From Water and Wastewater.com

Ask Tom! Column

“Shearforce” Rotor : Unique Concept in Pumping Fluids

Guest article by Frank Tybor of Shearforce Ltd. Company

Shearforce pumps utilize the patented “Shearforce” rotor which is a vane less impeller with non-parallel shrouds. These rotors improves the Shearforce pump’s capability of pumping certain applications which are not suitable for standard vane type impellers. Applications include entrained gas (air), high solid content, viscous and shear sensitive liquids.

Background

The background of shear force pumps is as old as the Egyptians when it was used to remove water from the Nile River. The Archimedes pump used a screw (auger) to move material down a cylinder. The rotation of the screw creates a shearing force on the material which drives it down the threads of the screw.

Figure 1: Shearforce rotor

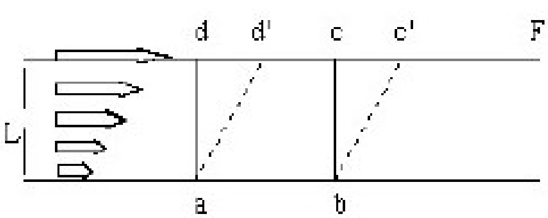
The Shearforce pump or vane less centrifugal pump utilizes the fluid viscosity to generate the necessary forces required to sustain a pressure differential and corresponding flow. As the rotor is spinning, fluid is introduced through the central region where it is drawn in a radial direction through the rotor spaces. Due to the fluid’s viscosity, the fluid is accelerated by the shear forces and assumes a tangential velocity. As the fluid progresses outwardly, the body forces continually develop, sustaining the pressure gradient and flow in the radial direction.

Boundary condition states that the normal component of the velocity at a boundary is zero in steady flow. With the Shearforce pump, the boundary layer (layer closest to the rotating shroud) is stationary, relative to the shroud. As the shrouds rotate, energy is transferred to successive layers of molecules in the fluid between the shrouds via viscous drag. This generates velocity and pressure gradients between the shrouds.

The basic principal is well studied in physics and fluid flow. When a fluid flows between flat plates or through a tube, under certain conditions, the flow pattern assumes that of thin layers or laminae which slide past one another. If there is a friction force along the surface of contact between the layers a force must be exerted to cause one layer of the fluid to slide past another.

The friction force arises from a property of the liquid called viscosity and the flow is said to be viscous, laminar, or in streamlines. To obtain a quantitative definition of viscosity, we shall consider the laminar flow of a fluid between two parallel flat plates, as show below. The upper plate moves to the right with velocity V due to the force F which is also to the right. The lower plate is stationary. The thin layer of fluid in contact with the moving plate is found to have the same velocity as that of the plate.

Figure 2: Intermediate layers of fluid



The thin layer adjacent to the stationary plate is at rest. The velocities of the intermediate layers of fluid increase uniformly from the stationary to the moving wall, as shown by the arrows. The layers of fluid slide over one another as do the leaves of a closed book when it is placed flat on a table and a horizontal force is applied to the top cover. As a consequence of this motion, a portion of the fluid which at some instant has the shape abcd, will a moment later take the shape abc'd' and will become more and more distorted as the motion continues, In short, the fluid is in a state of continually increasing shearing strain.

To maintain motion it is necessary that a force F be continually exerted to the right of the moving plate, and hence on the upper surface of the fluid. This force tends to move the liquid and the stationary plate as well to the right. Therefore an equal force F must be exerted to the left on the lower plate in order to hold it stationary. If A is the area of the fluid over which these forces are applied, the ratio F/A is the shearing stress exerted on the fluid. See our whitepaper on website for more details.

The primary difference in the Shearforce rotor compared to other impellers or rotors is the lack of vanes or a vane less impeller. This results in very little impingement on the fluid since very little fluid comes into contact with the rotor. The fluid that does come into contact with the rotor remains stationary relative to the rotor due to the boundary lawyer of the fluid with the rotor. The remaining fluid passes through the rotor due to the friction created by each progressive layer of fluid from the boundary layer to the center of the rotor. A high pressure area is created at the boundary layer closes to the outer shrouds with a resultant lower pressure area in the center of the rotor.

This enables the Shearforce pump to pump fluids with low shear and without impingement. The low pressure area in the center of the rotor which is a conduit for solids and gas to pass through the rotor without impingement. Since the Shearforce Rotor is utilizing the fluid viscosity to move the fluid, higher fluid viscosities such as sludge are no problem for the Shearforce rotor.

Specific Installations : DAF

Specific installations which have demonstrated the advantage of the Shearforce Rotors are DAF (dissolve air floatation) systems. A DAF system developed by Water Resources known as the DAF Whitewater System which utilizes the patented Shearforce technology. The heart of the system is the ability of the Shearforce pumps to pump air which has been injected into the suction of the pumps.

Figure 3: Installation of Shearforce Pumps installed in DAF application.

The injection of air results in Whitewater which is pumped through the innovative Pipe Flocculator. The Whitewater contains millions of microscopic tiny air bubbles. Extensive laboratory evaluation on the size of the air bubble and effective liquid-solid separation, overwhelming demonstrate that the smaller the air bubble, the more efficient the separation.

Another specific application which benefits from the Shearforce Rotor is sludge. Pumps typically used for this application are progressive cavity pumps. The screw type rotor of these pumps are subject to high wear due to the abrasive quality of the sludge. The pump equipped with the Shearforce Rotors are capable of passing the sand with minimal impingement and therefore wear.

Figure 4: Result of injecting air into the suction of the Shearforce rotor

Installation showing P.C. type pump on left being replaced with Dry Pit type pumps without need for piping modification.

Typical Applications

- DAF and Ozone Applications: Air can be injection into suction of Shearforce rotor creating millions of tiny air bubbles improving the efficiency of any DAF or ozone processes.
- Entrained Chemical Gas: Shearforce rotor can pump up to 20% entrained gas without effecting pump performance thus eliminating the need to remove gases produced in chemical processes.
- Latex Paint: Shearforce rotor will not shear the latex products producing a better product.
- Oil Sludge: Shearforce rotor can handle high viscosity and solid content.
- Oil Tank Loading: Shearforce rotor will not emulsify the crude oil saving in de-emulsification chemicals.
- Pharmaceutical Crystals: Shearforce rotor will not damage the crystals used in producing many pharmaceutical products.
- Plankton: Shearforce rotor will not damage the living organisms.
- Food Industry: Shearforce rotor can be installed in A3 pumps for shear sensitive foods such as milk, grape juice and wine.
- Shearforce Rotors have also been used successfully to pump oil sludge from sludge pits. The process includes modification. Shearforce Rotors have also been used successfully to pump oil sludge from sludge pits. The process includes the liquidizing of the sludge and the separation of the oil from the sand.

About our author

You can contact our author at

Mr. Frank Tybor
Shearforce Ltd. Company
5510 South Westmoreland, 300
Dallas, TX 75237
Email: tybor@shearforce.biz
Web site: http://www.shearforce.biz/

++++++++++++++++++++++++

Welcome to Ask Tom!, a monthly column by our resident water treatment guru, Tom Keenan of National Environmental Services Agency (NESA). Tom addresses the issues that bug you the most. And Tom knows!! With 35 years experience in providing environmental support services to public and private sector clients on a wide range of environmental issues.

Help others by posting your comments, suggestions and experiences with water or wastewater treatment or any other concerns you may have on our On-Line Help Forum. For past **Ask Tom!** Articles, visit the **Ask Tom! Archive**.

Guest articles for the **Ask Tom!** Column are always welcome, for more information please contact Tom Keenan directly at his email address: info@nesa.ie