The Roto-Jet pump: 25 years new

After a quarter of a century, the pitot tube pump concept remains as exciting and unique as it was the day it was first introduced. Often jokingly called, "The Backward Pump" because of its rotating case, the pitot tube's simple design and versatile performance have achieved areputation as the solution to many high pressure pumping problems. Twenty-five years later there are still many in the pump industry who remain unfamiliar with the pitot tube concept, and it is not uncommon to hear newcomers to the design comment, "How do you rotate this pitot tube?" Most design engineers find the simplicity of the pitot tube pump intriguing, while users delight in the increased dependability and ease of maintenance that come from this simplicity.

Steve Osborn, Director of Marketing, Roto-Jet Pump

Roto-Jet history.

1960s	Challenge-Cook Brothers Company acquire patent rights to the basic pitot tube pump.
1971	Kobe, Inc., a division of Baker International, purchases patent and manufacturing rights to the Roto-Jet pump.
1972	Kobe sells first of newly designed pitot pumps, the RB.
1972-1979	Kobe introduces six separate pump lines based on pitot tube technology. Kobe is awarded 35 patents for pitot tube pump designs.
1984	Baker International transfers the Roto-Jet product lines to Baker Lift Systems, another division of Baker International.
1985	The R11, a smaller version of the Roto-Jet pump, is introduced.
1987	Baker International merges with Hughes Tool; subsequent reorganization of the company leads to the emergence of EnviroTech Pumpsystems, a division of Baker Hughes, Inc.
1994	Two new pitot tube pumps are introduced; an increased capacity pump and the vertical Roto-Jet. A patent is awarded for the new vertical design.
	Baker Hughes, Inc. sells EnviroTech Pumpsystems to the Weir Group, based in Glasgow, Scotland.

Development

The pitot tube pump first appeared in U.S. patent history at the turn of the century. The pitot tube, named after its inventor, the eighteenth century French hydraulic engineer Henri Pitot, is commonly used to measure velocity pressure of fluids. The first pumps designed using the pitot tube principle were an open-ring rotor-type, which had numerous performance limitations. During the 1920s, the first basic closed rotor was described in patents.

During the 1940s, this closed rotor design was studied in both Germany and Britain for use in rockets and aircraft. Continued development of the pitot tube pump slowed when it was determined that this design was limited to flow rates of less than 5 gallons per minute and was highly susceptible to air locking. In the early 1960s, development started in the United States which led to the enclosed rotor and a cover that incorporated a closed radial-type impeller that would eventually form the basis for the Roto-Jet model of the pitot tube pump.

Principle of operation

The pitot tube pump design is best described as a single-stage centrifugal pump. Key elements of the pump's design are the closed rotating case and the stationary pitot tube. Liquid enters the rotating case through the enclosed vane of the rotor cover, which serves as the pump's impeller, increasing the velocity of the liquid. The liquid exits the impeller and spins at the rotational speed of the case. A stationary pitot tube extends from the center to the inside diameter of the rotating case. Here the velocity energy of the liquid in the rotating case is at its maximum as it impacts the opening of the pitot tube. The pitot tube's internal passage serves as a diffuser that combines the velocity head and centrifugal force of the liquid to develop the total head

created by the pump. This allows the pump to produce approximately 1.6 times the head as that of a similar sized conventional centrifugal pump operating at the same speed.

The simple design of the pitot tube pump provides a unique set of operating benefits that have caused thousands of customers to rely on the Roto-Jet pump as the solution for their high pressure needs.

Design simplicity

The pitot tube design produces high pressure through a single stage without requiring high speeds, close clearances, or complicated controls that are required by other designs. The mechanical seal is located on the suction side of the pump, isolated from the mechanical drive end. This minimizes the opportunity for seal leakage to contaminate bearings and places the mechanical seal in the low pressure area of the pump, extending seal life.

Operation

The pitot tube pump can operate at any flow condition on its head curve. This makes the pump ideally suited for applications with varying flow requirements. From full flow to shut-off, the pump can operate without being damaged. Both the radial load and the low axial load of the pump are independent of the pump flow rate. This allows the pump to operate at any point on its performance curve without damaging the bearings or destroying the shaft. The head the pump produces is a function of speed. To increase the head, the speed of the pump is simply increased.

This makes the Roto-Jet ideally suited for use with variable speed drives.

Performance flexibility

The pump performance, both flow and head, are easily changed. The pump's flow capability is determined by the size of the opening of the pitot tube. The pump's ability to produce head is a function of the speed of the pump. The complete flow and head performance of a model of pump can be achieved simply by changing one part, the pitot tube, and the speed of the pump.

Durability

The pitot tube pump is able to stand the shock caused by critical upset conditions. The pump

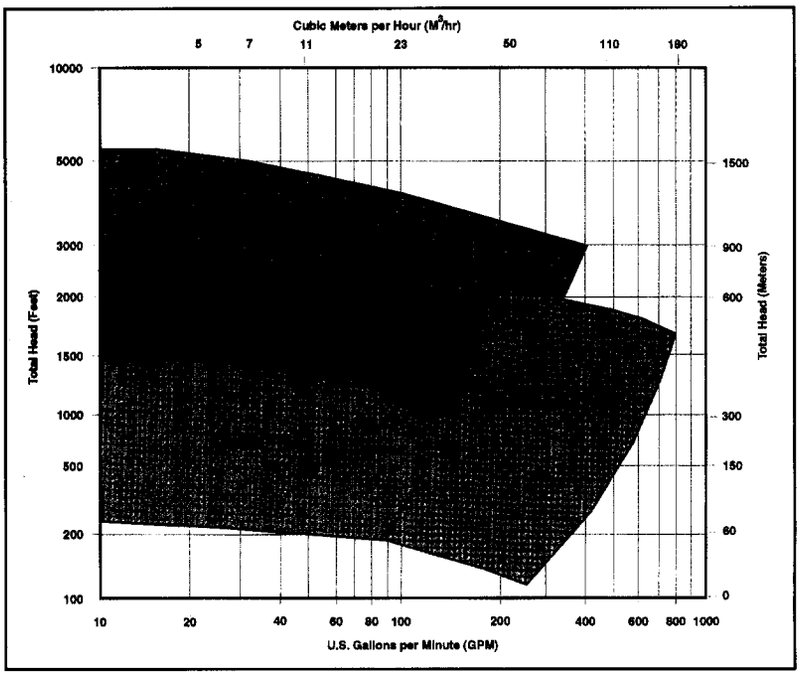

Figure 1. Roto-Jet family range curve.

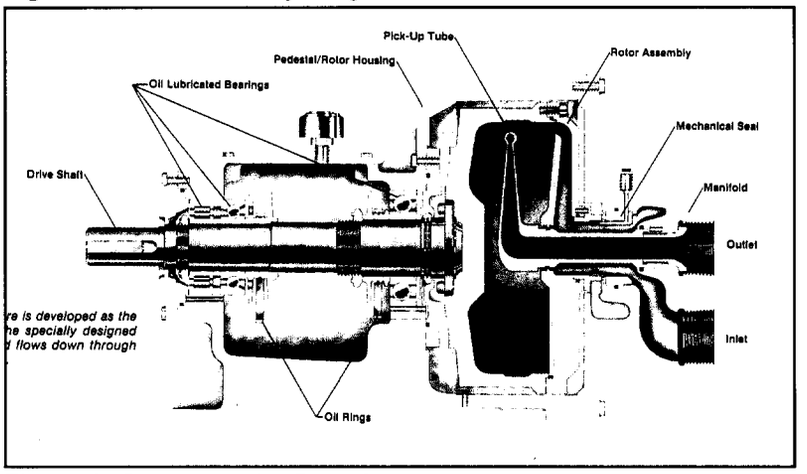

Figure 2. Cut-away of a Roto-Jet pump.

Figure 3. Roto-Jet pumps can operate at any point on their performance curves without damaging bearings or shaft.

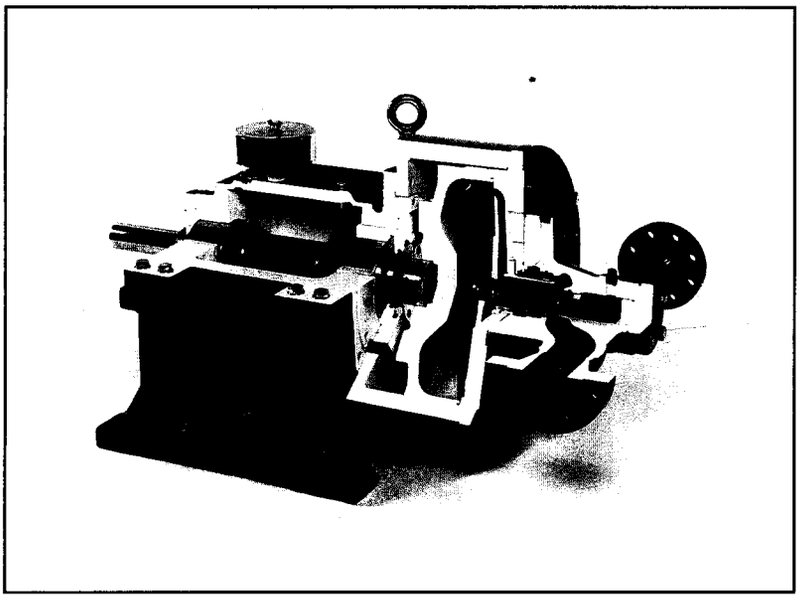

Figure 4. Cut-away photo of the Roto-Jet.

rotating assembly does not seize if run dry due to loss of suction. Since the mechanical seal is not mounted to the drive shaft, harmful leaks and temperature rise resulting from seal failure are not transferred to the critical bearing area. The pump design does not require wear rings or close shaft tolerances which would be subject to heat expansion and subsequent failure.

Ease of maintenance

The simple design of the Roto-Jet pump allows for easy maintenance.

With few moving parts and the low pressure seal design, routine maintenance can be accomplished with minimal effort. More extensive rebuilds are also completed quickly by simply replacing the rotating element.

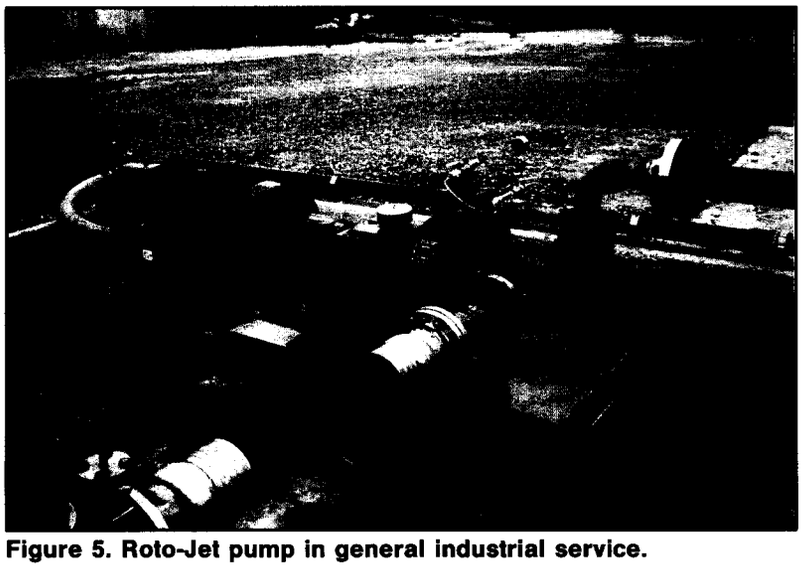

Figure 5. Roto-Jet pump in general industrial service.

Applications

Twenty-five years ago when the Roto-Jet pump first entered the marketplace, industrial users were in need of a dependable, low flow, high pressure pump. The performance flexibility and other operational benefits of the Roto-Jet design allowed it to achieve a quick entry into the major markets of central cleaning systems for the food industry and high pressure showers for the paper industry.

The strong reputation that the Roto-Jet pump earned within these industries, combined with continued development, has opened up a wide range of technical applications within the marketplace. Today the Roto-Jet pump remains ideally suited to meet the demands of both the food and paper industries. However, the Roto-Jet pump now finds itself equally at home in a wide range of industries. From a single pump used in a simple cleaning system in a rural food processing plant, to the high pressure water injection pump used for NOx control of sophisticated gas turbines used in power generation, the Roto-Jet design has proven to be a premier high pressure pump.

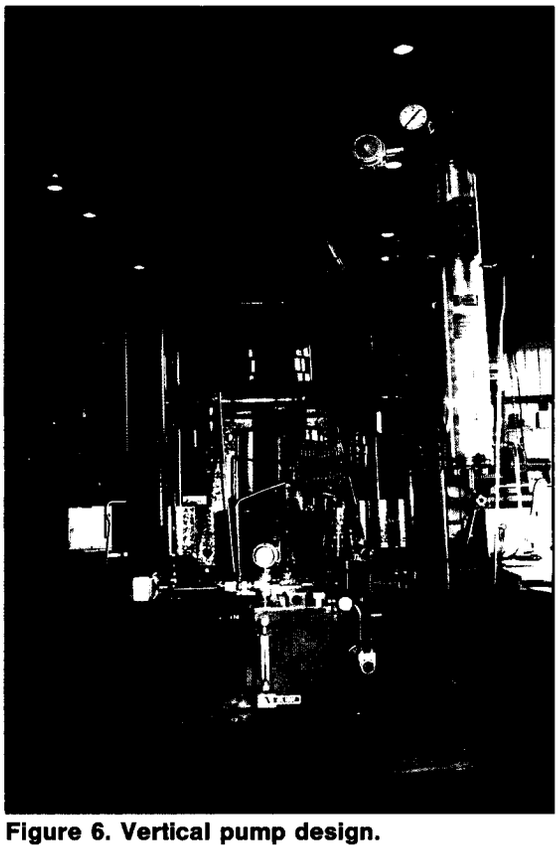

Figure 6. Vertical pump design.

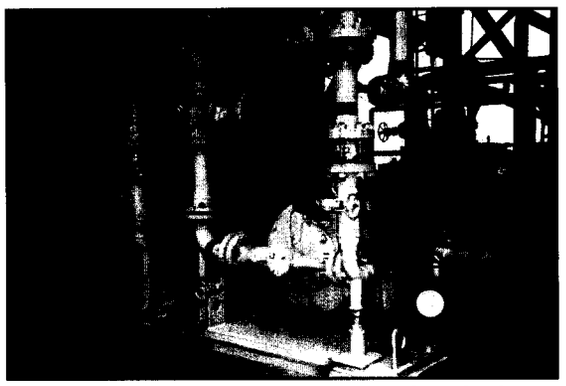

Figure 7. Roto-Jet pump in petrochemical service.

Figure 8. The early days of the pump.

- Food Processing

The Roto-Jet's ability to vary its flow and operate throughout its head curve has made it a natural fit for providing high pressure water to the central cleaning systems of the food industry. Spray guns are located throughout the food processing facility and can be used on demand for clean-up. This constantly changing demand requires that the pump be able to operate over a wide flow range. The Roto-Jet pump meets this need and is also able to operate at a low minimum flow during periods of time when there is no demand. These cleaning systems are found throughout the food processing industry, including meat packing, breweries, fruit and vegetable canning, prepared food processing, and beverage plants.

- Pulp and Paper

In the paper industry, high pressure water showers are used to clean the screens and felts of the paper machine. Keeping these felts and screens clean is an important element in the making of good paper. Without a thorough cleaning job on each pass, a pulp residue will build up on the screens or felt, affecting the quality of the paper being produced. Flow rates and pressures of the paper showers are varied, depending on the type of paper being processed and machine speed. Roto-Jet pumps excel in these shower applications because of their ability to meet the changing process requirements.

- Petrochemical and Petroleum Refining

Roto-Jet first introduced pitot tube pumps designed to meet American Petroleum Institute Standard 610, Centrifugal Pumps for General Refinery Services in the late 1970s. Since that time, the Roto-Jet pump's ability to produce high head from a single stage at relatively low operating speeds has allowed it to be used successfully in a wide range of applications within the petrochemical and refining industries. In light hydrocarbon and high pressure process applications, the low pressure designed mechanical seal is a benefit, while the high thrust capacity of the pump allows it to handle the high suction pressures commonly associated with lower specific gravity fluids.

In both high pressure injection and deep well disposal applications, the system pressure changes as a response to changes in the process, while often requiring a constant flow. When the Roto-Jet pump is applied using a variable frequency drive to control the speed, the pump is capable of matching the changing system requirements.

- Power generation

The need for unquestionable dependability has caused the power generation industry to look to Roto-Jet pumps to meet their high pressure needs. Roto-Jet pumps are often applied as boiler feed and desuperheating pumps for industrial boiler systems. Gas turbines used for electrical power generation require a high

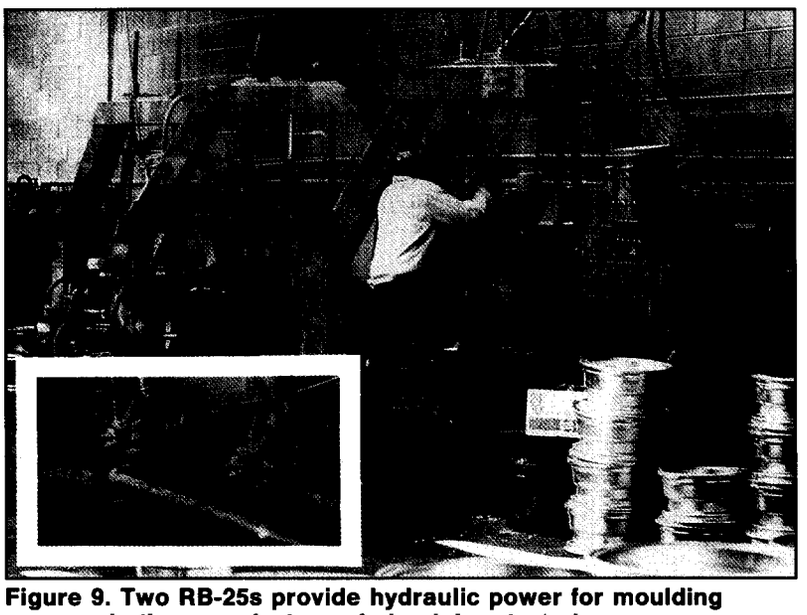

Figure 9. Two RB-25s provide hydraulic power for moulding presses in the manufacture of aluminium tyre rims.

pressure pump for both fuel injection and NOx emission control. The combustion temperature is controlled by injecting high pressure water with the fuel, reducing the NOx emissions.

Today the Roto-Jet pump remains ideally suited to meet the demands of both the food and paper industries. However, the Roto-Jet pump now finds itself equally at home in a number of different applications in a wide range of industries. Besides the applications within the industries outlined above, Roto-Jet pumps are used in automotive machining, mining and metals processing, transportation wash facilities, and reverse osmosis systems, while new applications continue to be discovered.

Future

Having firmly established itself as a leader in central cleaning systems, the Roto-Jet pump quickly found a niche in the paper industry, proving to be an excellent selection for meeting the high pressure shower needs of the paper machines. From those early industrial beginnings, the Roto-Jet pump's reputation, combined with the continued focus on product development, has opened a wide range of technical applications within the marketplace.

As industry requirements change, the pitot tube pump has changed. The need to operate pumps at higher speeds to meet the high pressure demands of today's applications has resulted in new bearing designs. A pitot pump using tilting pad thrust and radial bearings in place of the rolling element bearing design is being evaluated. Modern materials such as ceramics are being tested to improve the abrasion-resistance of key components of the pump. Advances in mechanical seal technology are continually being applied to the pitot pump. The introduction of a gas seal design is the latest such innovation.

After twenty-five years and thousands of world wide installations, the Roto-Jet pump has proven to be as dependable as it is versatile. The Roto-Jet pump is designed for the long haul, precision built to provide years of trouble-free service. The Roto-Jet pump is used in applications where durability and reliability are an absolute requirement. ■