

# COMBUSTION CALORIMETRY: YESTERDAY, TODAY AND TOMORROW.

**Andrei Yermalayeu<sup>1\*</sup>**

<sup>1</sup> Parr Instrument Company, Moline, IL, USA

\* E-mail: ay@parrinst.com

**Keywords:** oxygen vessel combustion calorimetry, combustion calorimetry instrumentation, combustion calorimetry applications

Oxygen vessel combustion calorimetry, resembling its current form, appeared in the second half of the 19th century. At the turn of the 20th century it found huge success in industry during mass electrification, when coal consumption skyrocketed. Businesses embraced a tool that allowed the characterization of an energy source by its heat generating ability. Further development of combustion calorimetry techniques and instrumentation continued on two fronts – fundamental thermodynamic research and industrial R&D. Despite significant differences in goals and objectives, advances made in one branch were gradually adopted by the other: new instrument designs, new materials for vessel construction, specialty calorimeters, etc. Combustion calorimetry development in thermodynamic research suffered from declining interest in the second half of the 20th century. However the industrial counterpart continued using advances in the microcontrollers and automation.

Today, combustion calorimetry is a well-established and consolidated domain, with characterized major use cases, and is far from decline. Modern day development is driven by special requests and gradual adoption of advancements in technology. The decades-long dominance of coal testing as the primary use for combustion calorimetry may be over, but the wide scope of other applications has dramatically gained popularity: medical and nutrition research, energetic compounds development, biomass characterization, recycling and waste management, building materials testing, etc. Globalization of markets has led to a usage harmonization, however regional markets still retain their unique aspects.

Balancing user convenience, price, and the suitability of the equipment to a given application has always been a primary driver in the industry. Calorimeter manufacturers offer models for variety of needs including: high-throughput lab testing, occasional standard testing, nonstandard testing, or teaching. Parr also provides customized options for special applications: from calorimeters with access to pressure profile data, to micro vessels for energetic compounds.

Looking forward, the field of combustion calorimetry finds itself in a peculiar position. Despite its maturity, growth into new applications, and many new users, continuity of the tradition seems to have been broken. Thermodynamic research which includes the pillars of theoretical and practical knowledge persists in a dwindling handful of groups around the world, while academia teaches just its most basic concepts. Calorimeter manufacturers, on the other hand, seem to restrict themselves to the codified standard use cases, resulting in the loss of understanding of the mechanisms underlying the methods. Rapid digitalization and user experience with consumer electronics also create misleading expectations that an instrument is a smart black box. The result is concerning: important fundamental details are often overlooked, and users frequently are not aware of combustion calorimetry pitfalls. And those who are, often fail to obtain required advanced knowledge, as well as useful tips and tricks, if they are not available at the click of a mouse.

Industrially-focused combustion calorimetry does not seem to be approaching its sunset, but a changing world brings new demands. On one hand measures must be taken to make knowledge and experience available for general users. At the same time it is a challenge for us, manufacturers, to adapt an old tool to the character of the new generations of digital native users and their expectations.