

1.) Calibration of Hotwires  $St = 0.212 \left(1 - \frac{21.22}{U_L}\right)$

The relation for the Strouhal number is only valid for  $40 \leq Re_D \leq 150$ .

The largest cylinder would be valid from  $Re_D = 40 \rightarrow Re_D = 150$  since  $Re_D \propto U$ . This would take us from 6 m/s  $\rightarrow$  18.75 m/s. The next cylinder would be smaller such that 18 m/s =  $Re_D = 40$  then as  $U_{\infty} \uparrow$  by a factor of 3.75  $U_{\infty} = 70.31$  m/s which is greater than 60 m/s.

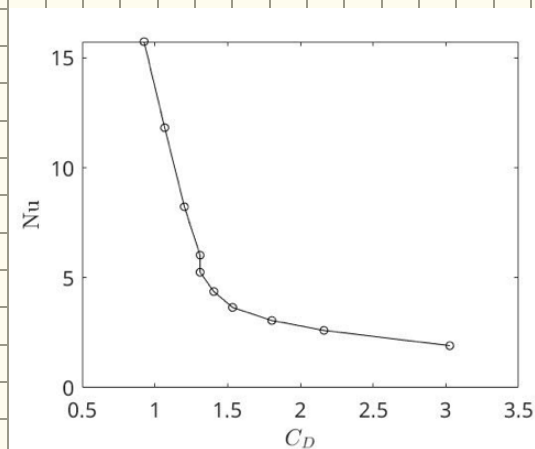
You would only need 2 cylinders, however 3 would provide more tolerance as the  $Re_D$  approaches 40 and 150 respectively.

- 1.2. 1) Start with largest cylinder at 5 m/s. With the hotwire in the wake measure the voltage then perform a FFT.  
 2) Once you have the peak shedding frequency,  $St = \frac{f_D}{U_{\infty}} = 0.212 \left(1 - \frac{21.22}{U_L}\right)$  Then use a nonlinear solver to determine  $U_{\infty}$ .  
 3) Then Traverse the Hotwire out of the wake, and record the Voltage now that you know  $U_{\infty}$ , assuming that  $40 \leq Re_D \leq 150$ .  
 4) Increase tunnel speed and Repeat Steps 1-4 until  $Re_D \geq 150$ .  
 5) Change to a smaller cylinder and Repeat 1-5 until the range of  $U_{\infty}$  is gathered.  
 6) Then use King's Law to relate Voltage and  $U_{\infty}$ .

- 1.3 AS cylinder diameter decreases make sure hotwire Acts as HW not a Control cylinder. This occurs due to the necessity for a small cylinder to keep the Reynolds number between 40 + 150. This could be further solved by moving the Hotwire downstream in the wake.



- 2.)  $Nu(Re) = \text{Churchill Bernstein Equation } C_1 + C_2$   
 $Cd(Re) = \text{Digitized } Cd(Re) \text{ Fig 3.6}$



- 3.) Add control cylinders This will suppress the Von Karman Vortex Street.

Add Tripping wire This will cause the Boundary layer on the cylinder to transition and remain attached longer.

Add Flexible trailing Silencers This will Mitigate the Von Karman Vortex Street.

- 3.2 The drag crisis is caused by the transition to turbulence of the boundary layer. Due to the elevated mixing in turbulent boundary layers the heat transfer will be larger than in laminar flow. This can be useful experimentally to track the location of the onset of transition and can be used in heat exchangers to boost efficiency.

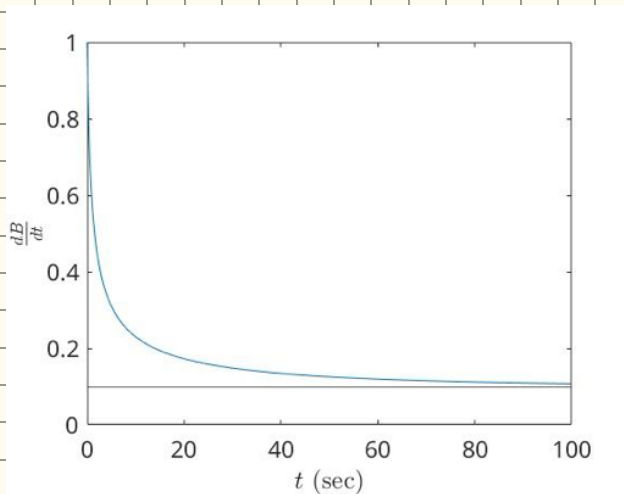
- 3.3 - Dimples (golfball)
- More Streamlined down stream Additions (i.e. splitter plate like) Ex. Turpedo Football
  - Passive Jet placed at the Stagnation point. (Control of the flow past a sphere near a flat wall using passive jet. Abdulkeem et al.)
  - Adaptive Boundary layer Trips (DOI 10.1063/1.5063908 Adaptive-passive control of flow over a sphere for drag reduction. Seaberg et al.)

4.)

Eq 3.1 
$$\frac{dB}{dt} = C_1 (Re - Re_{crit}) B - C_2 |B|^2 B$$
  
 $Re \neq Re_{crit}$

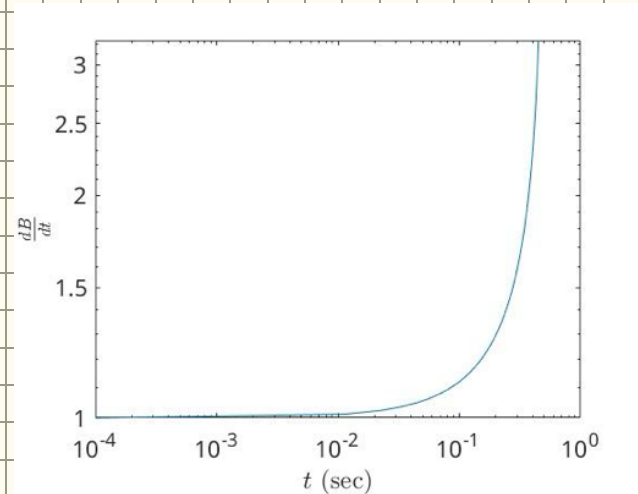
If both  $C_1$  &  $C_2$  are positive.

The solution saturates



If  $C_1$  is positive &  $C_2$  is negative.

The solution grows as  $B^3$  or exponentially in log-log space



2. Set  $\frac{dB}{dt} = 0$  The Saturation Amplitude can be solved as follows

$$0 = C_1 (Re - Re_{crit}) B - C_2 |B|^2 B \quad \text{if } B \neq 0$$

$$C_1 (Re - Re_{crit}) = C_2 |B|^2$$

$$\boxed{\sqrt{\frac{C_1 (Re - Re_{crit})}{C_2}} = B}$$