blood flow patterns, combustion dynamics, and rapid vacuum generation**
- In axisymmetric sudden expansion geometries, the flow tends to **transition between highly asymmetric and less asymmetric states** when changing from a symmetric planar sudden expansion (two-dimensional) to an axisymmetric (three-dimensional) geometry which **imparts challenges in optimizing fluid flow behavior**

**Technology Category/ Market**

**Category – Applied Mechanics & Mechanical Engineering**

**Applications**–Biomedical systems, combustion chambers, vacuum ejectors, Flow separation techniques , gas turbines, aerodynamics, Hydraulics

**Industry – Biomedical; Oil and Gas; Automotive**

**Market -Fluid Control Market** was valued at **USD 4,972.8 million in 2022** and is expected to grow at a **9.7% CAGR** from 2023 to 2029.

**Intellectual Property**

- IITM IDF Ref. 2224
- IN449740- Granted

**Key Features / Value Proposition**

❖ **Technology Perspective:**

- ✓ Provides an apparatus for flow control and mixing applications of fluid in a **sudden expansion geometry**
- ✓ Capable of continuously **switching flow of the fluid between asymmetric flow and symmetric flow**, to enhance the mixing characteristics of the fluid.
- ✓ **Precise control of fluid** flow while switching it between symmetric and asymmetric states at a specified rate
- ✓ **A higher flow growth rate** when the arcuate member is between the top and bottom walls indicates **better mixing enhancement**.

❖ **User Perspective:**

- ✓ A **cost-effective and efficient mechanism** in sudden expansion geometry in **both low-speed and high-speed flow conditions**

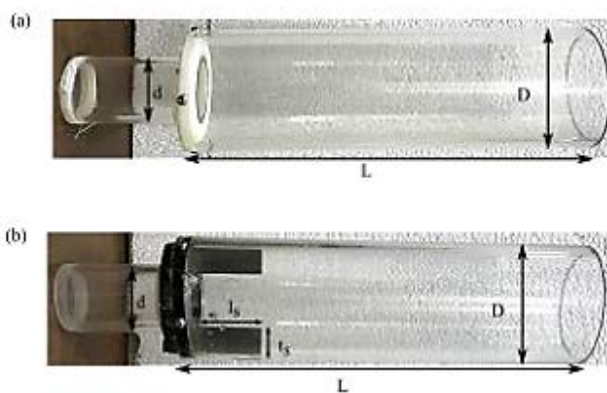
**Technology**

The present invention discloses an apparatus and a method for controlling flow of a fluid

**Major components include:**

- A sudden expansion member
- A flange
- An arcuate member

- **Sudden expansion member** has a top wall and a bottom wall and also comprises a pair of side walls
- **Flange** is connected to the proximal end of the sudden expansion member
- The **arcuate member** has a **U-shaped profile**, that includes opening in the form of a slot extending in the longitudinal direction of the arcuate member
- The arcuate member coupled to the flange is configured to move in a **lateral direction of the sudden expansion member**, the said opening is present for inlet of the fluid into the sudden expansion member



**Fig. 1(a)** illustrates an axisymmetric sudden expansion member with an expansion ratio of 2 and aspect ratio of 3.75 for controlling flow of the fluid.

**Fig. 1(b)** illustrates the axisymmetric sudden expansion member provided with a pair of splitter plates placed in a recirculation zone of the flow.

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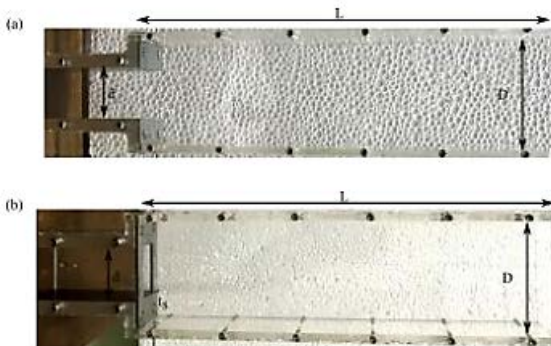
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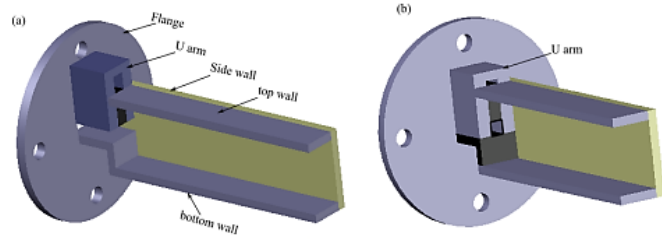
*The Method for Controlling Flow of Fluid the following steps :*

- **Control of Arcuate Member:** Flow of a fluid is controlled through the manipulation of an arcuate member, capable of lateral movement within a sudden expansion member
- **Velocity Profile Measurement:** The velocity profile of the fluid is measured at multiple axial locations within the sudden expansion member
- **Comparing a flow spread:** Compared at plurality of axial locations of the sudden expansion , to provide insights into the uniformity or asymmetry
- **Calculating a flow growth rate:** Rate of change of the flow spread at the plurality of axial locations of the sudden expansion member, when the arcuate member is between the top wall or the bottom wall
- **Evaluating Mixing Enhancement:** Comparing the flow growth rate with the rate of change of the flow spread of the fluid when the arcuate member is at any of the top wall or the bottom wall

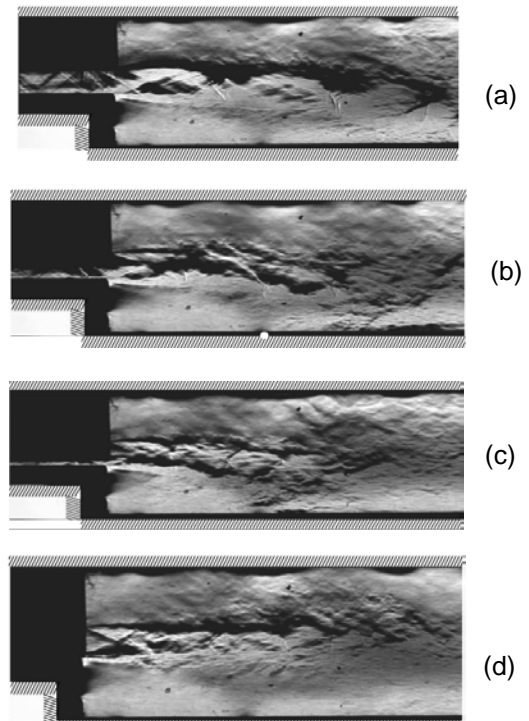
- ❑ The arcuate member moves between the top wall and the bottom wall to continuously **switch the flow of the fluid between an asymmetric flow and a symmetric flow**
- ❑ The apparatus may include a **controller for varying the speed of an output shaft** of the electric motor and a **hall-effect encoder** for measuring the speed of the output shaft of the electric motor.
- ❑ This comparison allows for the assessment of how effective the method is in enhancing the mixing of the fluid as it flows through the sudden expansion member.



**Fig. 2(a)** illustrates a planar symmetric sudden expansion member with an expansion ratio of 2 and an aspect ratio of 3.75 for controlling flow of the fluid.  
**Fig. 2(b)** illustrates the planar symmetric sudden expansion member with slotted plates placed at an entry location of the sudden expansion



**Fig. 3(a)** is the isometric view of FSSEM nozzle in two-dimensional position and **Fig. 3(b)** is the isometric view of FSSEM nozzle in three-dimensional position.



**Fig. 4(a) to 4(d)** illustrate images showing flow of the fluid in a sudden expansion geometry when an arcuate member is moved between a top and a bottom position, obtained by a schlieren flow visualisation technique.

**TRL (Technology Readiness Level)**

**TRL-5, Technology Demonstrated in Relevant Environment**

**Research Lab**

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