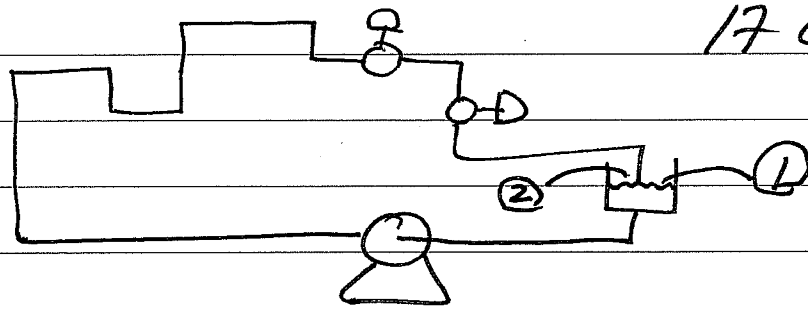
More on Pumping

CM3215
DR. FAITH MORRISON
17 OCT 2008



WE ANALYZE ANY PUMPING LOOP WITH THE MEB: (units: HEAD)

$$\frac{\Delta P}{\rho g} + \frac{\Delta (v^2)}{2\alpha g} + \Delta z + \frac{F}{g} = \frac{W_{s,on}}{mg}$$

FOR OUR LOOP, TWO EASY POINTS TO USE ARE ① surface of tank
② exit of pipe

FOR THESE POINTS:

$P_2 = 0$ (atm)

$P_1 = 0$

$V_2 = Q/(\pi R^2)$

$V_1 = 0$

$z_1 = z_2$

F IS GIVEN BY THE EXPRESSION FOR FRICTION DUE TO VALVES, BENDS, EXPANSIONS, ETC. (Function of Q^2)

$W_{s,m}$ IS HARDER TO KNOW, BUT IT IS SOME FUNCTION OF FLOW RATE.

THE PROBLEM NOW IS WE KNOW THE LHS AS A FUNCTION OF Q AND WE KNOW THE RHS IS A FUNCTION OF Q. WE WANT TO CALCULATE Q FOR A GIVEN OPERATING CONDITION OF THE PUMP.

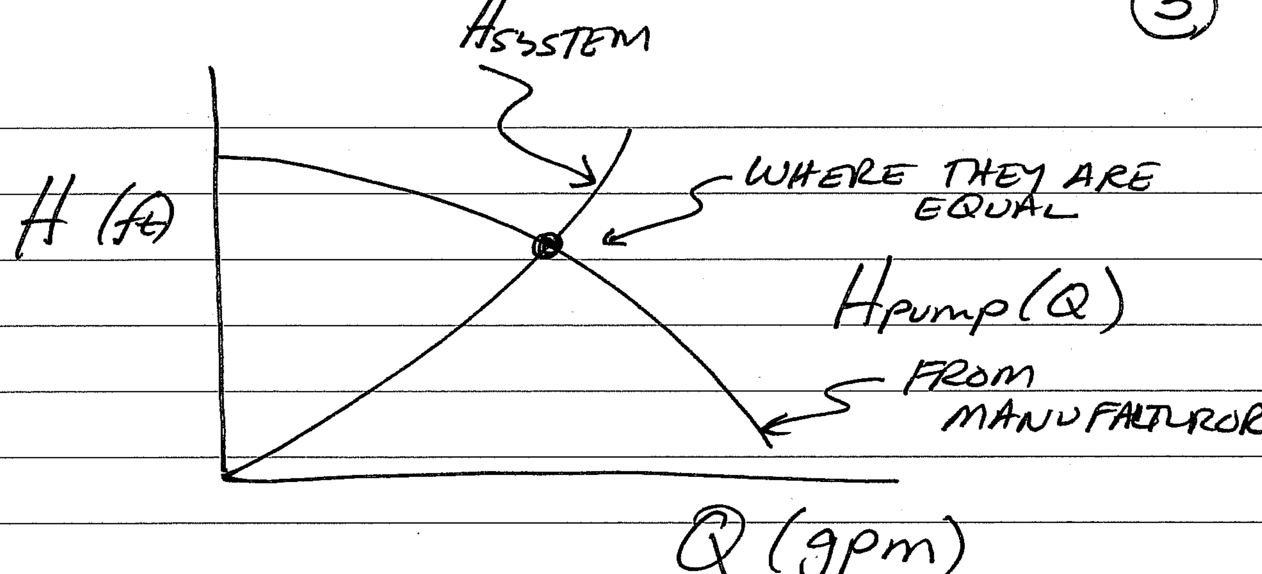
LHS = RHS

$$H_{system}(Q) = H_{pump}(Q)$$

H_{pump} ← at a given operating condition, e.g. RPM

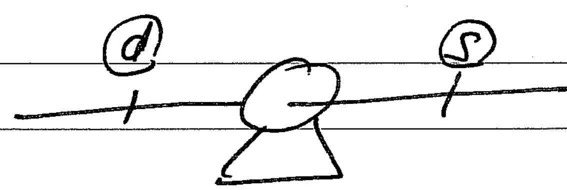
H_{system}: THIS FUNCTION WE KNOW

$H_{pump}(Q)$: THIS IS SUPPLIED BY MANUFACTURER WHEN YOU ARE CHOOSING A PUMP.



FOR OUR LAB, WE ARE MEASURING THE PUMPING HEAD CURVE. WE CAN MEASURE $H_{pump}(Q)$ BY

DOING A MEB ON THE PUMP ALONE:

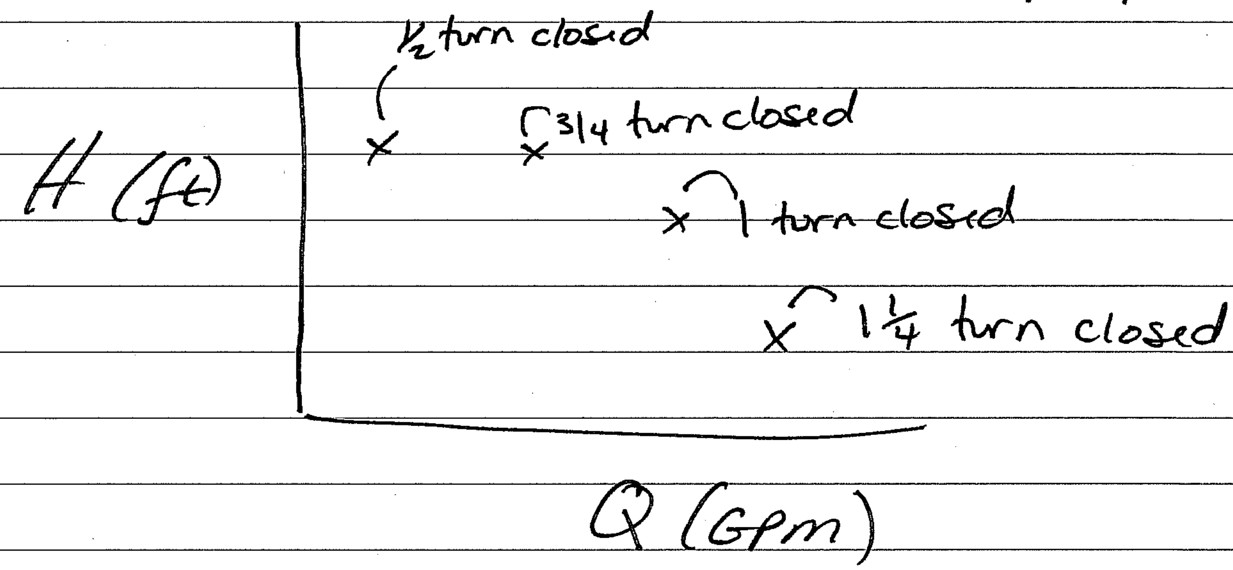


$$\frac{\Delta P}{\rho g} + \frac{\Delta (V^2)}{2\rho g} + \Delta z = \frac{\eta W_{s,on}}{\dot{m} g} = H_{pump}$$

P_d = measured
P_s = measured
$V_d = Q/\pi R_d^2$
$V_s = Q/\pi R_s^2$

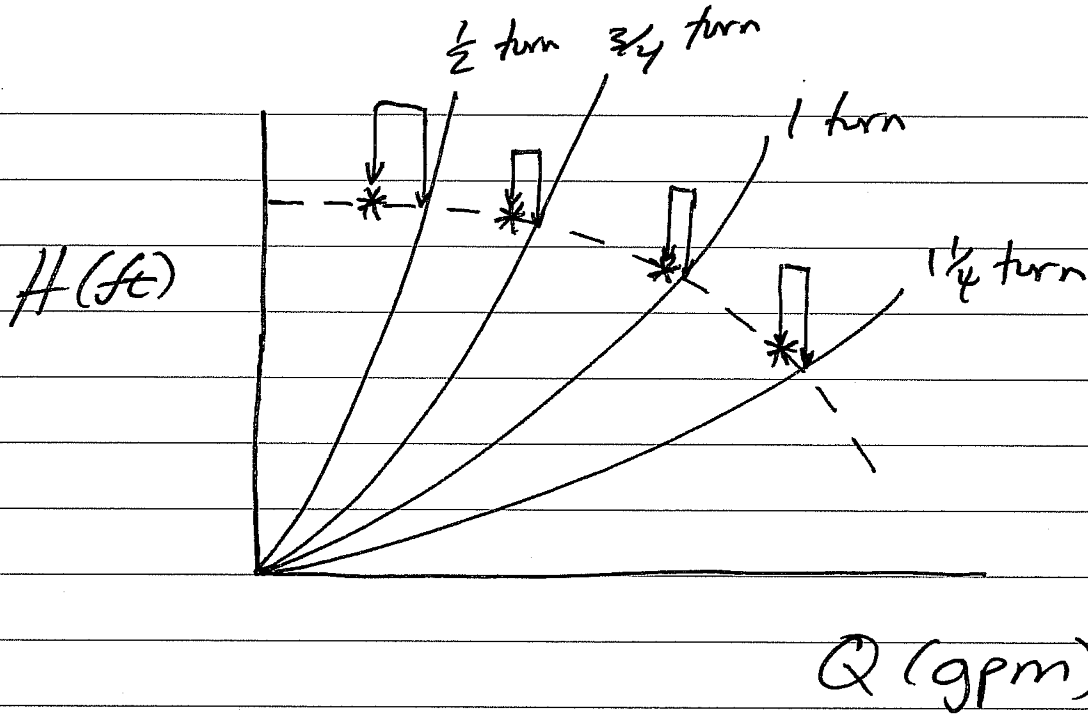
z_d = elevation of discharge
z_s = elevation of suction

WE KNOW OR CAN MEASURE ALL THESE QUANTITIES FOR OUR APPARATUS + THEN PLOT $H_{pump}(Q)$:



FOR THIS LAB, I AM ASKING YOU TO COMPARE THESE MEASUREMENTS TO A CALCULATED H_{system} FOR THE SAME APPARATUS.

IT MIGHT COME OUT LIKE THIS:



COMPARE THE PAIRS OF POINTS INDICATED BY ARROWS. (COMPARE VAVUES OF Q). DISCUSS DISCREPANCIES.