SELECTED TOPICS
In Aerospace Engineering

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In the previous chapter, it was assumed that the flow is two-dimensional and the radial velocity was neglected. This assumption is valid only for small blade heights. For high tip to hub ratio compressors, three dimensional flow must be considered. The radial flow results from the imbalance between the centrifugal forces and the restoring radial pressures. If the flow is under radial equilibrium, the streamlines lie in a circular, cylindrical surfaces and the flow is axisymmetric (neglecting the effect of the existence of the blades).

3.1 Theory of radial equilibrium

As shown in Figure 8, a small element of fluid of unit depth and an angle $d\theta$ is rotating about the axis with tangential velocity, c_θ. The element has a mass *dm*.

Under radial equilibrium condition, the pressure forces balance the centrifugal forces:

$$(p + dp)(r + dr)\,d\theta - p\,r\,d\theta - (p + \frac{1}{2}dp)\,dr\,d\theta = dm\,c_\theta^2 / r \qquad (3.1)$$

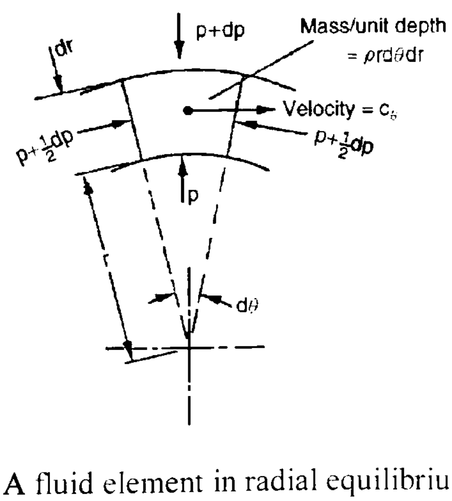

Figure 8 A fluid element in radial equilibrium ($c_r = 0$).