Supplementary Materials

(Detailed description of the numerical analysis model)

1. Shear-stress transport (SST) k-ω model

In the shear-stress transport (SST) k-ω model to predict the flow of rim seal is as follows, the turbulent kinetic energy $k$ and the specific rate of dissipation $\omega$ are calculated using the following transport equation.

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_i}(\rho u_i k) = \frac{\partial}{\partial x_j}\left(\Gamma_k \frac{\partial k}{\partial x_j}\right) + G_k - Y_k + S_k$$

$$\frac{\partial}{\partial t}(\rho \omega) + \frac{\partial}{\partial x_i}(\rho \omega u_i) = \frac{\partial}{\partial x_j}\left(\Gamma_\omega \frac{\partial \omega}{\partial x_j}\right) + G_\omega - Y_\omega + D_\omega + S_\omega$$

$G_k$: the production of turbulence kinetic energy.
$G_\omega$: the generation of $\omega$, $G_\omega = \alpha^\omega_k G_k$
$\Gamma_k$ and $\Gamma_\omega$: the effective diffusivity of $k$ and $\omega$.
$Y_k$ and $Y_\omega$: the dissipation of $k$ and $\omega$ due to turbulence.
$D_\omega$: the cross-diffusion term.
$S_k$ and $S_\omega$: user-defined source terms.

2. Species transport model

The local mass fraction of each species, $Y_i$, is predicted through the solution of a convection-diffusion for the $i^{th}$ species. This conservation equation takes the following general form.

$$\frac{\partial}{\partial t}(\rho Y_i) + \nabla \cdot (\rho \vec{v} Y_i) = -\nabla \cdot \vec{j}_i + R_i + S_i$$

$R_i$: the net rate of production of species $i$ by chemical reaction.
$S_i$: the rate of creation by addition from the dispersed phase plus any user-defined sources.
$\vec{j}_i$: the diffusion flux of species $i$, which arises due to gradients of concentration and temperature.

The mass diffusion in turbulent flows is as follows.

$$\vec{j}_i = -\left(\rho D_{i,m} + \frac{\mu_t}{S_c} \right) \nabla Y_i - D_{T,i} \frac{\nabla T}{T}$$

$D_{i,m}$: the mass diffusion coefficient for species $i$ in the mixture.
$D_{T,i}$: the thermal (Soret) diffusion coefficient.
$S_c$: the turbulent Schmidt number. $S_c = \frac{\mu_t}{\rho \nu_t}$, where $\mu_t$ is the turbulent viscosity and $\nu_t$ is the turbulent diffusivity.
Reference
1. ANSYS Fluent. 15.0 Theory Guide.