How Coriolis flowmeters got their name – and kept it

Jesse Yoder, founder of Flow Research, explores the scientific and commercial history behind the Coriolis flowmeter – and the enduring legacy of its name

Coriolis flowmeters hold the distinction of being the only type of flowmeter that measures mass directly.

Other devices – such as thermal meters, mass flow controllers, and multivariable flowmeters – either derive mass flow by multiplying volumetric flow by density, or by relying on other indirect indicators. One exception is that some mass flow controllers also utilise the Coriolis principle.

Coriolis meters can measure both liquids and gases. However, they perform more effectively with liquids due to their greater density.

The operating principle of a Coriolis meter involves the momentum of the fluid causing deflection of the flow tube. As gases are less dense, they struggle to produce enough momentum to deflect the tube effectively. While straight-tube Coriolis meters have found success in liquid measurement, applying them to gases has proven more challenging.

A major application area for Coriolis meters is in downstream petroleum operations, where they are increasingly replacing positive-displacement meters. Unlike these mechanical meters, Coriolis meters contain no moving parts–aside from the oscillating tube–making them both efficient and durable.

Setting the record straight: Before micro motion

Many people trace the origin of the Coriolis flowmeter to Jim Smith, founder of Micro Motion in 1977.

While Smith rightly receives credit for the invention and, more importantly, its commercialisation, a chain of scientific developments long predates his contribution. Even before discussing the technical brilliance of these meters, the origin of the name "Coriolis" provides a fascinating historical insight.

A Coriolis flowmeter

The legacy of Gaspard-Gustave de Coriolis

Gaspard-Gustave de Coriolis (1792–1843) was a French mathematician, physicist and engineer, best known for describing inertial forces in rotating reference frames – what is now termed the Coriolis effect.

His work bridged theory and practice, influencing modern meteorology, oceanography and fluid dynamics.

His 1835 paper, *Sur les équations du mouvement relatif des systèmes de corps*, laid the groundwork for what later became known as the Coriolis force. In it, Coriolis explained how Newton's laws must be adjusted when applied within rotating frames of reference. He introduced the now-famous term:

$$F = -2m(\omega \times v)$$

Where:

- m is mass
- ω (omega) is angular velocity
- v is linear velocity

To this day, Coriolis' original 1835 paper has not, to our knowledge, been officially translated into English.

> **"Even if the theory remains debated, there is no dispute that Coriolis flowmeters changed the landscape of flow measurement forever"**

Flow Research, in collaboration with Belinda Burum, undertook this task and will publish the full translation in an upcoming volume on mass flow measurement, under Taylor & Francis.

Though Coriolis' work is often associated with waterwheels, his paper made no mention of them.

That connection arose later through reinterpretations of his findings. His use of the term *force vive* ("living force") reflected the language of classical mechanics, and has since evolved into our modern understanding of kinetic energy.

Coriolis in the scientific lexicon

Coriolis' ideas slowly entered the scientific mainstream:

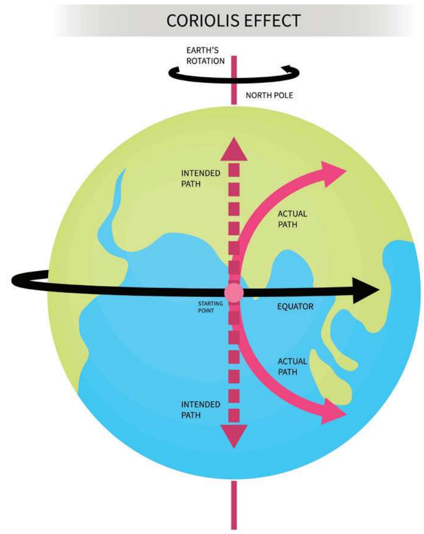
- **1835:** Publishes foundational paper on rotating systems.
- **1856:** William Ferrel applies Coriolis equations to explain wind deflection due to Earth's rotation.
- **1877:** Félix Tisserand incorporates Coriolis terms into celestial mechanics.
- **1901:** The term "Coriolis effect" becomes widely used in meteorology and oceanography.

The name enters the flowmeter world

Although Coriolis' force became standard terminology in physics, it was not until the mid-20th century that it entered the world of flow measurement.

Several engineers attempted to apply the principle to mass flow measurement, each contributing to the development of what we now call Coriolis flowmeters.

Roby White – 1958
White was the first to use the term "Coriolis mass flowmeter" in a patent. His invention used actual rotation of a fluid in a curved path to invoke Coriolis forces. Though quite different from today's vibrating-tube designs, it was a foundational step. Claim excerpt: "A flowmeter comprising a conduit curved in a loop... rotating the conduit about an axis to impart angular velocity... displacement caused by Coriolis forces."



This image shows the Coriolis effect

Yao Tzu Li – 1960
An MIT professor and aerospace engineer, Li refined White's design. His rotating conduit system was more accurate and demonstrated the viability of Coriolis-based mass flow metering.

Anatole Sipin – 1965
Sipin was the first to propose using oscillation instead of rotation. His vibrating-tube design measured inertial deflection caused by fluid movement–essentially anticipating modern Coriolis meters.

James E. Smith – 1975 (patented 1978)
Smith's design marked the first commercially successful Coriolis flowmeter. Using flexible vibrating tubes, he measured the phase shift between inlet and outlet caused by the fluid's mass flow. His patent cited Sipin's work but was the first to fully embrace the Coriolis force as an explanation.

Patent abstract: "An apparatus... measuring the torque generated by the Coriolis force."

Oscillation vs rotation: A semantics debate

While some argue that oscillation is a form of rotation, they are mechanically distinct. Rotation involves circular movement around an axis, whereas oscillation is a back-and-forth motion about a central point.

Critics of the Coriolis nomenclature point out that vibrating-tube meters do not operate in a rotating reference frame.

However, proponents argue that "the maths works," and that's what matters for functionality. Indeed, the phase shift between the inlet and outlet tubes is central to how these meters measure mass flow.

One could argue – based on inertial motion – that the deflection of tubes is not due to Coriolis force per se, but rather the result of fluid inertia.

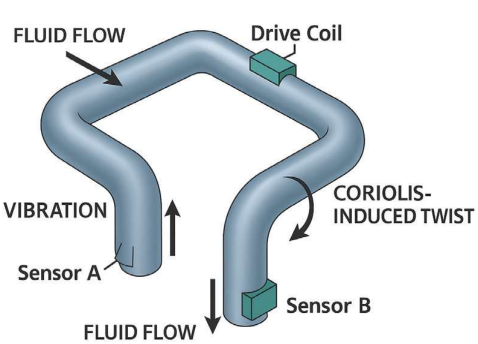
This alternative interpretation doesn't change how the device functions, only how we explain it. In 2011, Dr Jesse Yoder even proposed the term inertial mass meters as an alternative in Flow Control magazine.

Why the name stuck

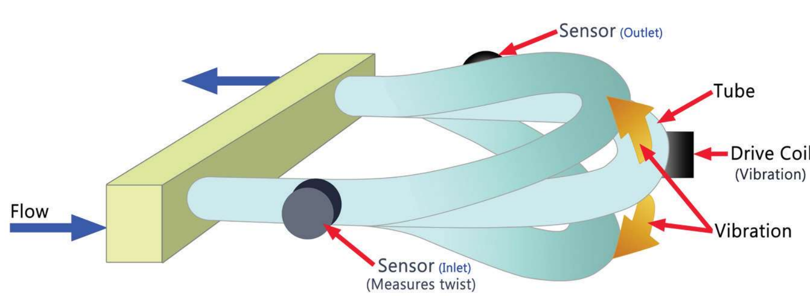
Despite debates, the name "Coriolis" stuck – thanks largely to Roby White's 1958 patent. Sipin, while foundational, avoided the term in his patent. Jim Smith, however, fully embraced it and commercialised the vibrating-tube design with great success.

By the time Micro Motion was acquired by Emerson in 1984, Coriolis meters had become the industry gold standard – offering the highest accuracy of any flowmeter on the market. Today, they remain the global revenue leader in flow measurement technology.

For more information:
Visit: flow.research.com



Pic 3: An image of the Coriolis tube



(Coriolis Mass Flowmeter)