

Upgrading the IEC41 code with respect to acoustic discharge measurement

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IEC 41: Acoustic discharge measurement: transit time method (time of flight)

- **Secondary method → primary method**
- **Integration technique**
- **Application limits**
- **Installation issues**

Primary method

Time has come for an upgrade (1991)

- **Many years of experience (learned our lessons)**
- **Positive features**
 - **continuous flow measurement (best practice requirement)**
 - **little degradation of components**
 - **stable operation, good accuracy**
- **Technological advance for acoustic measurement methods**

Integration technique I

- **As today: Gauss-Jacobi for circular and Gauss-Legendre for rectangular section for 4-paths in one plane and uniform velocity distribution**
- **Inclusion of positions and weights for turbulent velocity profile**
 - **circular sections** → **OWICS (Optimal Weighted Integration for Circular Sections)** Voser [1999],
Tresch et al [IGHEM 2006]
 - **rectangular sections** → **OWIRS (Optimal Weighted Integration for Rectangular Sections)**
Lüscher et al [IGHEM 2008]

Integration technique II

- **Table for arbitrary path numbers from 2 to 9?**
- **Inclusion of correction formula for non-ideal path positions**
 - **generic presentation and table for important cases**
Tresch et al [IGHEM 2008]
- **Procedure of how to calculate the flow in non-ideal crossed path configurations (path parameters of crossed paths not equal)**

Application limits I

- **Influence of protrusion**
 - formula
 - error range as a function of velocity, path length and sensor length
- **Limits of application expressed by the product $L(\text{or } D) \cdot v$**
 - Table for certain values of L and v

$L \cdot v = \text{const} \rightarrow \text{same accuracy}$

Application limits II

- **Limits of applications expressed by difficult flow conditions**
 - **Under what conditions increasing the number of paths does not help anymore?**

Lüscher et al [Hydro 2007]

- **In which cases simulation studies can help?**
- **Effect of particles and air bubbles?**

Installation Issues

- **Distinction between pump and turbine operation**
 - **effects of obstacles up- and downstream**
 - **Table with recommended distances from obstacles**
- **Orientation of path planes with respect to pipe axis for most important applications**