ABSTRACT The anti-icing systems are usually used to protect aircrafts from icing. The anti-icing system protects the components from ice accreting by heating the surface and evaporating the water impinged on the surface. The anti-icing surface may form a water film if the heating energy cannot evaporate all the impinged water and the water film runs back due to aerodynamic forces. An accurate computational model of the water flow and heat transfer on the anti-icing surface is necessary for the anti-icing system design and the anti-icing performance analysis. A method of a fractional volume of fluid (VOF) is developed and applied to simulate the water film flow and heat transfer on an anti-icing surface. The mass transfer of the thin water film flow is considered in the calculation. The impinging mass, obtained by the computation of droplet impingement characteristics, and evaporating mass is also added into the continuity equation of the volume fraction as a source term. The flow field around the airfoil is obtained by ANASYS FLUENT software. The water impingement characteristic is calculated by using Eulerian approach after obtaining the flow field. In impingement regions, the surfaces are covered by continuous water film. The model of the heat and mass transfer of the runback water flow are embedded in the calculation using the User-Defined Functions (UDFs) in ANASYS FLUENT. The verification is conducted by the comparison with the results of the experimental measurement of water film thickness. The heat flux distribution on the anti-icing surface at different airflow temperature and wall temperature is analyzed.