1.6.10. STUDY AND DEVELOPMENT OF DEVICE FOR LOCALIZATION OF LEAKS IN VACUUM SYSTEMS

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Paper presents analysis of possibility to create localizing device for leaks in vacuum systems.

Timely detection of leaks is an important task in vacuum systems. One of the leak detection methods is vacuum method. It represents one of the non-destructive testing methods allowing detection of defects coming to a surface: cracks, cavities, lack of fusions, pores and other discontinuities of surface and weld-affected zone. The present methods makes it possible to detect the presence of leaks, rather than their localization in tested area. Vacuum bubble method is intended for this purpose and is based on the recording of bubbles of the foam-forming liquid applied preliminarily on the tested surface, which occur in the places of discontinuities. This method allows also defect size to be evaluated qualitatively under the rate of bubble size growth.

Vacuum bubble method is featured by the series of disadvantages: partiality of testing; omission of rough leaks due to the possible disrupt of the liquid film from a surface in the result of high intensity of gas flow escaping from a leak; possible false “activation” on closed pores due to the gas emission from the volume of part-through flaw; high labor intensity and low productivity; impossibility of process automation; low metrological support.

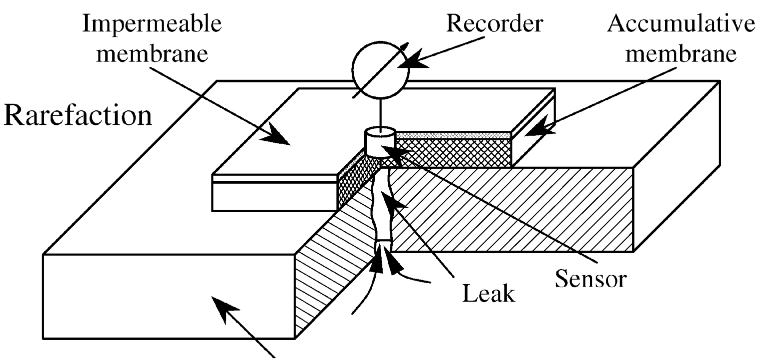

Figura 1

For localization of leaks, leak detection method with accumulative membrane (see fig. 1) is proposed. For its implementation, the following mathematical model is proposed – diffusion-convection equation for air in a membrane in the form of assembly of filtration equation with added continuity equation:

$$\begin{cases} \varepsilon \dfrac{\partial n}{\partial t} + \vec{w}\nabla n = [D]\Delta n + Q; \\ \vec{w} = -\dfrac{K}{\eta}\nabla P; \\ P = knT; \\ \operatorname{div}\left(\rho\vec{w}\right) = 2\pi Q, \end{cases}$$

where ε – is membrane porosity; n – additional air density in membrane; $\vec{w}$ – air velocity in membrane, $[D]$ – effective diffusion factor; Q – air flow through a leak; K – permeability index; η – coefficient of dynamic viscosity; P – pressure in membrane; k – Boltzmann constant; ρ – air density.

With initial and boundary conditions of the following form:

$$\begin{array}{ll} z = 0, & z = H, \\ x \in [0;\, B], \quad y \in [0;\, L], & x \in [0;\, B], \quad y \in [0;\, L], \\ c(x,\, y,\, 0) = \delta(y - y_{\text{ò}})(\eta(x) - \eta(x - B)); & c(x,\, y,\, H) = 0. \end{array}$$

Paper presents result of studying the present method and provides practical recommendations on its practical application.