Numerical modeling of a low partial pressure water source for vacuum process

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The presence of hard-to-remove water in the vacuum systems of research facilities or process lines is a problem in most cases. The ability of water to be easily absorbed and poorly desorbed by the surface of metal elements leads to the need for a long pump-down every time it opens to the atmosphere. It is necessary to get rid of water from the elements of the system by a thorough bake-up at temperatures of 400-500 K to achieve an ultrahigh vacuum [1-2].

On the other hand, some chemical experiments and technological processes require a controlled source of water vapour capable of keeping a low partial pressure (0.001-1.0Pa) in the given zone of the system (usually in the reaction or process zone) for a predetermined period of time (up to several hours).

For such a system this paper proposes a method to use the carbon-free metal surfaces of existing or specially introduced elements of the vacuum system (receivers, tanks, bellows etc.) as a source of water under its controlled heating. Intuitively clear, but yet difficult to implement in practice, the idea of using thermally desorbed water as a stable source now seems quite real when involving a computer simulation of the vacuum system. Such a model ensures the calculation of such a heating law of the source in time W(t), which would provide the required water pressure at the indicated point of the vacuum system, taking into account the temperature distribution along the system and the existing pumping means.

The paper presents a simulation cycle for such a water source using the example of an installation for studying high-temperature corrosion of SiC/C structures in water vapour. For calculations, the model of free molecular flow and the method of angular coefficients for its numerical approximation are used [3]. The source provides a stable value (or linear, or governed by any smooth law as needed) of water vapour pressure in the range between 0.005 Pa and 0.5Pa in the heating zone (at up to 1,700K) for 4-5 hours, depending on the required pressure value and the area of the desorbed source surface.

Acknowledgements

The work was carried out within the framework of the grant No.AP05132169 of the Ministry of Education and Science of the Republic of Kazakhstan.

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