Catching the sludge with a centrifugal filter pump

Have you ever wondered where the ideas for specific technologies come from? Inspiration can be found in surprising places. Jim Hosford of Rotoflush Filters provides the inside story of how a big problem on his dairy farm – a clogged centrifugal pump – led him to design his own line of pumps and start a company built on his invention.

Rotorflush Filters started in 1996 following an invention by UK dairy farmer Jim Hosford. He designed a self-cleaning suction filter for use on the 2 kW surface mounted centrifugal pump pumping effluent from his dairy unit. This effluent consisted of cow manure, straw, silage, and sometimes leaves and plastic bags that had been blown into the lagoon. A large static screen filter supplied with the pump was blocking every hour or so, making the system unusable. The self-cleaning suction screen he designed enabled the pump to work continuously for months on end with no maintenance. It had two internal backwashing jets that were powered by a proportion of the pump's output. The rotating jets continually backwashed the screen, removing any detritus that was starting to blind the screen. After winning his category in the 1994 inventions competition run by the UK's *Farmers Weekly* magazine, he decided to start Rotorflush Filters to commercialise the invention. Hosford named his company "Rotorflush" after the revolving flushing jets inside the filters, which is a common feature of all its products .

Figure 1. Production version on first customers pig unit wastewater lagoon (1996).

Developing the filter pump

The next logical progression was designing a self-cleaning intake filter that could be incorporated as an integral part of a submersible pump. This would make a much simpler unit that could be dropped into almost any water source and produce a pressurised filtered supply with no maintenance.

Initially, the driving force behind the innovation was simple problem solving. Solids-handling centrifugal pumps only develop relatively low heads. In many situations fibrous matter, string, plastic bags and other detritus will block even these pumps. If the pump is not blocked, then solids in the water can plug upstream valves and nozzles

High pressure multistage pumps can only pass very small solids and their inlet strainers soon get fouled if they are used in water containing any quantity of suspended solids. A self-cleaning intake filter solves these problems. A multi-stage submersible pump can be used that produces high pressures, the pump and upstream equipment are protected and the whole unit is very compact and simple to install.

How it works

The filters on the submersibles work in the same basic way, but the method of providing the flow to the revolving jets is different. Instead of providing the backwashing liquid from the pump's output an extra impeller and volute is provided driven by an extension to the main pump shaft (Figure 2). The figure shows a computer generated graphic to show the self-cleaning

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intake filter that is fitted to the bottom of a submersible pump. The large blue arrows show the main flow that has come through the filter screen and up into the submersible pump, while the red arrows show the flow that is re-circulated by the backwash impeller and out through the screen via the nozzles. The yellow arrow shows the rotation of the volute and nozzles. The extension shaft is attached to the end of the main pump shaft and drives the backwash impeller. The backwash impeller recycles the water that has already been through the filter screen, pressurising and expelling it through the nozzles. The nozzles are slightly angled and cause the backwash pump volute to rotate around the impeller at approximately 60 rpm. The water expelled through the nozzles passes back through the filter screen removing any detritus that may be beginning to stick to the screen. In fact, it often moves particles away from the screen before they are even exposed to it.

In the last year, Rotorflush has invested in tooling to injection mould the backwash nozzles and rotating volute. Previously these were fabricated in stainless steel, which made them expensive owing to the amount of fiddly welding. The shape also varied slightly because of heat distortion. The geometry of the backwash assembly is critical to make it rotate at the correct speed. The whole assembly rotates on ceramic bearings. The thrust bearing uses two pump seal faces that ensure long life. The injection-moulded rotating volute can be fitted with nozzles of different lengths to accommodate different filter screen heights. Impellers with different widths can be accommodated depending on the amount of backwash required. At present the largest filter screen apertures are 300 microns; any larger than this will allow particles to block the nozzles. However, Rotorflush plans to produce filter screens with up to 5 mm apertures. The backwash nozzles will be replaced with rubber fan nozzles that the company already uses in its other self-cleaning filter products. These enable larger particles through without blocking. A vortex type backwash impeller will then be used that can cope with the larger particles coming through the coarse screen.

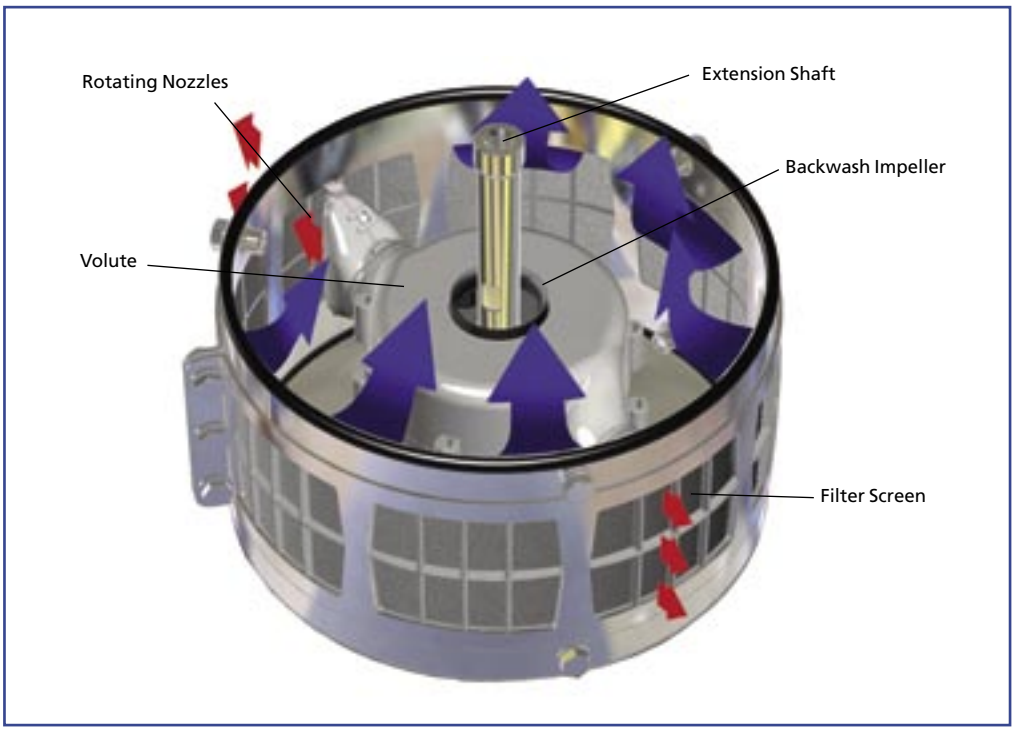

Figure 2. Computer generated graphic to show the self-cleaning intake filter that is fitted to the bottom of a submersible pump.

Rotorflush control valve

Another result of a busy year is the development of the Rotorflush control valve. In most situations, the self-cleaning filters will work for long periods without maintenance. However, in some situations very high levels of suspended solids may be present that can overcome the backwash of the filter, causing it to become blocked. In sewage works where the Filterpumps are being used to provide wash water for inlet screens, occasionally, usually owing to a storm, the sewers will be scoured of debris and very high levels of solids arrive at the sewage works, causing the filters to block. The level of solids that the filter can cope with depends on the ratio of the main flow (blue arrows in Figure 2) to the backwash flow (red arrows). The higher the backwash flow in relation to the main flow, the more solids it will filter out without blocking. Adjusting the output of the submersible pump in response to the level of solids in the water ensures that the filters can never block, regardless of the solids loading in the water.

A number of solutions have been tried over the years, but in the end, Rotorflush decided to develop its own mechanical control valve. A valve was required that would be able to throttle the output of the pump in response to the pressure differential across the filter. The valve needed to offer low flow resistance and not be affected by suspended solids. It needed to be able to throttle and shut off the pump's flow at pressures up to 10 bars.

Figure 3. The Rotorflush Filterpump fitted with control valve.

With only 50 mb pressure differential available, (the pressure exerted by a column of water ½ m high), to provide the motive force to close the valve, careful design was required to balance the pressure and minimise friction. The all stainless steel valve uses rolling diaphragms to balance the pressures across the 50 mm valve seat and a larger sensing diaphragm that has a connection to the inside of the filter. As pressure inside the filter drops during times of high solids loading, the valve starts to close, restricting the output of the pump. The valve automatically keeps the output of the pump at a level where the filter can continue to clear the debris from the screen. It may only require a slight reduction in the pump's output to keep the screen clear and when the solids levels in the water subside the pump returns to maximum capacity.

Figure 4. The Rotorflush Control Valve.

Range of applications

The pumps have been used in a number of applications over the last four years. One of their uses is at sewage works where they are providing wash water for inlet screens where previously potable water was being used. The pumps are positioned either just after the inlet screens or in the primary, secondary or final effluent tanks. Even final effluent contains particles that block the spray nozzles on the head works screens. The pumps provide the pressure required and ensure that the nozzles stay clear.

The Damar Group provides civil, mechanical and electrical engineering services to the water industry in the UK. They have been using the Rotorflush Filterpumps on their de-scumming equipment at sewage works. This application involves pumping water from the outflow of the primary settlement tanks back to spray jets that disperse and sink the scum from the surface of the vessels. The pumps are also being used to provide process washwater for inlet screens and sludge thickening installations.

"The design team from Damar chose the Rotorflush Filterpump because it's the only pump available with a self cleaning inlet filter," a spokesperson from the company said. "The multistage submersible provides the pressure we need and the self-cleaning inlet filter ensures that particles that would block the pump or the 2 and 3 mm spray jets are kept out of the system. The pumps have performed extremely well and enabled us to achieve our objective of providing cost effective wash water to the smaller systems with very low maintenance."

Increasingly, customers want to take water from natural water sources rather than from the mains for irrigation. Geoff Wood of Water Designs Ltd near Bath in the UK designs and installs irrigation systems. He has used Rotorflush Filterpumps to provide a filtered supply of water for landscape irrigation from lakes. "The Rotorflush Filterpumps are a simple and cost effective way to provide protection of the pump from weed and debris," Wood said. "They eliminated the need for complicated and expensive upstream self-cleaning filters and have proved reliable and maintenance free even though we have one installed in a particularly dirty part of a lake."

A constant flow of filtered effluent needs to be provided to the analyser at sewage works and factories. Keith Perkins, who manufactures analysers in the UK, has been using Rotorflush's Filterpumps to continuously feed his analyser cells on sewage works. Perkins says, "The Rotorflush Filterpump is an ideal solution for extracting a filtered sample for our analyser. There can often be weed and other detritus in the final effluent channel that would block a wastewater pump. The 125 micron self cleaning inlet screen provided on the submersible pump not only protects the pump from blockage but provides a filtered sample with no requirement for cleaning of conventional filters."

The filterpumps have been used for many other uses, including water recycling systems on vegetable washer units, pre filtering and pumping water contaminated with waste in the nuclear industry and at a steeple jack company for filtering the output of water cooled chainsaws used for taking down chimneys. A recent enquiry is the use of the Filterpumps to provide a filtered supply of cooling water to the seals on large pumps. The product has international patents and may be suitable for pump companies who want to making larger models. ■

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