1.6.5. RESEARCH OF LEAK DETECTION SYSTEMS WITH ACCUMULATIVE MEMBRANES

Mjasnikov V.M., Sazhin S.G.,
Dzerzhinsky Polytechnic Institute NGTU, Dzerzhinsk, Russia

Gas analyzing group implementing the method of probe is referred to the most demanded methods of flaw detection data acquisition. The essence of method consists in that tracer gas is supplied under pressure in article due to the pressure drop; this gas flows in leak channel and forms concentration field over article surface. Then, article surface is scanned with probe (sampler) in order to determine concentration of tracer gas by collection of sample and its transportation through capillary into the chamber of leak detector. Place of leak is determined by the position of zone with high concentration of tracer gas.

During localization under method of probe, problem of detection of small and large leaks should be marked out. Thus, probe displacement from a leak of $3.5 \cdot 10^{-8}$ $m^3 \cdot Pa/s$ size by the distance of 0.5 mm decreases sensitivity in four times. It is related with the fact that air flows present in the position of testing and dilute analyzed sample to concentration of tracer gas presenting in an atmosphere. As a result, sensitivity threshold is reduced. Large leaks with value of about $5.7 \cdot 10^{-3}$ $m^3 \cdot Pa/s$ and more form wide area with increased concentration of tracer gas. However, chaotic airflows presenting in the position of article testing distort concentration field and reduce leak coordinates determination accuracy.

As a measure to protect concentration field against external effects of atmospheric air, it is reasonable to use membrane method. Its essence consists in that membrane of porous structure is positioned over tested surface, while analyzed sample is collected from membrane or its surface. Since leaks generate small flows, concentration field is defined by tracer gas diffusion equation. In this case, the lesser is diffusion factor, the higher is concentration of tracer gas in the vicinity of leak. As a result, testing sensitivity increases. Presence of porous membrane over tested article surface contributes the reduction of diffusion factor. It can be traced by dependence establishing relationship between the tracer gas diffusion factor D in porous structure and atmosphere:

$$D = D_a \frac{\varepsilon}{T},$$

where D_a – is tracer gas diffusion factor in atmosphere; ε – is membrane material porosity; T – is sinuosity of pore channel in membrane. By selection of porous material with parameters $T = 1.5$ and $\varepsilon = 0.4$, it is possible to increase in 3.75 times the tracer gas concentration in the vicinity of leak and, hence, to improve sensitivity of testing.

Paper present results of studying the influence of porometric characteristics of membranes and their overall dimensions on interference immunity of the concentration field of tracer gas leak.

Under results of performed studies, conclusions are made and practical recommendations are given on the development of leak localization systems implementing the group of gas analyzing methods by means of probe:

– improvement of accuracy of determination of leak places and sensitivity of detected defects depends on measures undertaken in order to eliminate exposures from the part of atmospheric air flows upon concentration field of leak of tracer gas;

– exposures of atmospheric air flow upon concentration field of leak of tracer gas can be eliminated in full extent by location of a membrane with pores of open structure over tested surface;

– membrane thickness H and pore channel diameter D must comply with inequation $H / D \geq 6$;

– achievement of stable concentration field overcomes an obstacle in the field of creation of automated leak localization systems operating under method of probe;

– in order to increase testing sensitivity and productivity, it is necessary to select membrane material with lesser porosity, but with maximal sinuosity of pore channel;

– during testing of weld seam, membrane width and thickness must be equal to the triple width of weld seam tested zone;

– during mathematical simulation of the process of analyzed sample transfer in leak localization systems, selection of the quasi-homogeneous approximation method is justified.