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Title:
Secondary flow structure characteristics of an automotive mixed flow turbocharger turbine volute at different aspect ratios

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Abstract:
This paper presents an experimentally validated numerical analysis of the influence of volute aspect ratio (VAR) on the fluid flow characteristics of a volute in a mixed flow turbine. The geometry of the volute subjects the flow to centrifugal forces that affect the vertical motion of the fluid, commonly known as secondary flow, which is fundamentally opposed in straight channels commonly associated with the primary flow. The flow characteristics were analysed for four-volute designs with constant volute area-to-centroid radius ratio (A/r) but with different VARs ranging from 0.5 to 2.0 at selected circumferential positions under steady state at different operating conditions. Secondary flow structure characteristics were identified based on pressure contours, velocity contours and streamlines. The internal volute flow structure was found to be dependent on the VAR. The results show corner and counter-rotating Dean effect-type vortices at higher volute aspect ratios. In addition, the results also show that as the pressure ratio increases, the deflection of primary flow increases and at certain positions, flow separation occurred. The resulting secondary flow structures that exist in the volute are strongly influenced by the VAR at different operating conditions, thus affecting turbine performance.