The salient features of capacitance pressure pulsation sensors are presented.

A whole group of problems in research on physical and production processes involve the acquisition and processing of data streams, problems which are solved with difficulty at great cost with the aid of modern sensors for physical quantities. This applies, in particular, to problems of obtaining information about discrete and integrated values of the pulsations of pressure, temperature, heat flow, and deformation, and determination of complex physical transitions in short, repeated short, and long time intervals. Solving those problems using modern flowmeters involves distorting the conditions under which physical processes occur on the surface of objects and requires additional treatment of the surface of the object being studied; this is expensive because the work is so laborious.

One way of increasing the future effectiveness of aeronautical engineering, shipbuilding, and mechanical engineering is to use newly developed thin-film sensors for physical quantities. Those sensors have a high functional density and allow several different physical parameters to be measured simultaneously, thus substantially cutting the measuring time by combining a number of experiments.

One of the most important distinguishing features of the thin-film sensor is that it can average the pressure over the measuring area. Such a sensor can thus be used to measure the local and integrated pressures that act on a considerable area. Solving such a problem with ordinary sensors requires that tens of sensors be located in a thin section. A flexible film is used and several sensing elements (SE) are formed on one substrate. As a result, flow distortions caused by local thickening due to the placement of several sensors along the airfoil in aerodynamic tests can thus be avoided. The pressure sensor is a plane condenser of an SE made of metallized dielectric films [1, 2].

If such sensors for physical quantities are to be made, it is most necessary that the turbulent, laminar boundary layers in a gas flow, along with their transition regions, shock waves, and parameters of the perturbed liquid (gas) flow be determined and that their measurement be combined with the simultaneous measurement of the deformation, temperature, and heat flow. Determination of the local and integrated pressures, buffeting of aircraft and an estimation of transient aerodynamic loads make it possible to solve a large number of aeroelasticity problems.

It is important that the physics of the aerodynamic processes be penetrated without additional treatment of the surfaces of objects and without distortion of the conditions of flow past the surface of the model, which are done at great expense when flowmeters are used.

Here we present the main characteristics of several types of thin-film sensors that ensure a wide range of conversion characteristics and work reliability in aerodynamics, aeronautical acoustics, under the conditions of corrosive media, low and elevated temperatures, salt water, making it possible to raise the economic indicators and reliability of aviation engineering, manufacturing, power engineering, etc.
When fabricating thin-film pressure sensors with sensing elements of solid (homogeneous) and gaseous (heterodyne perforated) dielectric, we should use the dependence of the variation of interelectrode (interplate) gap on the input signal (pressure), which enables us to obtain the necessary characteristic calibration range and accuracy of measurement, a broad band of input and output parameters and high reliability indicators.

To this end we must:

1. Design sensors to simultaneous measure discrete and integrated values of pressures in a given segment, combine pressure measurements with other kinds of measurements, and ensure reliability of measurement by doubling the sensing element.

2. Design sensors with a minimum discreteness step (with a high resolution).

3. Study the operating principle of capacitance thin-film sensors – elastic compression (sensing element with a solid dielectric) and bending of a membrane inside perforation cells (sensors with a gaseous dielectric).

4. Choose reasonable values for the size of the sensing element and the load (pressure) so as to ensure a maximum sensitivity coefficient or maximum pressure pulsation, given a static pressure [1, 3].

The sensitivity of the solid-dielectric sensor of the DET-3 type depends on the elastic modulus \( E \) and Poisson’s ratio \( \mu \),

\[
\frac{\Delta C}{C} / p = \frac{1-2\mu}{E},
\]

where \( C \) is the initial capacitance, \( \Delta C \) is the capacitance increment, and \( p \) is the pressure.

This equation holds when the sensor is not mounted on the surface of the object being studied, but is in a free sound field.

When the thin-film capacitance sensor is glued onto the surface of an object of any configuration and is placed in a free acoustic field, the sensitivity of the sensor is

\[
\frac{\Delta C}{C} / p = \frac{(1+\mu)(1-2\mu)}{E(1-\mu)}.
\]

According to the last two formulas, the sensitivity of a solid-dielectric sensor lies between \( 1.67 \cdot 10^{-10} \) and \( 2.78 \cdot 10^{-10} \text{ Pa}^{-1} \), respectively.

A gaseous-dielectric sensor has to be designed because of the low resolution of solid-dielectric sensor in the range of low pressures (20 to 40 Pa). The three-layer and four-layer gaseous-dielectric sensors (DEG-3 and DET-4) are of this type.

We calculate the parameters of the sensor by using the equation for the deflection of a cantilever beam. We determine the capacitance of a perforation cell and wall and the increment of the capacitance and of the sensitivity coefficient. The sensitivity of a sensor with a cell to the pressure \( p \) is

\[
\frac{\Delta C}{C} / p = \frac{a^4(1-\mu^2)}{16Et\delta^3},
\]

where \( a \) is the radius of the perforation cell, \( t \) is the thickness of the perforated film, located between the plates of a plate capacitor, and \( \delta \) is the thickness of the sensor membrane (or the thickness of the upper plate of the capacitor).

The integrated pressure sensitivity of the sensor is

\[
\frac{\Delta C}{C} / p = \frac{a^4(1-\mu^2)}{16Et\delta^3} \frac{nC_p}{C_2 + nC_p},
\]

where \( n \) is the number of perforation cells, \( C_2 \) is the capacitance of a perforation cell, \( C_p \) is the capacitance of the \( n \)th unit cell with gaseous dielectric.

In practice the sensitivity of a gaseous-dielectric sensor lies within the limit \( \frac{\Delta C}{C} / p = 10^{-8} \ldots 10^{-5} \text{ Pa}^{-1} \).