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TECHNICAL INFORMATION
Bulletin

NUMBER TEN

PUMP INDUCERS

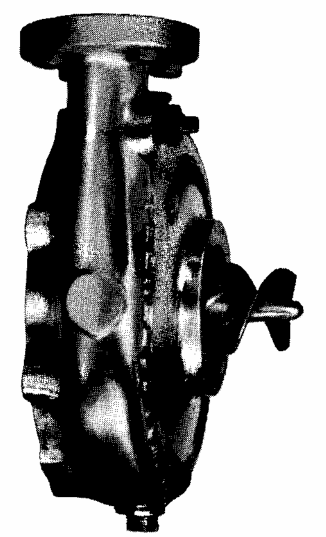
A practical proven product that can: (1) Lower System NPSH Requirement (2) Eliminate Impeller Cavitation

A MAJOR PROBLEM encountered in many pumping applications, particularly those involving fluids at or near their boiling points, is a lack of adequate net positive suction head (NPSH). Net positive suction head is the absolute pressure, above the vapor pressure of the fluid pumped, available at the pump suction flange, to move and accelerate the fluid entering the impeller.

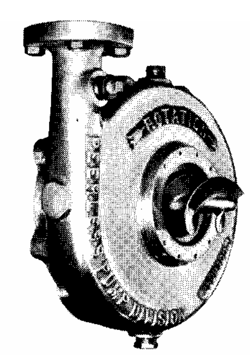
If the NPSH available in an installation is insufficient, the pump will cavitate and serious operational difficulties may develop. These troubles can include reduction in capacity and efficiency, excessive vibration, reduced life of pump parts due to cavitation erosion, and damage to the pump from possible vapor lock and running dry.

Proper design of a system to provide sufficient NPSH for the pump often requires elevated tank or other costly design considerations. Reducing the NPSH required by the pump can result in substantial construction savings.

Now, by design, this desired effect is now practical with the new —



INDUCER
End –Suction Chemical and Water Handling Centrifugal Pumps



NPSH—A MAJOR FACTOR IN PLANT DESIGN

AT ANY GIVEN temperature all liquids have a definite pressure at which they boil. Everyday we witness the fact that a liquid boils at atmospheric pressure when it reaches a sufficiently high temperature. It is important also to remember that a liquid will boil at any temperature if the pressure is reduced sufficiently. It is the problem of process and pump application engineers to make certain that there is sufficient pressure on the fluid being fed to the pump so the liquid does not boil in the suction system of the pump.

The term “suction lift” is very misleading. No reciprocating, gear, turbine vane or centrifugal pump can lift any liquid. It is imperative that liquid be forced into the pump for it to operate properly. The weight of air in the earth’s atmosphere is frequently used to force liquid into the pump Suction and this creates the illusion that a pump can lift a liquid. In a closed process system where atmospheric or other pressure in excess of the liquid vapor pressure is not available, the liquid level must always be maintained above the pump centerline.

The total energy of a liquid is the sum of potential energy (pressure and elevation) and dynamic energy (velocity head). To maintain a constant total energy any increase in the velocity of a liquid reduces the pressure a corresponding amount. The pressure forcing the liquid into the pump must overcome the static elevation, the friction and turbulence losses in the suction line, accelerate the fluid, and maintain sufficient pressure to keep the fluid in the suction line from boiling.

After the fluid has reached the suction flange of the pump, there must exist sufficient additional pressure to overcome the pressure drop which occurs within the pump itself.

This pressure drop takes place between the suction flange and the leading edge of the impeller vanes, and. is a phenomenon identified with the term “required NPSH.” All pumps have this loss because of:

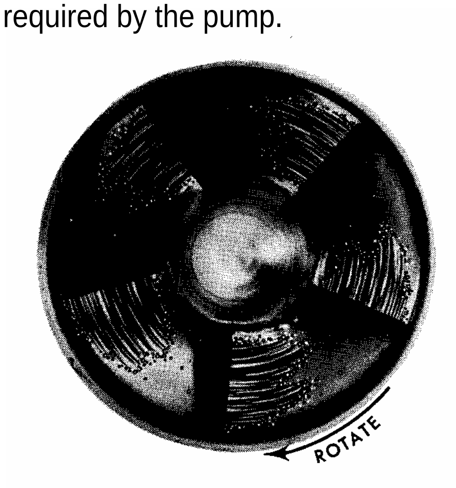
1. An increase in the velocity between the suction flange and entrance to the impeller vanes.

2. Friction and turbulence losses between the suction flange and entrance to the impeller vanes.

NOW, WHAT IS NPSH?

“The net positive suction head (NPSH) is the total suction head in feet of liquid absolute determined at the suction nozzle and referred to datum, less the vapor pressure of the liquid in feet absolute.”

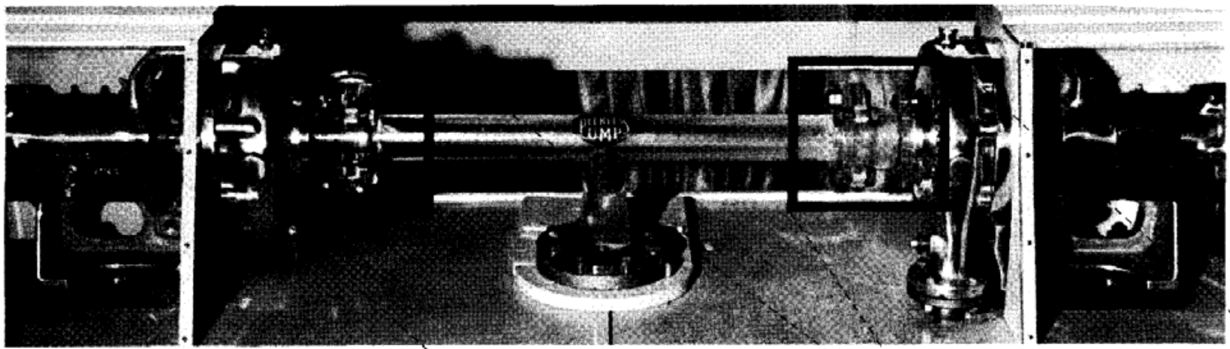
The NPSH required by a pump is equivalent to the drop in pressure between the suction flange of the pump and the entrance to the impeller vanes plus the velocity head at the pump suction. Any system must be so designed that the available NPSH of the system is equal to or exceeds the NPSH required by the pump.



This photo, taken by means of special photography, shows the occurrence of cavitation at the impeller vanes where there is insufficient NPSH in the system. Although the pump will still operate under these conditions, it will be noisy, have a reduced head and efficiency. Severe pitting would occur on these impellers If operated for an extended period of time under these conditions.

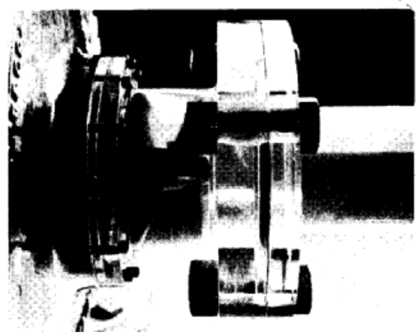
WHAT PRECISELY DOES THE INDUCER DO?

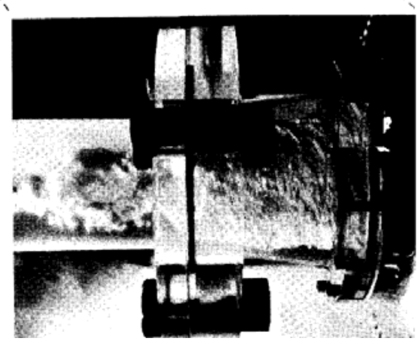
To achieve reduction in the NPSH requirements of a pump, Peerless has utilized a booster impeller which is referred to as an “Inducer.” This Inducer is mounted in front of a standard impeller and is used on a standard pump with only a slight machining modification on the volute.



The above two pumps are identical. Operating conditions are precisely the some. Only variation is that the pump at left is equipped with the Peerless Inducer. Study the inset blowups. Note the complete absence of fluid boiling in the pump at left. The one at right shows significant vaporization taking place—the primary cause of impeller cavitation.

Both pictures shown at right were taken with pumps running at full operating speed. Pumps were "stopped" with stroboscopic lights and high speed camera.

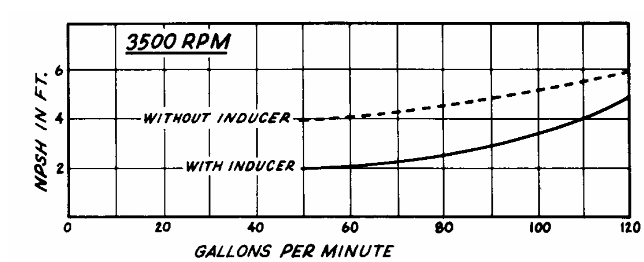




The Inducer actually functions as an axial flow type impeller in series with the radial flow type pump impeller. It imparts sufficient energy to the fluid to overcome the "pressure drop" phenomenon previously discussed. When cavitation occurs on a radial flow type of impeller, the pump performance drops off very rapidly and the pump loses prime. However, under similar conditions, axial flow type impellers continue to pump with only slight reduction in performance. Addition of the Inducer actually transfers the "low pressure" point from the eye of the pump impeller to the entrance of the Inducer itself. However, this reduction in pressure is substantially less than that encountered with the standard impeller. This fact, coupled with the inherent hydraulic differences between axial and radial impellers, accounts for the resulting reduction in overall NPSH requirements of the pump.

It should be noted, however, that the Inducer will not reduce the NPSH available in the system, but will reduce the NPSH requirement of a given pump. Also, due to design limitations on a given Inducer, this NPSH reduction is accomplished over a specific capacity range.

TYPICAL CURVE – REQUIRED NPSH

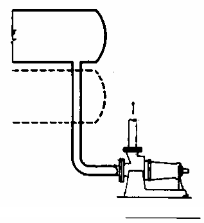


The above chart is based on the NPSH required by a Peerless 1 x 2 x 8½ Type DM pump. Comparison curves with and without the Peerless Inducer added to the pump show the marked reduction of NPSH required when the Inducer is used.

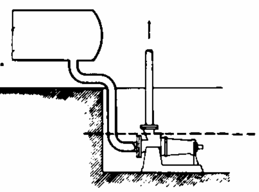
HOW THE INDUCER REDUCES PUMP COSTS:

Often it is necessary to consider various design solutions to achieve sufficient NPSH. Here are some common basic design approaches and the corresponding benefits provided by the Peerless Inducer.

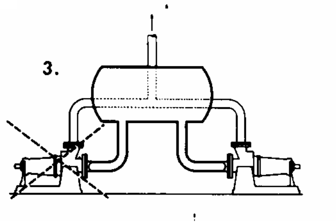
1. ELEVATE THE SUPPLY VESSEL
Inducer permits lower tanks – pumped to lower levels

1.


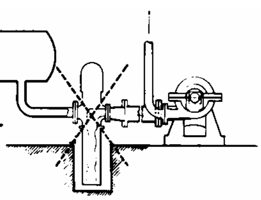
2. LOWER PUMP IN A PIT
Inducer reduces depth of pit required. (Often the pit can be eliminated)

2.


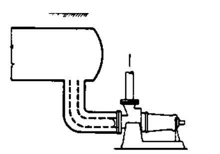
3. USE LARGER OR MULTIPLE PUMP IN PARALLEL
Inducer allows use of smaller pumps or eliminates need of parallel design

3.


4. USE OF VERTICAL PUMP IN BARREL AS BOOSTER PUMP AHEAD OF CENTRIFUGAL UNITS
Inducer simplifies design of installation—allows use of shallow pit or reduces cost of booster

4.


5. USE LARGER PIPELINES TO DECREASE FRICTION LOSS
Inducer allows reduction in size of pipeline

5.


10 QUESTIONS AND ANSWERS ABOUT THE INDUCER

1. Q. Can the Inducer be applied to any existing pump?
   A. The Inducer is engineered to match" the impeller with which it is teamed. Hence it cannot be used in other pumps.

2. Q. Can an existing pump be reconditioned for an Inducer?
   A. Yes. Normally replacement of the liquid end of the pump will be required to insure maximum efficiency and desired effect when the Inducer is added.

3. Q. In what metals is the Inducer available?
   A. Usually the Inducer is produced in type 316 stainless steel, and for most operating conditions, this metal is recommended. However, it can be fabricated of any machineable metal.

4. Q. Will the inducer handle all marginal NPSH problems?
   A. Like any product the Inducer has specific operating range. Curves supplied on request will quickly show whether the Inducer will meet your needs.

5. Q. What about maintenance of the inducer?
   A. Little if any is required. However, access to the Inducer is readily accomplished by removing section of pipe bolted to the volute, or in most cases by rear pullout" on pumps used with 5" spacer coupling. Inducer is threaded onto pump shaft to facilitate easy removal.

6. Q. Is the inducer versatile enough to handle all process fluids?
   A. The quick rule of thumb here is the application of the pump to the job. If an end-suction centrifugal pump can be used, the Inducer can also be used.

7. Q. Does use of the Inducer effect pump efficiency and head capacity?
   A. Both plant and field tests have shown the addition of the Inducer causes less than 1% change in pump efficiency and capacity.

8. Q. What about the pumping range of an inducer?
   A. The Inducer, like the impeller it teams with, is designed to best function over a specific capacity range. Proper information supplied on pumping conditions will enable correct recommendations to be offered.

9. Q. Are operating clearances important to inducer operation?
   A. The Inducer is a precision instrument and the clearance tolerances are generally similar to those of an impeller.

10. Q. What is the availability of the inducer?
    A. The Inducer is available on the most popular sizes of Peerless end-suction centrifugal process pumps. Some sizes are carried in stock.

TO ARRIVE AT REQUIRED NPSH

The system NPSH available in a proposed installation can be calculated by the formula:

$$H_{sv} = H_p + H_z - H_f - H_{vp}$$

Where:

H_{sv} = NPSH expressed in feet of fluid.
H_p = absolute pressure on the surface of the liquid where the pump takes suction expressed in feet of fluid.
H_z = static elevation of the liquid above the centerline of the pump (on vertical pumps the correction should be made to the entrance eye of the impeller) expressed in feet. If the liquid level is below the pump centerline, H_z is minus.
H_f = friction and entrance head losses in the suction piping expressed in feet.
H_{vp} = absolute vapor pressure of fluid at the pumping temperature expressed in feet of fluid.

The system NPSH available in an existing installation can be measured as follows:

$$H_{sv} = P_a + P_s + \frac{V_s^2}{2_g} - H_{vp}$$

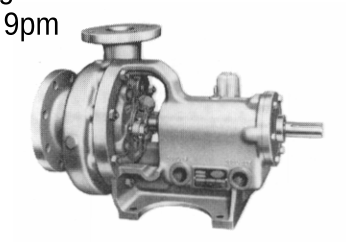
Where:

P_a = atmospheric pressure for the elevation of the installation expressed in feet of fluid.
P_s = gage pressure at the suction flange of the pump corrected to the pump centerline and expressed in feet of fluid. P_s is minus if it is below atmospheric pressure.
$\frac{V_s^2}{2_g}$ = velocity head at the point of measurement of P_s
H_{vp} = absolute vapor pressure expressed in feet of fluid.

THESE ARE THE PEERLESS PUMPS ON WHICH THE INDUCER IS AVAILABLE—

TYPES DL, DM, DR

A very comprehensive line of chemical process service pumps. Full range of sizes corned in stock.
Capacities: up to 1000 9pm
Heads: up to 430 feet
Temperoture ranges: up to 450°F.
Packing gland or shaft seal construction.
Described in Bullelin B-1608, B-i 610.



TYPES PR, PRS

Heavy duty, packing gland (Type PR) and shaft seal (Type PRS) construction for refinery process, chemical process and hot and cold water pumping.
Heads: up to 700 feet
Capacities up to 1200 gpm.
Described in Bulletin No. B-1605.