§14. Acceleration of a Dust Particle in SOL/Divertor Plasma of HL-2A Tokamak

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The behavior of the dust particle in the SOL/divertor plasma of the HL-2A tokamak [1] with the single-null configuration is investigated. The background plasmas parameters are calculated by the B2-EIRENE code [2]. The ion flows, parallel and radial velocities, near the outer boundaries are shown in Fig. 1 for the 500 kW power input from the core region to SOL region, where the distance is calculated from the surface of the inner divertor plate to the outer one along the poloidal direction. The parallel flow speed gets to few km/s, which is much faster than the radial flow speed. The stagnation point of the parallel ion flow is located at the top of the SOL region. The plasma density, the electron temperature and the ion temperature near the stagnation point are about 10^{18} m^{-3}, 2 eV and 1 eV, respectively. The dust particles produced on the first wall, which is made of SS, move to the divertor plate along the parallel direction due to the strong plasma flow. The dust particle produced at the stagnation point reaches the maximum speed at the divertor plate. The time evolutions of the iron dust velocity along the parallel and poloidal directions with the radius of 1 μm at the high-field side and the low-field side are shown in Fig. 2 (*a*) and (*b*), respectively, where the initial speed of the dust particle is zero. In Fig. 2 the positive velocity of the dust corresponds to the direction from the inner divertor plate to the outer one along the poloidal direction. At the high-field side the iron dust is accelerate to 80 m/s in 320 ms along the magnetic field. On the other hand at the low-field side the dust parallel speed to the parallel direction reaches 50 m/s fin 400 ms, which depends on plasma parameters. During the acceleration the dust particles move around 6 m or 3 m along the parallel direction for the case of the high-field side and the low-field side, respectively. Please note that the major radius of the HL-2A is 1.65 m. The poloidal dust speed is around one third of the parallel dust speed in the HL-2A, which depends on the magnetic pitch angle around the SOL/divertor region. The total charging times due to electrons and ions during the movements are as short as ~ 10^{-9} sec, which is much faster than the dynamics of the dust particles (~ a few msec). This means that the equilibrium charge is applicable to this calculation. The normalized relative speed changes from around 0.01 to 3.0 for both cases of the high-field and the low-field sides. According to this change, the dust charge state Z_d changes from about 4000 to 50.

1) Liu, Y., Ding, X.T., Yang, Q.W., et al., Nucl. Fusion **45**, S239 (2005).
2) Pan, Y.D. and Schneider, R., J. Nucl. Mater. **363-365**, 407 (2007).

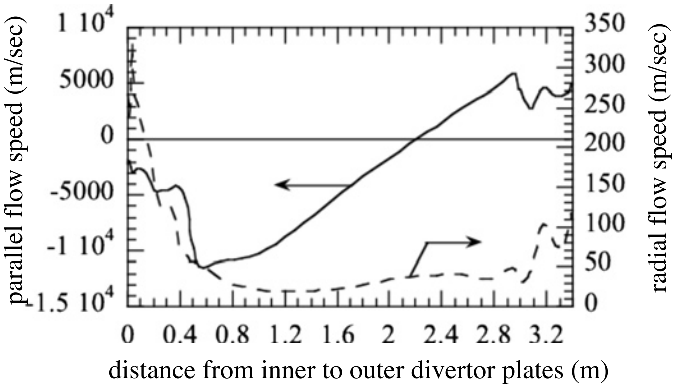

Fig. 1 Spatial change of the plasma ion flow speeds, parallel flow speed (straight line) and radial flow speed (dashed line), near the outer boundaries, where the distance is calculated from the surface of the inner divertor plate to the outer one along the poloidal direction.

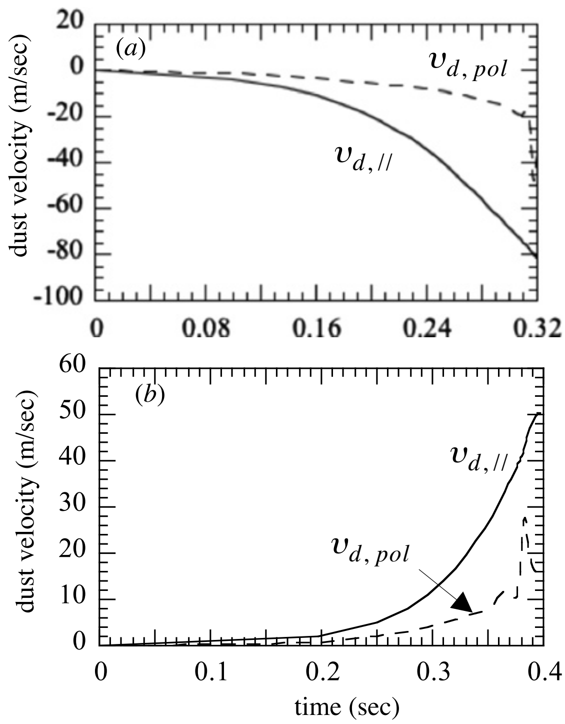

Fig. 2 The time evolution of the iron dust velocity with the radius of 1 μm along the parallel direction at (*a*) the high-field side and (*b*) the low-field side, where the initial speed of the dust particle is zero. The direction of the dust velocity is positive from the inner divertor plate to the outer one along the poloidal direction. The parallel and poloidal velocities are shown by the straight and dashed lines.