Experimental Study and Numerical Simulation of Two-phase Flow on Water-vapor Separator in Space

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Water-vapor separation device is significance for the regenerative environmental control and life support in space. Because of the design features of the separation device, the internal roller will retain some residual liquid. The flow and distribution of the residual liquid in the separator under microgravity has an indispensable impact on the security of the spacecraft.

The microgravity experiment was carried out on the aircraft French NOVESPACE Airbus A300 ZERO-G by weightlessness flight tests. The performance of the separator was verified under microgravity environment. Water and urine were taken as the experimental fluids which were set in the grooves of the devices. The results were obtained by CCD camera during the weightlessness flight periods. Corresponding to the liquid distribution of the separator in space, Fig.1 and Fig.2 show the distribution of the liquid in the weightlessness conditions. It can be seen that the middle surface of the liquid declined and the edge of the liquid extended along the wall out of the grooves when the environmental acceleration transited from $1.8g_0$ to microgravity. There were some differences of the flow details between the two devices left and right sides of the figures. And for the both devices, there will be no residual liquid overflow from the outlets. In addition, the VOF method was used to simulate the free surface flow of liquid-vapor. By numerical simulations, we validated that the residual liquid can be well managed since the structure of the separators internal roller in the shutdown conditions.

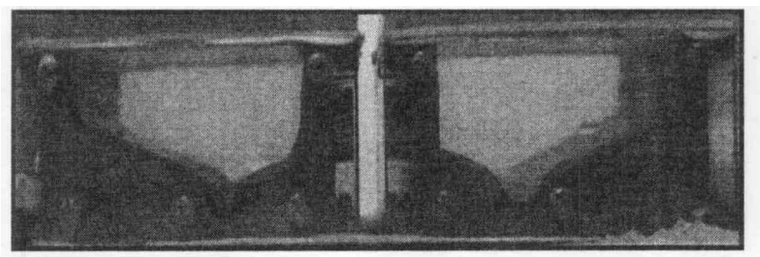

Figure 1: The liquid distribution in the weightlessness condition (water).

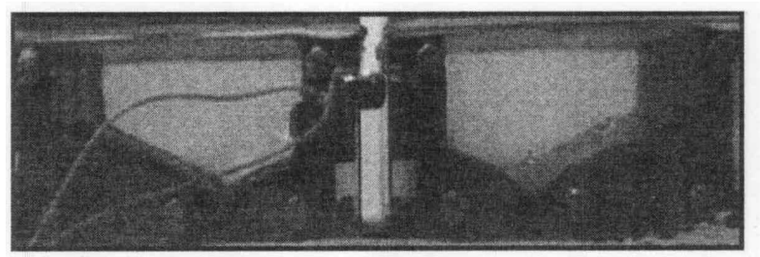

Figure 2: The liquid distribution in the weightlessness condition (urine).

References

[1]Scardovelli R., Zaleski S., Direct numerical simulation of free-surface and interfacial flow/ Annu. Rev. Mech., **31**:567–603 (1999).