

Transonic tunnel techniques

By

Sangram Samal

Induced Flow tunnel

- In this type of tunnel a high speed jet is forced through a narrow annular slot downstream of the working section
- The jet induces the flow inside the working section
- If blowing pressure is high enough then the test section velocity can increase to supersonic
- The blowing jet can be provided from the compressor or from a compressed tank
- The advantage of this tunnel is that, this can run longer time compare to intermittent tunnel
- Blowing jet can be blown from compressor for longer time to have long run of tunnel

High Speed Subsonic Tunnel

- The speed and Mach No are increased simply by increasing the blowing pressure as the case of low speed tunnels.
- At subsonic Mach no at test section the flow at some point downstream of test section reaches to sonic due to boundary layer growth and tunnel is choked
- Choking may be delayed by using the slightly divergent walla

Chocking

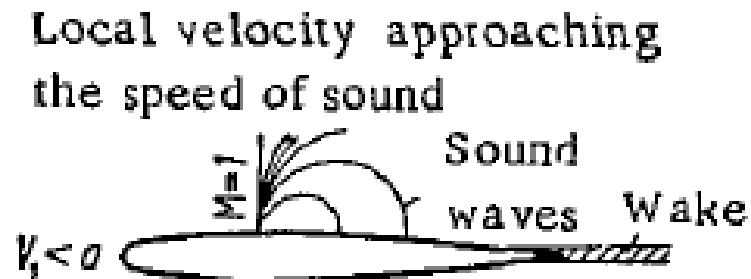
- The phenomenon of chocking occurs when the local mach no in a high speed tunnel reaches to one at some point other than the nozzle throat
- This may happen due to the the effective area of cross section is reduce due to the boundary layer thickness, shock or presence of model
- When the chocking occurs the supersonic flow in working section brake down

Transonic Wind Tunnel

- It is impossible to get more than .85 mach no in high speed tunnel and below 1.1 with CD nozzle
- Due to the chocking special design is required to oparate the wind tunnel at transonic speed (0.85 to 1.15)
- The test section of this transonic tunnel is not solid wall
- Slots or holes are made in the walls of the test section
- The excess air associated with boundary layer growth or presence of the model (solid blockage) can escape through these hole (perforations) thus the chocking will not occurs
- The excess air which are escape through the hole is fed back into tunnel down stream of test section using plenum chamber.
- The flow can expand supersonically using perforated walls. Some time suction can be applied to plenum chamber to increase test section velocity to 1.15 mach

Difficulties for transonic tunnel

- For $M < 1$ the shape of the tunnel may be almost the same as for conventional subsonic tunnels.
- As the free-stream velocity increases, a critical value (M_{cr}) is reached at which the local velocity at certain points on the surface of the test model becomes sonic, although the flow is subsonic everywhere else.
- At such velocities, shocks will propagate from the model in the test section toward the tunnel walls,
- This shock will cause choking in wind tunnel and wrong result (data) from testing
- Chocking can be avoided by following methods
 - Decrease the blockage by smaller model
 - provide an open test section
 - The best method to prevent choking is to provide a test section with perforated walls



HYPERSONIC WIND TUNNELS

- In supersonic tunnel model can be tested up to $M = 4$ or 4.5
- We need hypersonic tunnel for greater than above mach no
- When air flows hypersonic speed following can be observed
 - Rise in temperature of the gas layer close to the surface of the vehicle be considered as a perfect gas ($p\nu = RT$)
 - Large numbers of positively and negatively charged particles appear.
 - New gas species, such as NO, are also formed by chemical reactions
 - Electromagnetic forces might become considerable in the boundary layer
 - In addition to measuring forces and pressure distributions, it becomes necessary to study the heat exchange between the medium and the body

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- New types of wind tunnels have been developed for high-temperature hypersonic tests. These include:
 - 1) hypersonic wind tunnels with air heaters;
 - 2) installations with adiabatic compression;
 - 3) shock tubes;
 - 4) electric plasma wind tunnels;
 - 5) installations for free flight of the model (ballistic ranges).