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Primary Measuring Transducer of a Diagnostic Spirometer Based on a Venturi Flowmeter

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Abstract

The presented work is devoted to the development of a primary measuring transducer implemented on the basis of Venturi flowmeter for a portable spirometer. A modified Venturi flowmeter design has been proposed to enable measurement of two phases of the respiratory cycle (expiratory and aspiratory). This modification differs from the classical version in that it has a symmetrical shape relative to the median plane, which is perpendicular to the tube axis at the throat section. It has been shown in the paper that the curves showing dependence of pressure drop Δp on inlet flow Q, for classical and modified Venturi flowmeter have good convergence. In order to develop a mathematical model of the proposed Venturi flowmeter design, basic hydrodynamic equations, such as Bernoulli equation and continuity of flowequation, have been used and calculation methodology of Venturi nozzle for rhinomanometry problems has been applied. Using the calculation results, a 3D model of the Venturi flowmeter was created in SolidWorks CAD, followed by static and dynamic studies. Based on the simulation results, the pressure distribution graphs along the Venturi flowmeter inner surface at maximum $Q = 16\ l/s$ and minimum $Q = 0,1\ l/s$ inlet flow rates have been obtained. These graphs made it possible to determine theminimum andmaximum pressure drop at the installation points of the differential pressure sensor (secondary transmitter) and to establish the pressure variation range in which the sensor should measure. The error of the simulation and calculation results was assessed and showed good convergence in the input flow range $Q = 0,1 \div 8\ l/s$.

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Further research will focus on developing a secondary transducer and integrating it with the primary transducer to create an air volume velocity transducer with improved metrological characteristics.

Keywords: diagnostic spirometers, differential pressure sensors, spirometers, spirometry, Venturi tubes

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