Karol Jabłoński Gliwice, 16.11.2020 r.

PhD Thesis synopsis
"Improvement of metrological parameters of flamable gas sensors"

The possibility of an explosive atmosphere in industrial facility requires constant monitoring of the air composition for traces of flammable substances. Correct risk assessment, which is possible thanks to reliable detection of hazardous substances, is the basis for taking adequately swift and proportionate preventive actions. The reliability of the measurement is crucial here, and it can only be provided by a system that generates no false alarms and responds quickly to a real danger. The sensor, which is its core, must be characterized by resistance to disruptions (including environmental factors), appropriate sensitivity, short response time, and resistance to damage. It is also important for the used technology to inspire consumer confidence.

Therefore, research was taken to comprehensively understand the functions of the catalytic flammable gas concentration sensor (pellistor) and possibly improve its metrological parameters.

As part of the thesis, the functioning of catalytic sensor was thoroughly analyzed, which resulted in the creation of dynamic mathematical model and the analysis of its nonlinear parameters. Appropriate measurement systems have been designed and used to conduct comprehensive studies into sensors available on the market. The research included almost year-long tests, which facilitated the understanding of temporal transducer drifts and provided basic information enabling their further selection for appropriate applications, made it possible to adjust their service period, and also allowed to decide on the correct compensation algorithms. The sensitivity of sensor ambient temperature difference was also examined and the method of temperature error identification was proposed which works without the use of expensive and time-consuming tests in a climate chamber. The impact of humidity on the sensors was studied, requiring the creation of an original gas humidity control system.

The sensor response times were tested in numerous hardware configurations, taking into account the many variants of flameproof covers. The main subject of this test were sintered metals, which while providing flameproof barrier allowing for atmosphere diffusion. In addition to reaction times, the device sensitivity as well as its mechanical resistance were also analyzed. The sensitivity of the sensor to gas flow was also tested, which required the construction of appropriate testing area. In addition, the influence of various mechanical cover designs on the parameters of the sensor was analysed.

In the light of this research, it was proven that the optimization of sintered metal parameters and other elements of the sensor flameproof shield allow for a wide range of adjustments of its metrological parameters such as sensitivity, response time, and the resistance to external conditions. This enables the sensor to be improved and adapt it to a given environmental requirements.

The aforementioned research made it possible to prepare a methodology for testing pellistor sensors for compliance with the PN-EN 600079: *Explosive atmospheres* series standards and consumer expectations. The information obtained also allowed for selection of the best parameters for commercial applications of flameproof measuring heads. Ultimately, the sensor equipped with the housing designed based on the results obtained in the study received a certificate of compliance with european standards of the International Electrotechnical Commission (IEC) issued by the Physical-Technical Testing Institute FTZU in the Czech Republic.

Further research on accelerating the sensor response was conducted by analyzing the voltage and current signals in the working circuit. The use of algorithms for recovery measurement signals combined with appropriate methods of identifying the inverse model allowed for a significant reduction in the sensor response time for the appearance of explosive atmosphere.