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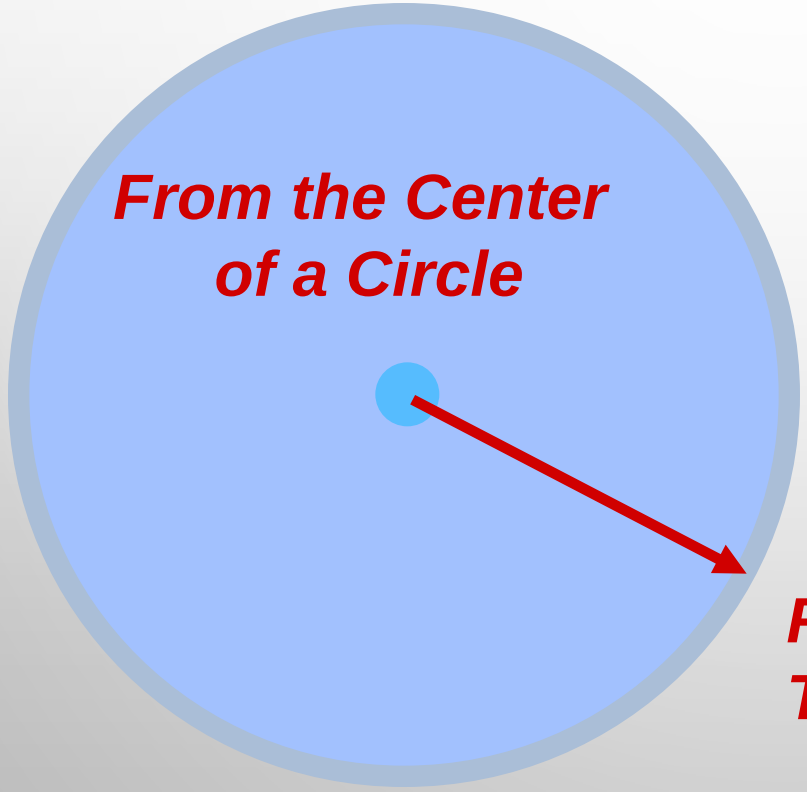
CENTRIFUGAL PUMPS & TURBINES

CENTRIFUGAL PUMPS

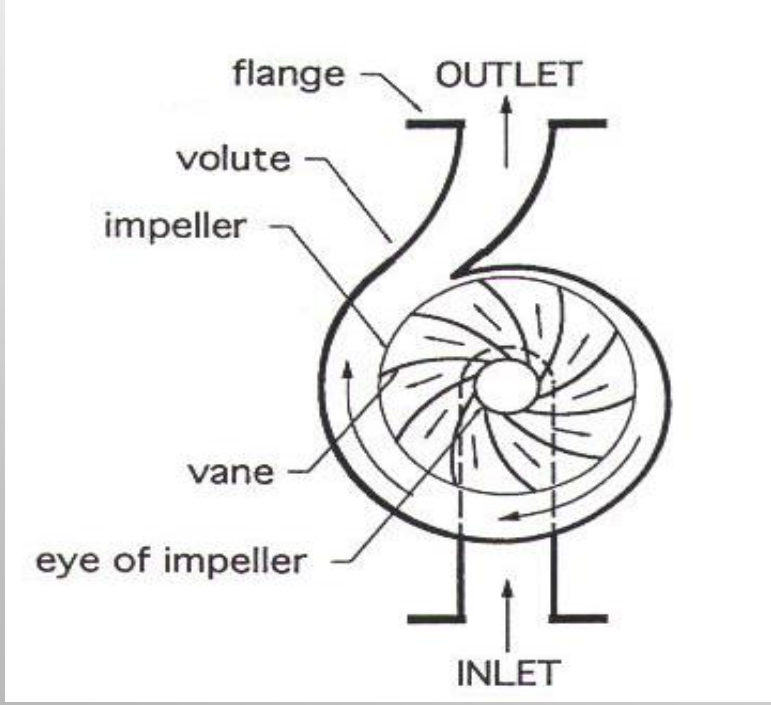
A MACHINE FOR MOVING FLUID BY ACCELERATING THE FLUID *RADIALLY* OUTWARD.



RADIAL DIRECTION
To the Outside of a Circle

TERMINOLOGY

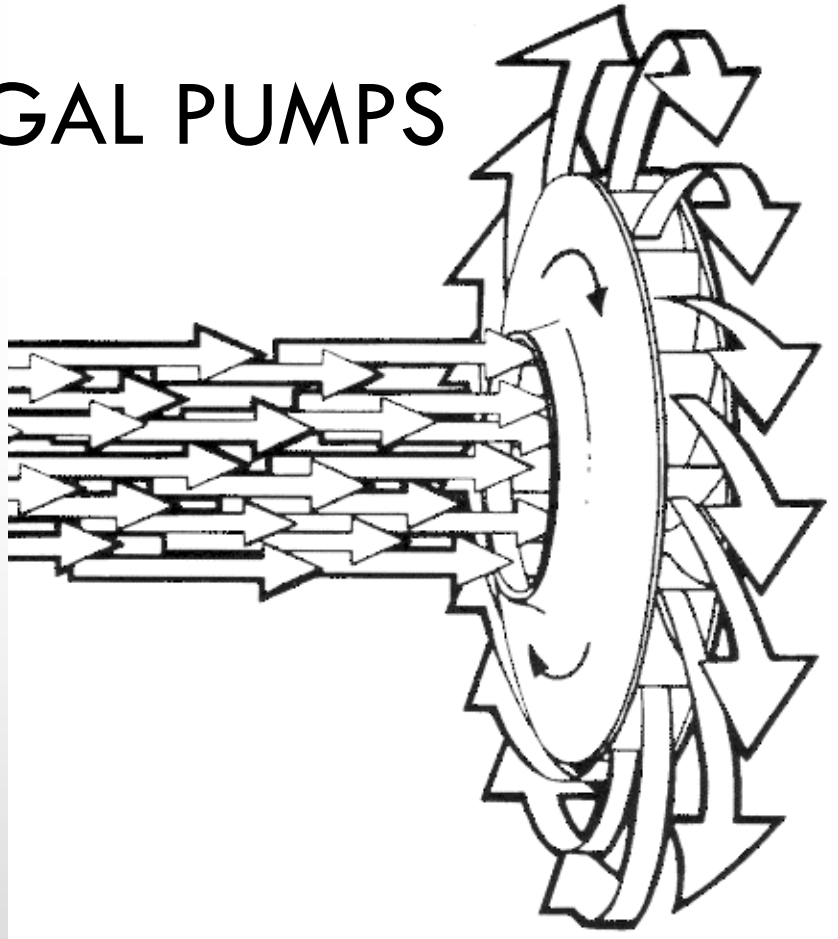
A COLLECTION CHAMBER IN THE CASING CONVERTS MUCH OF THE KINETIC ENERGY (ENERGY DUE TO VELOCITY) INTO *HEAD* OR PRESSURE.



CENTRIFUGAL PUMPS

- **THIS MACHINE CONSISTS OF AN *IMPELLER* ROTATING WITHIN A VOLUTE CASE (DIFFUSER)**

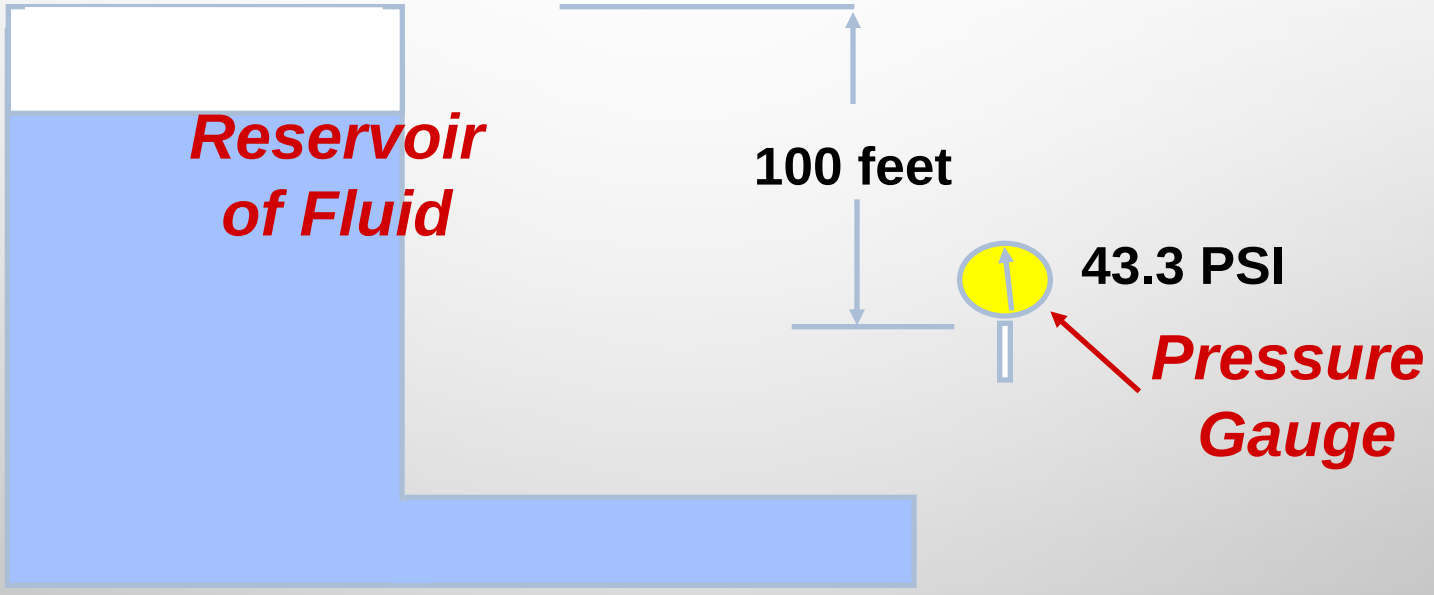
- **LIQUID DIRECTED INTO THE CENTER OF THE ROTATING IMPELLER IS PICKED UP BY THE IMPELLER'S VANES AND ACCELERATED TO A HIGHER VELOCITY BY THE ROTATION OF THE IMPELLER AND DISCHARGED BY CENTRIFUGAL FORCE INTO THE CASE (DIFFUSER).**




GRUNDFOS
GRUNDFOS
GRUNDFOS

"HEAD"

- HEAD IS A TERM FOR EXPRESSING FEET OF WATER COLUMN
- HEAD CAN ALSO BE CONVERTED TO PRESSURE



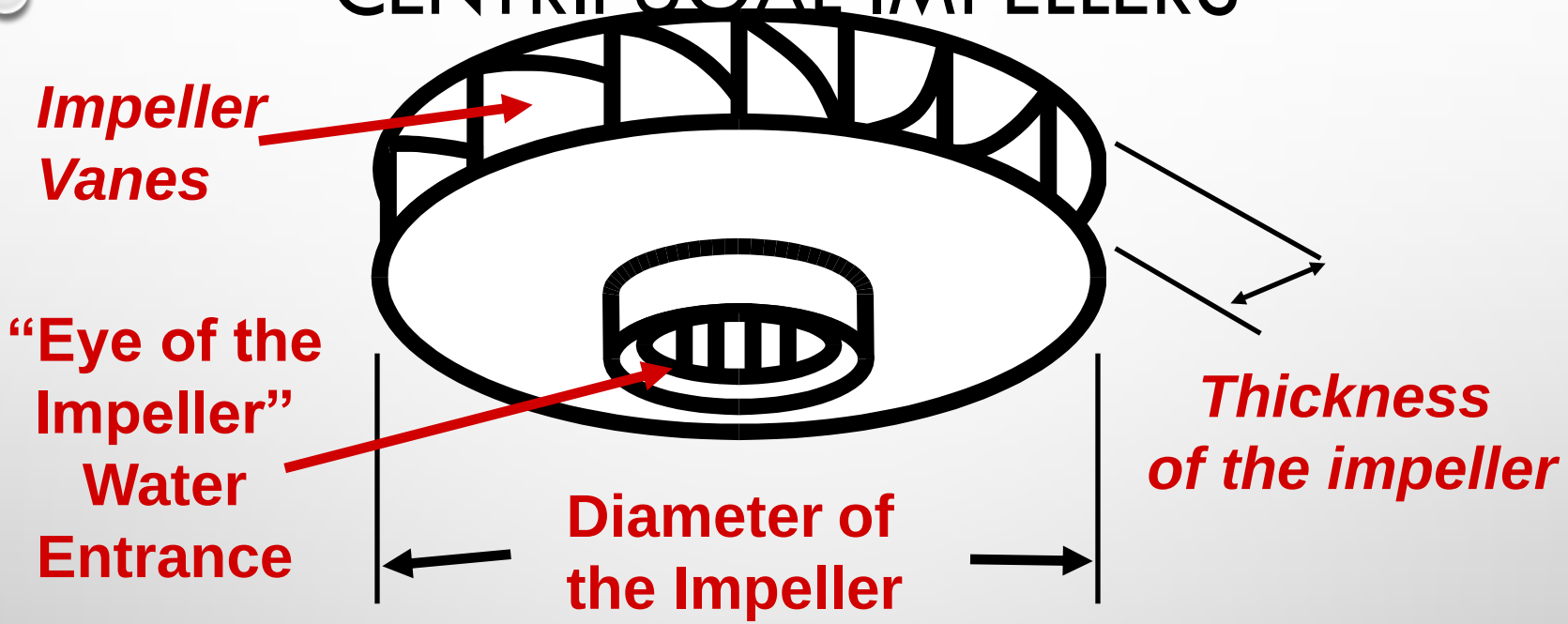
CALCULATION OF HEAD DEVELOPED IN A PUMP:

- **HEAD (FEET OF LIQUID) =PRESSURE IN PSI X 2.31 / SP. GR.**
- **PRESSURE IN PSI = HEAD (IN FEET) X SP. GR. / 2.31**
- **PSI IS POUNDS PER SQUARE INCH**
- **SP. GR. IS SPECIFIC GRAVITY WHICH FOR WATER IS EQUAL TO 1**
  - **FOR A FLUID MORE DENSE THAN WATER, SP. GR. IS GREATER THAN 1**
  - **FOR A FLUID LESS DENSE THAN WATER, SP. GR. IS LESS THAN 1**

HEAD

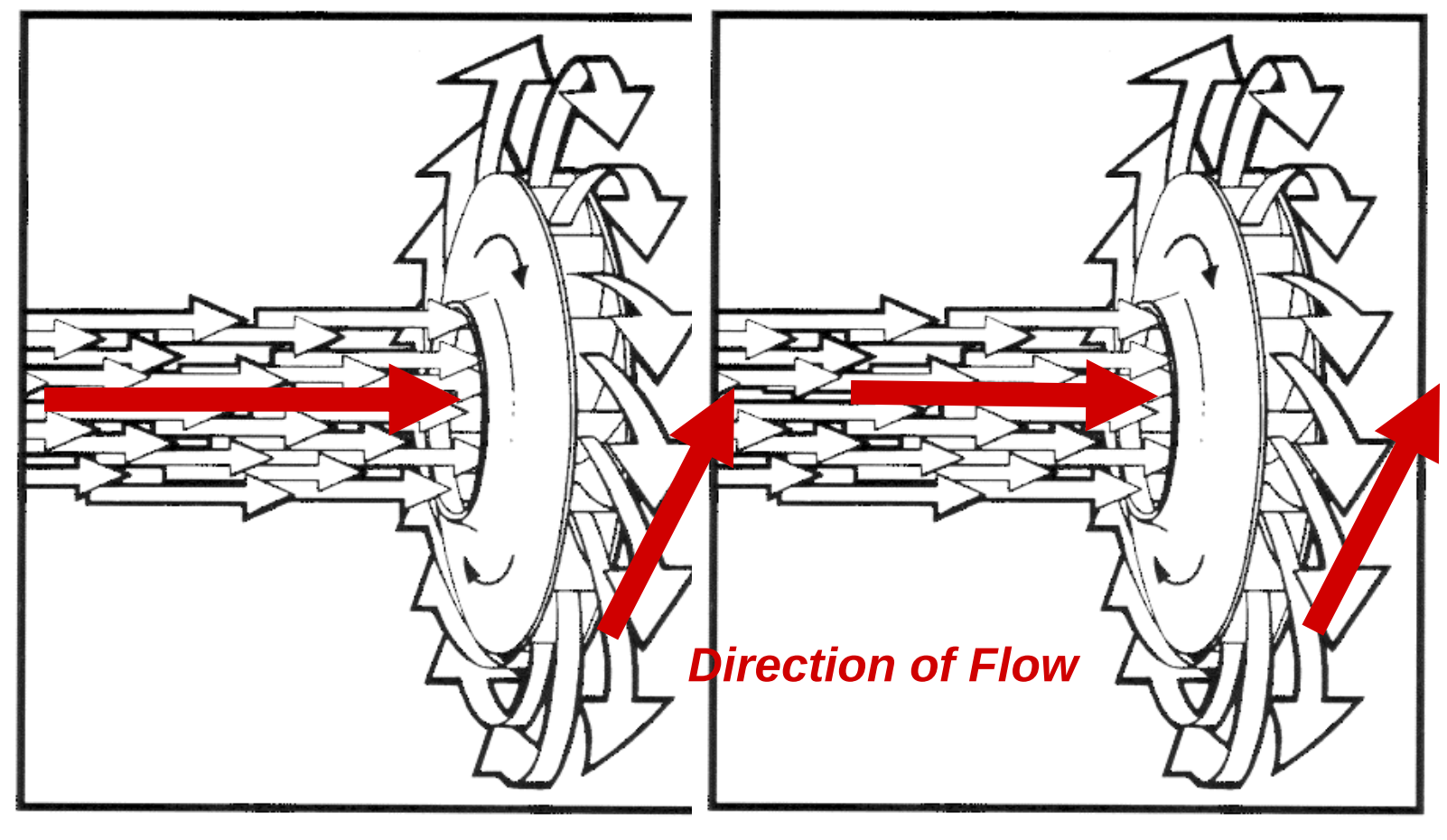
- HEAD AND PRESSURE ARE INTERCHANGEABLE TERMS PROVIDED THAT THEY ARE EXPRESSED IN THEIR CORRECT UNITS.
- THE CONVERSION OF ALL PRESSURE TERMS INTO UNITS OF EQUIVALENT HEAD SIMPLIFIES MOST PUMP CALCULATIONS.

CENTRIFUGAL IMPELLERS



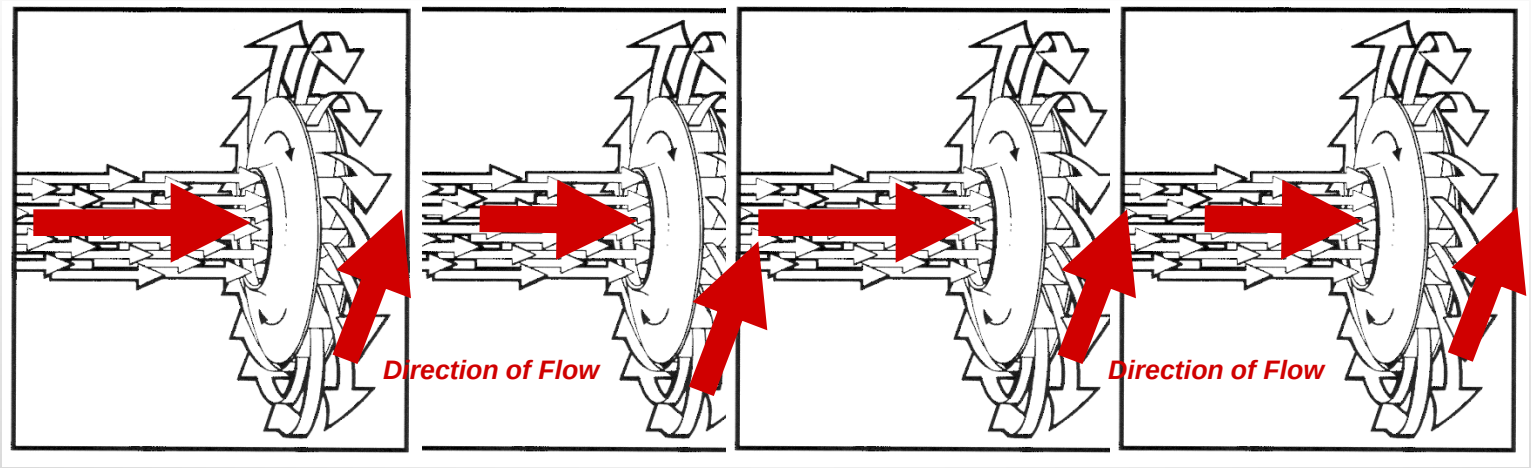
- THICKER THE IMPELLER- MORE WATER
- LARGER THE DIAMETER - MORE PRESSURE
- INCREASE THE SPEED - MORE WATER AND PRESSURE

TWO IMPELLERS IN SERIES



- TWICE THE PRESSURE
- SAME AMOUNT OF WATER

MULTIPLE IMPELLERS IN SERIES



- PLACING IMPELLERS IN SERIES INCREASES THE AMOUNT OF HEAD PRODUCED
- THE HEAD PRODUCED = # OF IMPELLERS X HEAD OF ONE IMPELLER

WORKING OF PUMPS DEPENDS ON FOLLOWING LIQUID PROPERTIES:

- LIQUID FIND THEIR OWN LEVEL
- A LIQUID IS ALMOST INCOMPRESSIBLE IN CONTRAST TO GAS.
- AT ANY POINT IN A LIQUID PRESSURE ACTS EQUALLY IN ALL DIRECTIONS AND IS SAME AT SAME LEVELS IN A LIQUID AT REST.
- PRESSURE PER UNIT AREA VARIES DIRECTLY AS THE HEAD.
- WORKING OF PUMPS DEPENDS ON ARCHIMEDES PRINCIPLE AND BERNOULLI'S THEOREM.

CONSTRUCTION OF A TURBINE PUMP:

A TURBINE PUMPS CONSISTS OF:

- NUMBER OF IMPELLERS MOUNTED ON ONE SHAFT.
- A STATIONARY SPIRAL OR VOLUTE CASING.
- SUCTION PIPE CONNECTED TO FLANGE.
- DELIVERY PIPE CONNECTED TO FLANGE.
- DIFFUSER
- BALANCER

THERE ARE 2 TYPES OF PUMPS:

- SINGLE INLET PUMP
- DOUBLE INLET PUMP

DIFFERENCE BETWEEN WORKING OF TURBINE AND CENTRIFUGAL PUMPS

- TURBINE PUMP DIFFERS FROM THE CENTRIFUGAL PUMP IN THAT THE FORMER CONSISTS OF A NUMBER OF IMPELLERS MOUNTED ON ONE SHAFT AND THE WATER OF EACH IMPELLER ENTERS STATIONARY DIFFUSING CHANNELS OF THE DIFFUSER SURROUNDING THE IMPELLER.
- WATER ENTERS THE IMPELLER NEAREST TO THE SUCTION PIPE, IS CARRIED BY THE ROTATING IMPELLER TO THE PERIPHERY AT A HIGH SPEED AND IS CONVERTED TO HIGH PRESSURE AND LOW SPEED AT THE END OF THE DIFFUSER.
- WATER THEN ENTERS THE NEXT IMPELLER AT A HIGH PRESSURE AND LOW VELOCITY TO UNDERGO SIMILAR PROCESS FURTHER INCREASING PRESSURE AND LOWERING THE VELOCITY FURTHER.
- THE PROCESS CONTINUES TILL WATER ENTERS THE DELIVERY PIPE WITH A HIGH PRESSURE BUT ONLY A LITTLE VELOCITY.

EACH IMPELLER WITH THE DIFFUSER CONSISTS ONE STAGE AND THE HEAD DEVELOPED PER STAGE VARIED FORM 15-50 M DEPENDING UPON

1. DIAMETER AND SPEED OF IMPELLER
2. CURVATURE OF IMPELLER
3. DESIGN OF DIFFUSER

A TURBINE PUMP CARRIES A BALANCING DISC WHICH IS NOT PROVIDED ON CENTRIFUGAL PUMP. THE NUMBER OF IMPELLERS ON SHAFT DOES NOT EXCEED 10 IN ORDER TO PREVENT BENDING AND TO REDUCE THE LENGTH.

BALANCING OF AXIAL THRUST

IN CASE OF SINGLE INLET IMPELLERS, A CONSIDERABLE END THRUST IS DEVELOPED WHICH ACTS TOWARDS THE SUCTION END OF THE PUMP. THE AXIAL END-THRUST OCCURS BECAUSE WATER UNDER PRESSURE LEAKS INTO THE CLEARANCE SPACES ON BOTH SIDES OF EACH IMPELLER, BETWEEN THE IMPELLER AND ITS ENCLOSING DIAPHRAGMS.

TOTAL THRUST=DIFFERNECE OF 2 AREAS*PRESSURE PER UNIT AREA IN CLEARENCE SPACE*NUMBER OF IMPELLERS

COUNTERING OF AXIAL THRUST

AXIAL THRUST CAN BE COUNTERED IN THE FOLLOWING WAYS:

1. IN CASE OF A SINGLE STAGE CENTRIFUGAL PUMP BY USING A DOUBLE ENTRY IMPELLER
2. IN CASE OF A DOUBLE STAGE CENTRIFUGAL PUMP BY PLACING THE IMPELLERS BACK TO BACK.
3. BY USE OF A THRUST BEARING
4. BY USE OF A BALANCER DISC.

LAWS OF CENTRIFUGAL OR TURBINE PUMP:

- QUANTITY OF WATER DELIVERED BY A GIVEN PUMP VARIES DIRECTLY AS THE PERIPHERAL SPEED OR RPM OF IMPELLER
- PRESSURE VARIES AS SQUARE OF SPEED
- POWER REQUIRED VARIES AS PRODUCT OF PRESSURE AND QUANTITY AND HENCE VARIES AS CUBE OF PERIPHERAL VELOCITY.

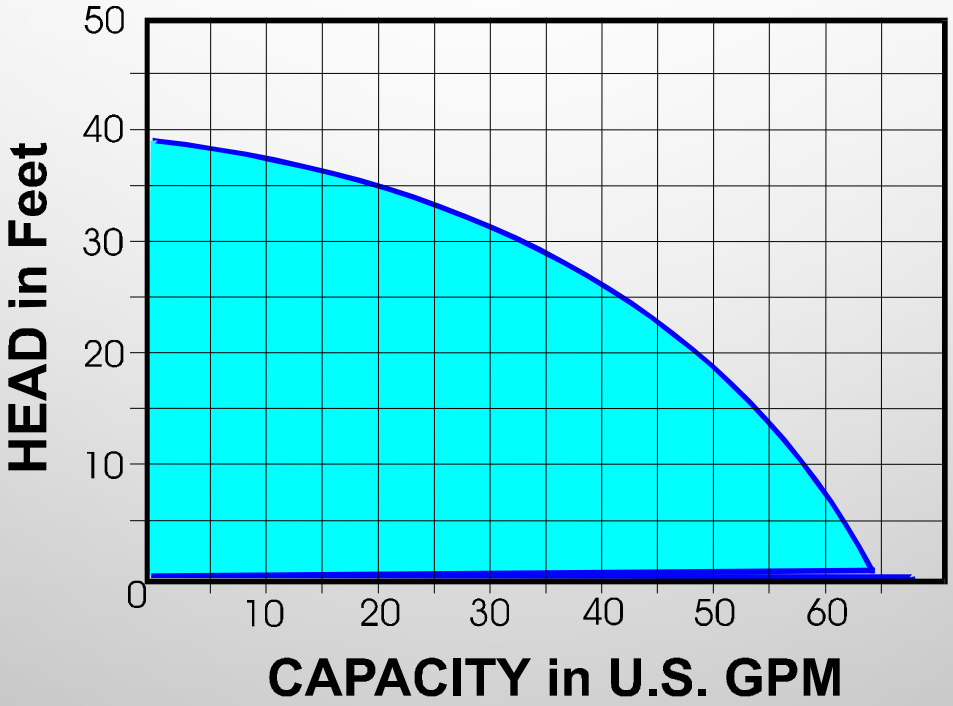
$$Q=K*V$$

$$P=K*V^2$$

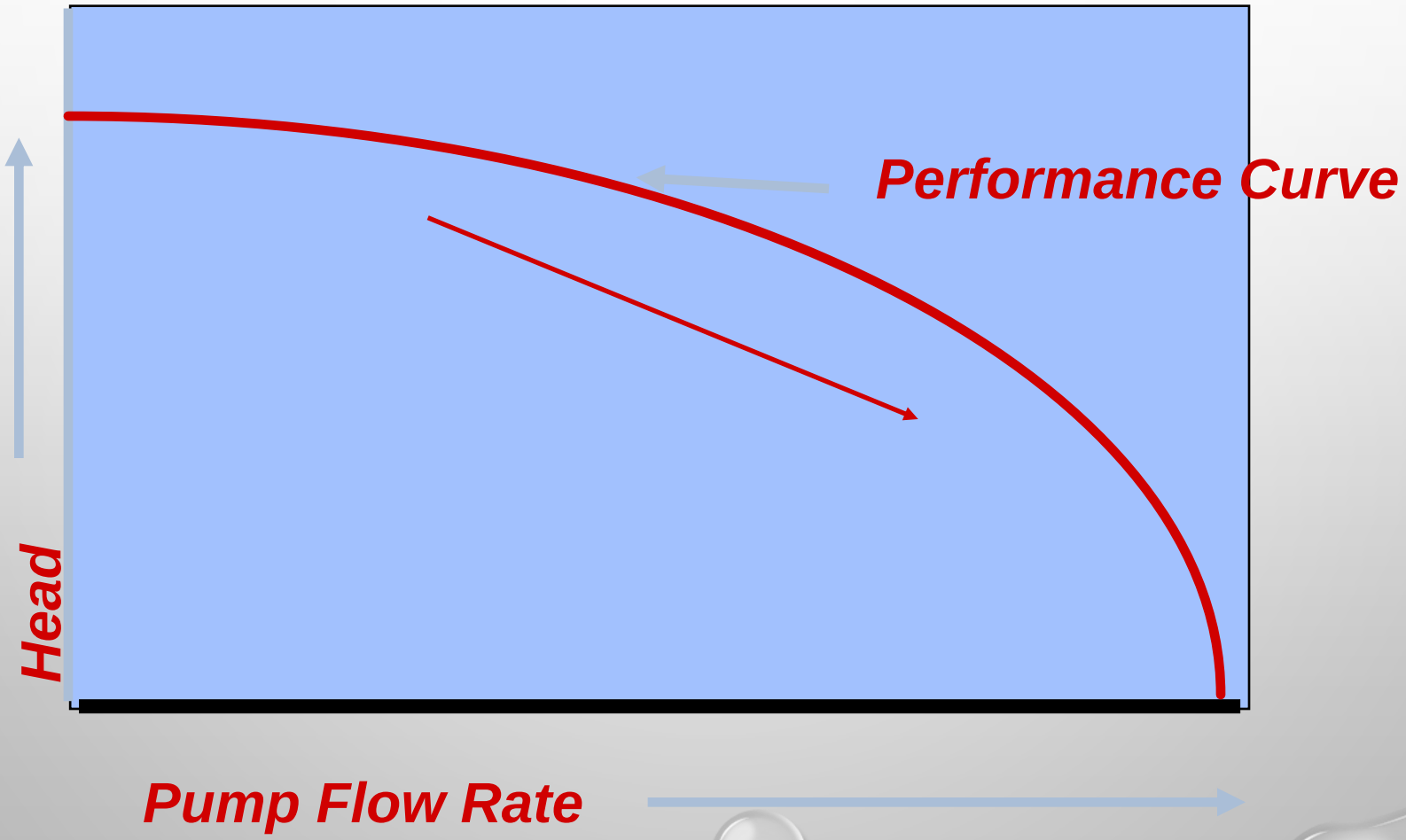
$$POWER=K*V^3$$

PUMP PERFORMANCE CURVE

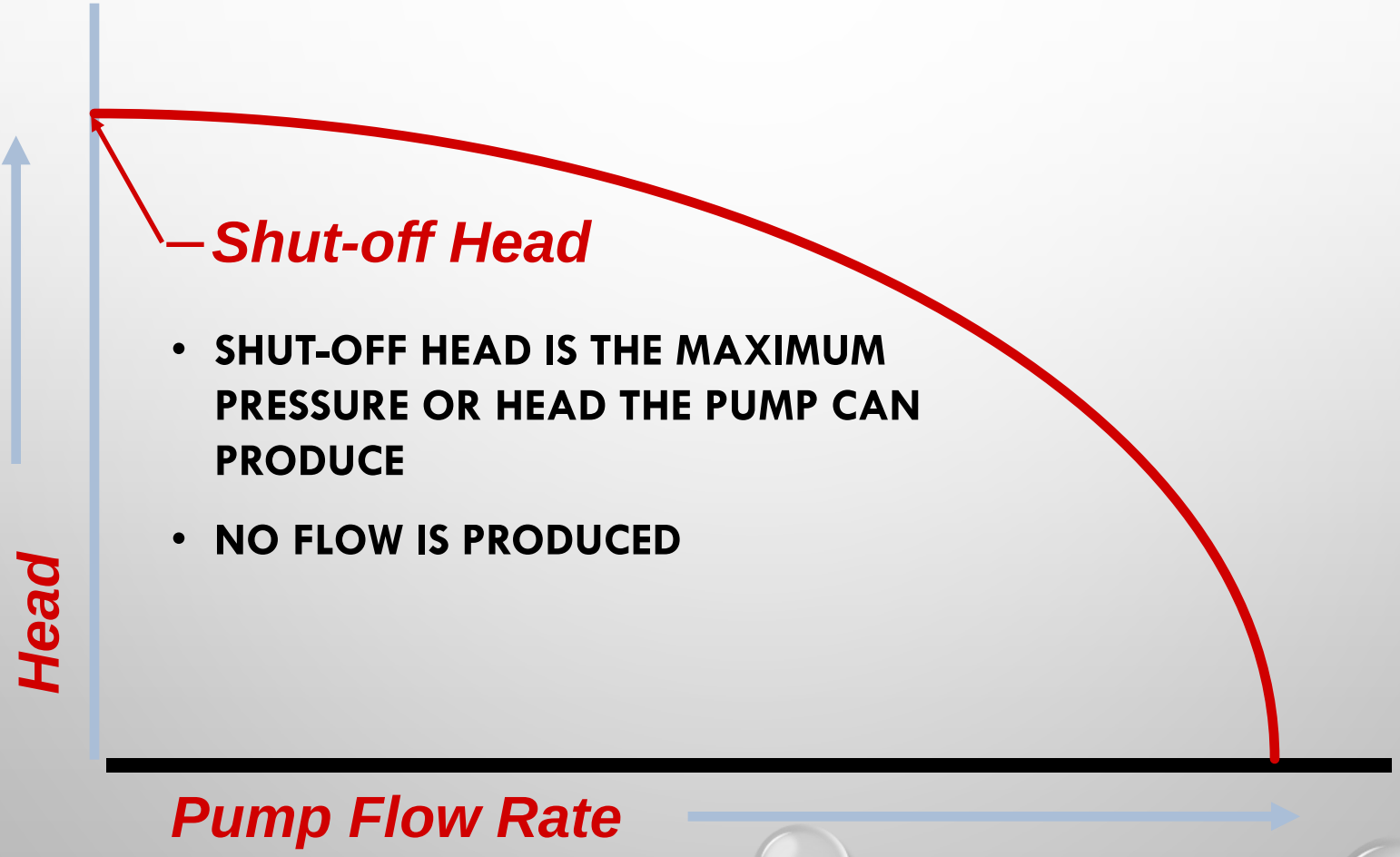
- **A MAPPING OR GRAPHING OF THE PUMP'S ABILITY TO PRODUCE HEAD AND FLOW**



PUMP PERFORMANCE CURVE

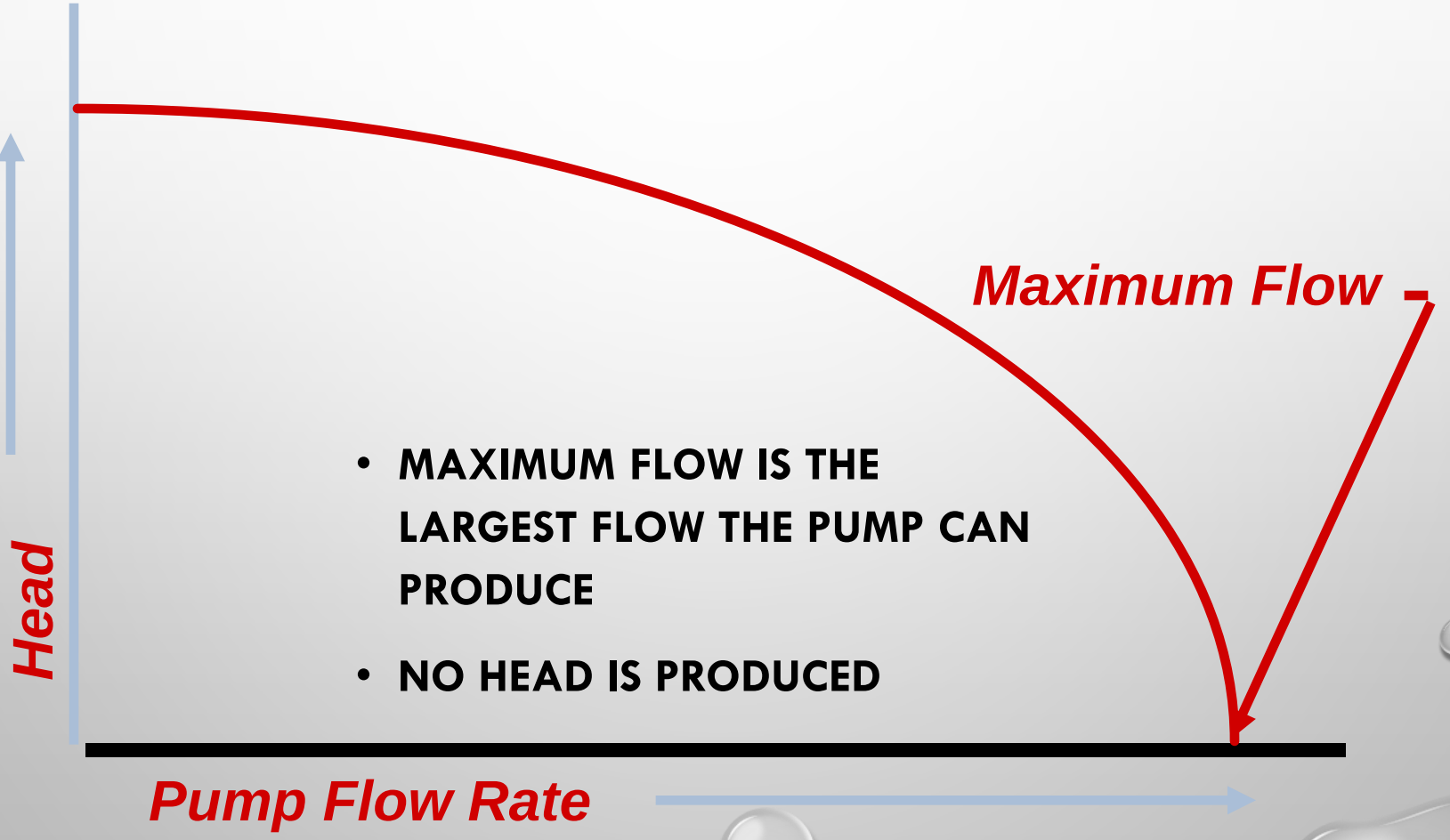


PUMP PERFORMANCE CURVE IMPORTANT POINTS



- SHUT-OFF HEAD IS THE MAXIMUM PRESSURE OR HEAD THE PUMP CAN PRODUCE
- NO FLOW IS PRODUCED

PUMP PERFORMANCE CURVE IMPORTANT POINTS

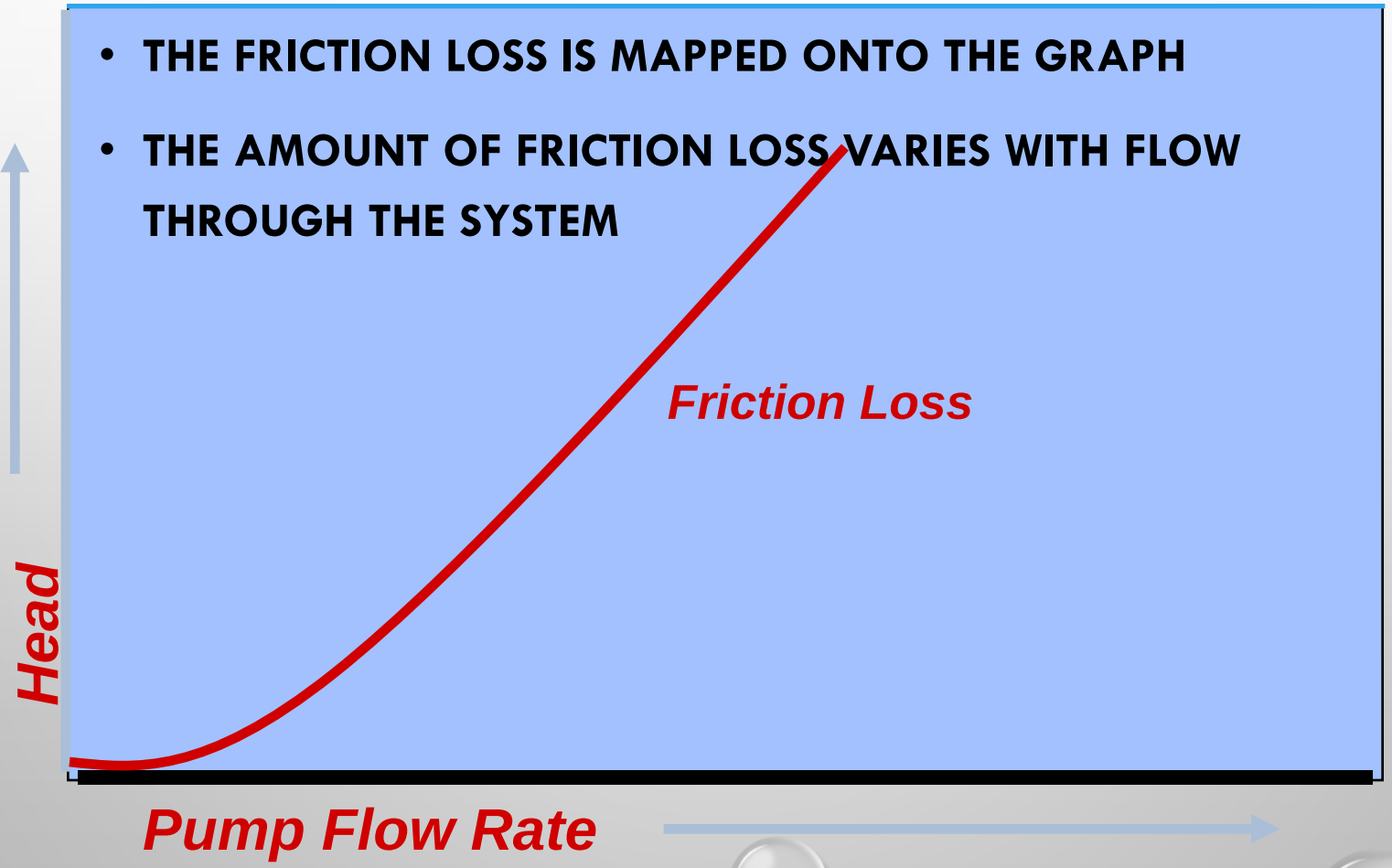


- MAXIMUM FLOW IS THE LARGEST FLOW THE PUMP CAN PRODUCE
- NO HEAD IS PRODUCED

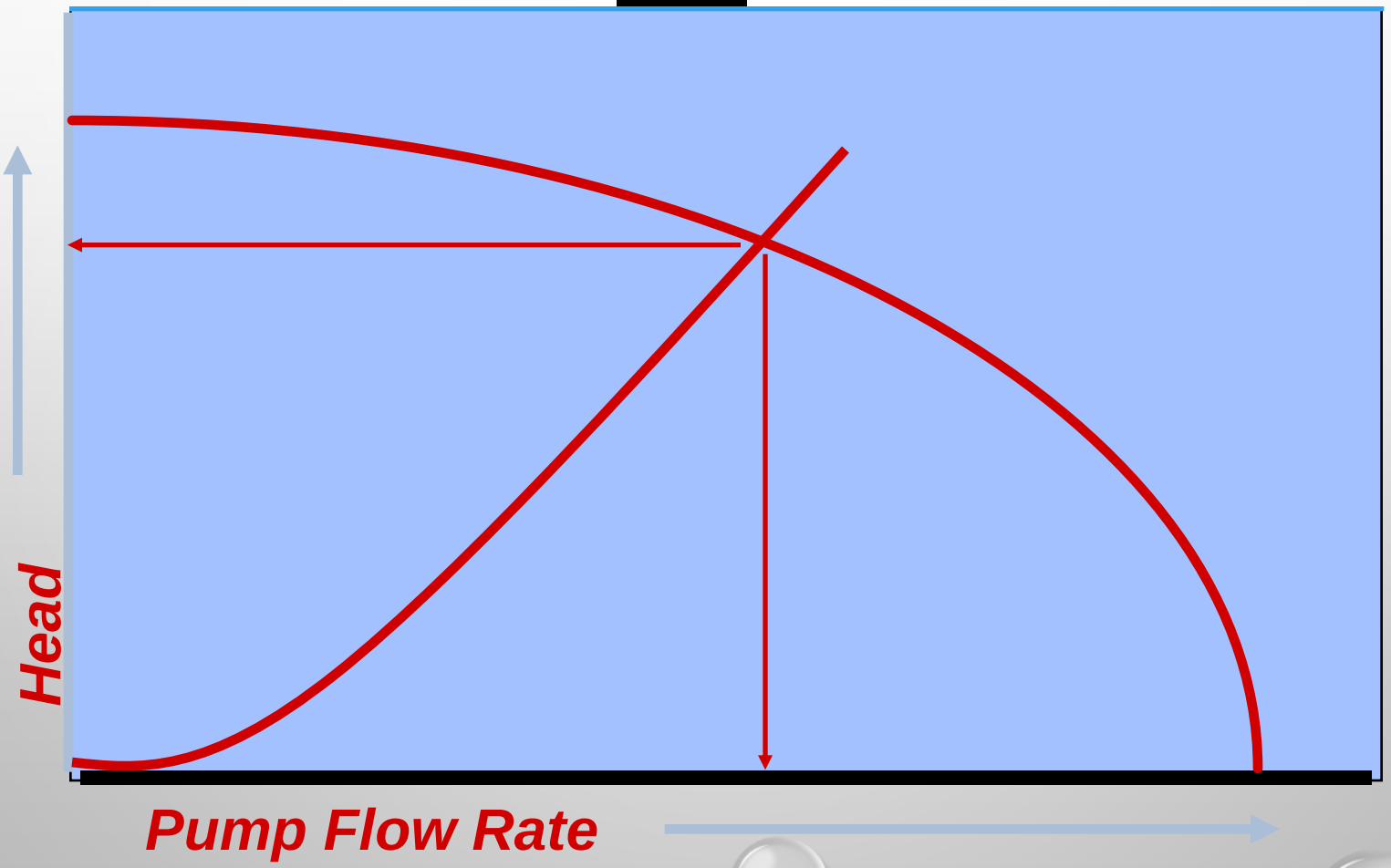
SYSTEM PERFORMANCE CURVES

- SYSTEM PERFORMANCE CURVE IS A MAPPING OF THE HEAD REQUIRED TO PRODUCE FLOW IN A GIVEN SYSTEM
- A SYSTEM INCLUDES ALL THE PIPE, FITTINGS AND DEVICES THE FLUID MUST FLOW THROUGH, AND REPRESENTS THE FRICTION LOSS THE FLUID EXPERIENCES

SYSTEM PERFORMANCE CURVE



The point on the system curve that intersects the pump curve is known as the <u>operating point</u>.



QUESTIONS???