



Ejector Solutions for the Nuclear Industry





It's what we do

Ejectors (also referred to as Jet Pumps or Eductors) provide a simple, robust and reliable method of mixing or pumping nuclear slurry. With no moving parts and no maintenance, they are increasingly being used instead of mechanical pumps.

In operation, slurry Ejectors utilise the energy available from high pressure motive liquid to entrain nuclear slurry and then pump the resulting mixture to further tanks.

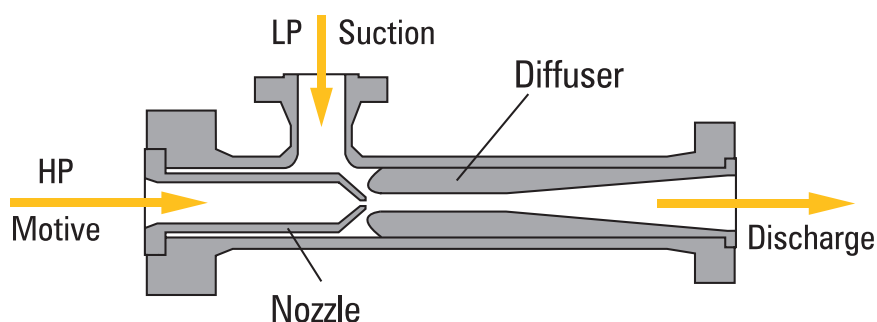
Ejectors can also be used to dilute slurry to improve slurry transportation and Tank Jet Mixing Ejectors can be designed to suit the exact process mixing requirements of each individual nuclear tank.

For nuclear applications, ceramic internals are recommended to minimise wear of the nozzle and diffuser and to reduce/eliminate the need for regular maintenance.

Ejector operation is based on Bernoulli's principle, whereby by increasing the velocity of a fluid as it passes through the nozzle, a low pressure region is created within the Ejector. This region entrains and compresses the secondary LP stream which we call the suction fluid.

As the combined HP and LP streams pass through the Ejector's diffuser section, the velocity decreases and the pressure is regained, resulting in an intermediate pressure, which lies somewhere between the LP and HP inlet pressures.

“ Ejectors use a high pressure fluid to compress a low pressure fluid to an intermediate pressure. ”





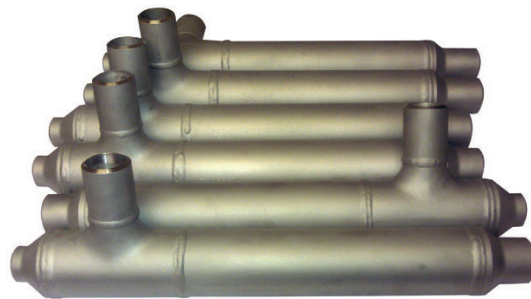
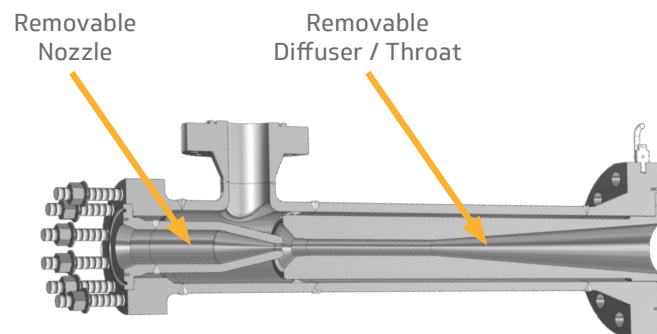
Why choose Ejectors?

- ▶ Environmentally friendly - zero emissions
- ▶ No maintenance
- ▶ No moving parts
- ▶ Proven reliability
- ▶ Easy to install
- ▶ Simple to control
- ▶ Controlled by standard techniques
- ▶ Low cost & weight
- ▶ Robust construction
- ▶ ATEX not applicable
- ▶ Short pay-back & significantly cheaper than mechanical pumps / compressors
- ▶ Safe to operate
- ▶ Performance easily modified to suit changing conditions
- ▶ Can be installed in tight spaces
- ▶ Handles radioactive slurry without damage
- ▶ Can be performance tested prior to despatch



Ejectors - Suited for Nuclear

- ▶ Compact design - ideal for Small Modular Reactor (SMR)
- ▶ Robust, flexible and proven design
- ▶ Pressure retaining shell fully meets site piping standards
- ▶ Patented removable nozzle & diffuser design enables a complete change in Ejector operating conditions
- ▶ 'Universal Design' Ejectors allow for standardisation of Ejector body, with customisable internals for specific sites, supporting SMR design approaches.
- ▶ Ceramic nozzle & diffuser inserts can be fitted or retrofitted to resist wear due to solids erosion
- ▶ Units can be fully performance tested prior to installation
- ▶ Maintenance eliminated with ceramic internals



6 x size 2 Liquid Jet Pumps with ceramic internals for transfer of radioactive product



Ceramic internals suitable for Nuclear applications

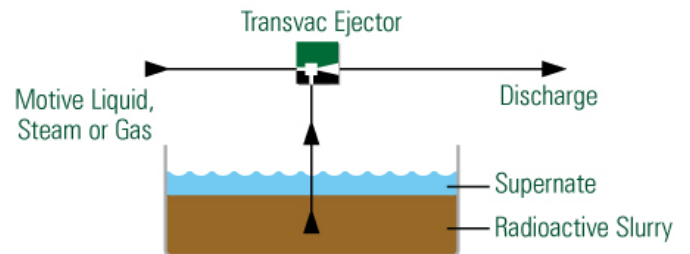
Slurry Handling

Direct Pumping of Nuclear Waste

Typically motivated by pressurised water, Liquid Jet Pumps can be used to entrain and transfer radioactive waste from settlement tanks / ponds.

Liquid is often used to transport radioactive slurries in order to maintain velocity within long discharge pipelines and thereby prevent solids settlement.

When pumping abrasive slurries, materials are typically stainless steel complete with ceramic internals.

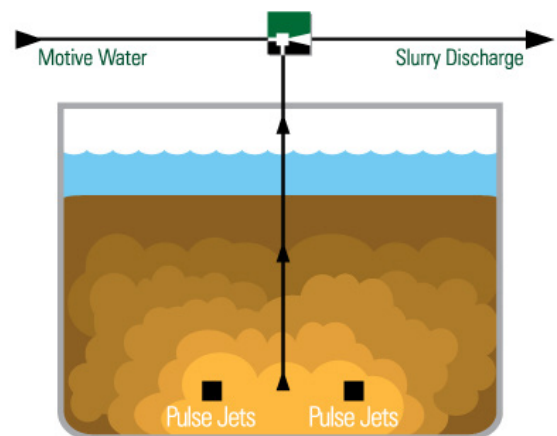


SPP Applications

For SPP (Sludge Packaging Plant) applications, Transvac Liquid Jet Pumps are installed above the radioactive slurry.

In operation 'Pulse Jets' submerged in the slurry agitate an area around the suction leg of the Liquid Jet Pump allowing it to transfer slurry to reception tanks elsewhere on site. As the tank slurry is removed, liquor is added to the tank to maintain a constant head.

The SPP Ejectors include Transvac ceramic internals to resist wear.



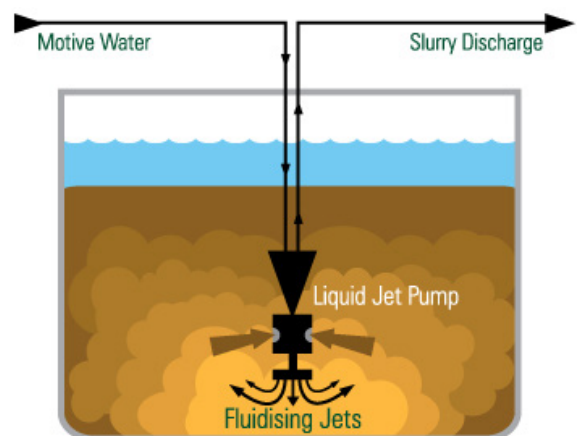
SIXEP Applications

For SIXEP (Site Ion Exchange Plant) applications, Transvac Liquid Jet Pumps, complete with a special fluidising jet systems, are submerged in the radioactive slurry.

In operation, the fluidising jets agitate an area around the suction ports of the Jet Pump allowing it to transfer slurry to reception tanks elsewhere on the site.

As the tank empties, the Jet Pump and fluidising jets are gradually lowered.

The SIXEP Ejectors includes Transvac ceramic internals to resist wear.



Buffer Storage Application

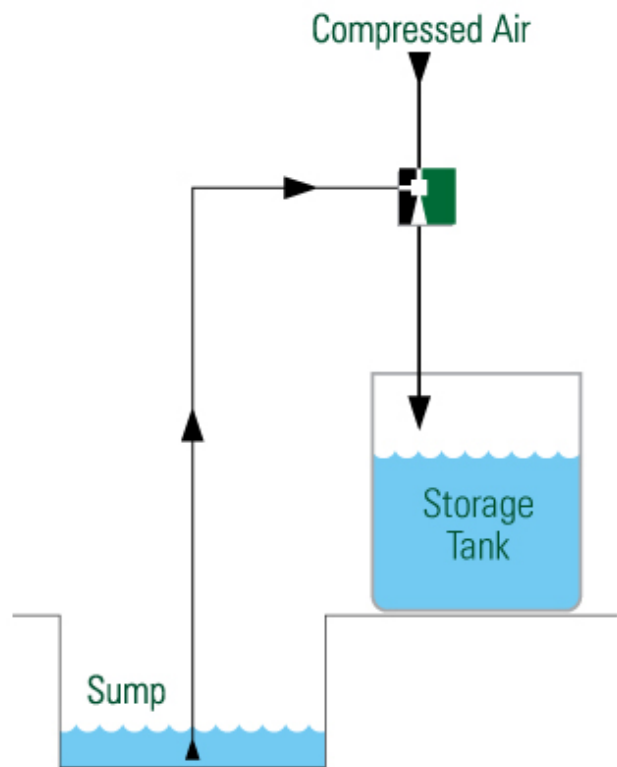
Transvac Air Jet Syphons are used to decant (directly transfer) radioactive magnox liquor from cell sumps into the BSV tank as shown in the diagram.

Using compressed air as the motive fluid enables the transportation of radioactive liquor without adding any extra fluid to the quantity handled.

Steam is also a very effective medium to motivate Ejectors when directly pumping radioactive slurries over short distances.

One advantage of using steam is that it is easy to provide and adds very little additional liquid to the radioactive slurry being pumped, which can be a major benefit for downstream processes. Typically discharge pressures would be >2 bar(g).

Gas is not an effective medium for directly entraining and pumping liquids. It can only be used as the motive fluid for Air or Gas Jet Syphons when entraining and pumping small quantities of liquids / slurries over short distances.

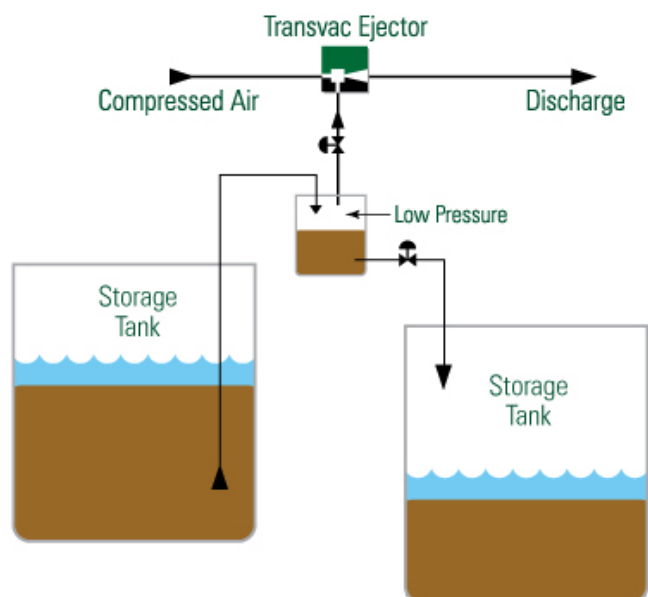


Indirect Pumping of Nuclear Waste

Steam, Air or Nitrogen can be used to motivate an Ejector to create a vacuum within a transfer vessel to draw in liquids / slurries. The steam, Air or Nitrogen is not in direct contact with the fluid being pumped.

Once the volume of liquid reaches a preset level in the transfer vessel, the Ejector is switched off. The vessel contents can then be simply drained by gravity to the discharge point.

This system is usually used for transferring small quantities of suction fluids.



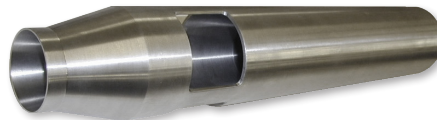


Tank Jet Mixing

Tank Jet Mixers provide a simple method of mixing and agitating tanks with no in-tank moving parts and no maintenance. Transvac Jet Mixers can achieve a discharge flowrate equal to 4 times it's motive liquid flowrate.

Performance is controllable by adjusting the motive fluid flow provided by an external pump.

Each Tank Jet Mixer is designed to suit the process mixing requirement and single mixers or a number of mixers mounted on an in-tank manifold are available.



Stainless Steel Tank Jet Mixer

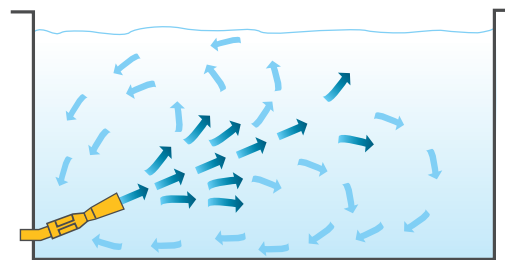
Transvac can offer the basic mixers or a complete system including pipework, pumps and valves. Materials of construction can offered in most materials including ceramics.



Hastelloy Tank Jet Mixer

Advantages of Jet Mixers

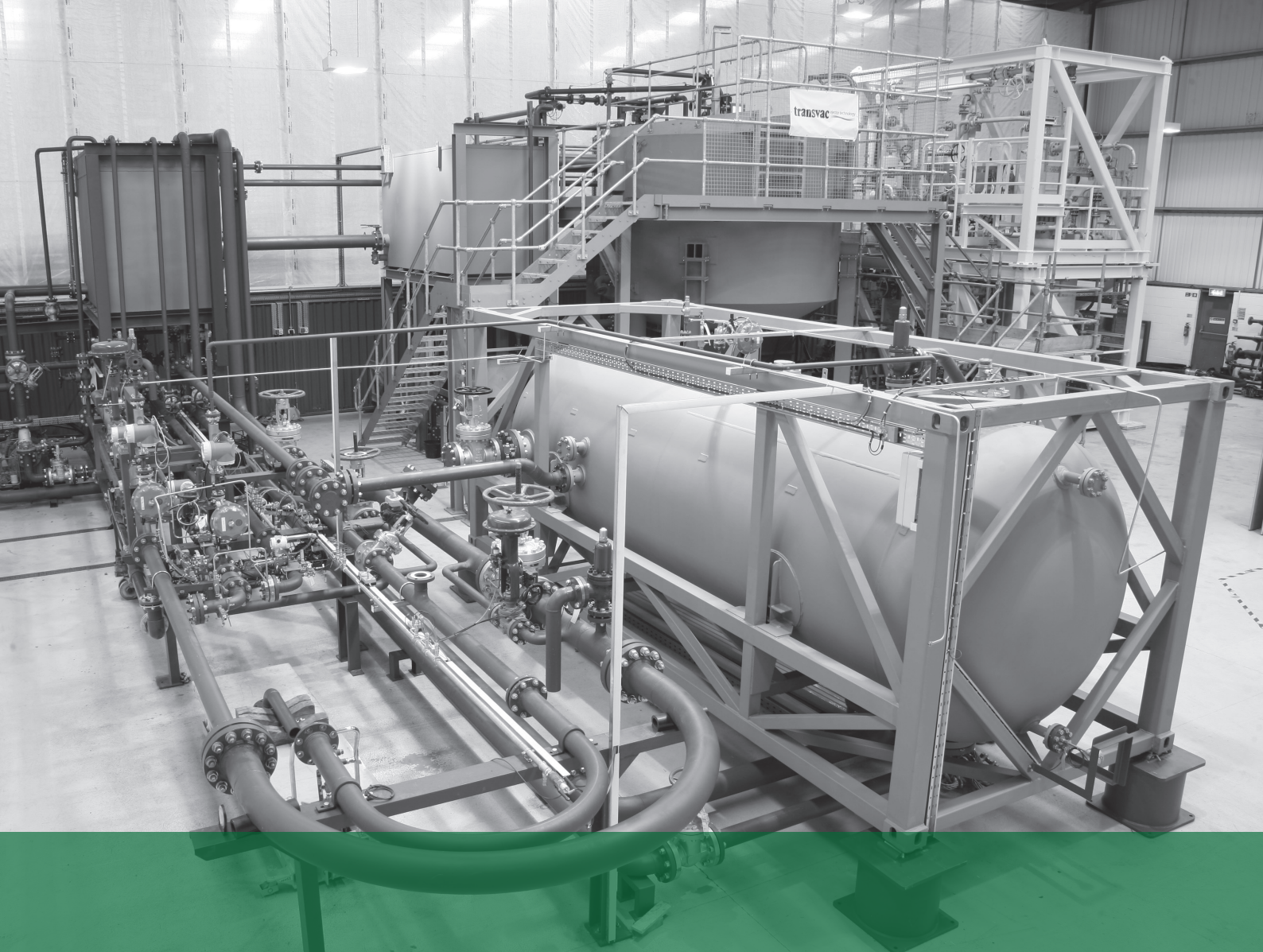
- ▶ No moving parts
- ▶ No splashing or aerosol created
- ▶ Operates at variable depths
- ▶ No bridges or bearings used
- ▶ No in-tank maintenance needed
- ▶ Evenly distributes mixing
- ▶ Controllable mixing
- ▶ Simple, reliable and robust



Transvac Tank Jet Mixer Flow



Size 1 1/4 Tank Jet Mixers for mixing radioactive waste



R&D Test Facility

Transvac's R&D Test facility is the heart of our 'Ejector Centre of Excellence'. The state-of-the-art test facility primarily develops new oil & gas Ejector technology for nuclear, subsea processing, flare gas recovery, sand slurry pumping and enhanced recovery & production solutions.

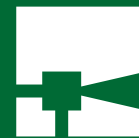
Ejector applications for the bio-fuel, chemical and wastewater industries are also under development.

The R&D test facility includes high and low pressure equipment for handling water, oil, gas, multi-phase and slurry. Test programmes are supported by CFD studies and include fundamental University research.

The Transvac facilities include liquid flow lines for high, medium & low pressure testing (in excess of 350 barg) and solids handling systems.

Various nuclear Ejectors have been thoroughly performance tested at Transvac's R&D facility before being installed on site.





Nuclear Testing

Transvac can fully performance test nuclear Ejectors using water and slurry simulants, including duty and off-design operating points.

Transvac has supplied Sellafield Sites Limited (via Doosan Babcock) a set of Ejectors for pumping radioactive slurry as part of the SPP1 project.

A new sand slurry rig was purpose built to be able to replicate nuclear slurry.

Transvac carried out preliminary trials using sacrificial test units followed by full Ejector performance testing of the finalised designs prior to despatch.

Completed units included special grade ceramic internal parts to resist abrasion during operation. The ceramic internals are also subjected to erosion studies to test suitability for nuclear applications.



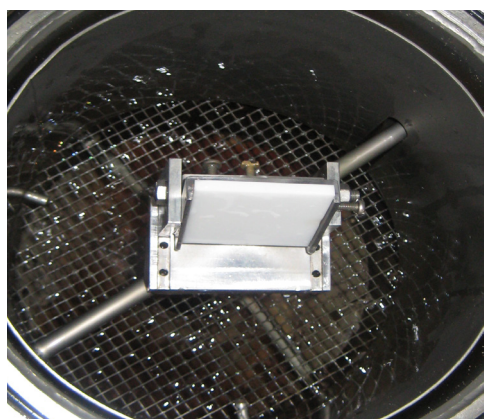
Sellafield sand slurry rig, purpose built for nuclear Ejector testing



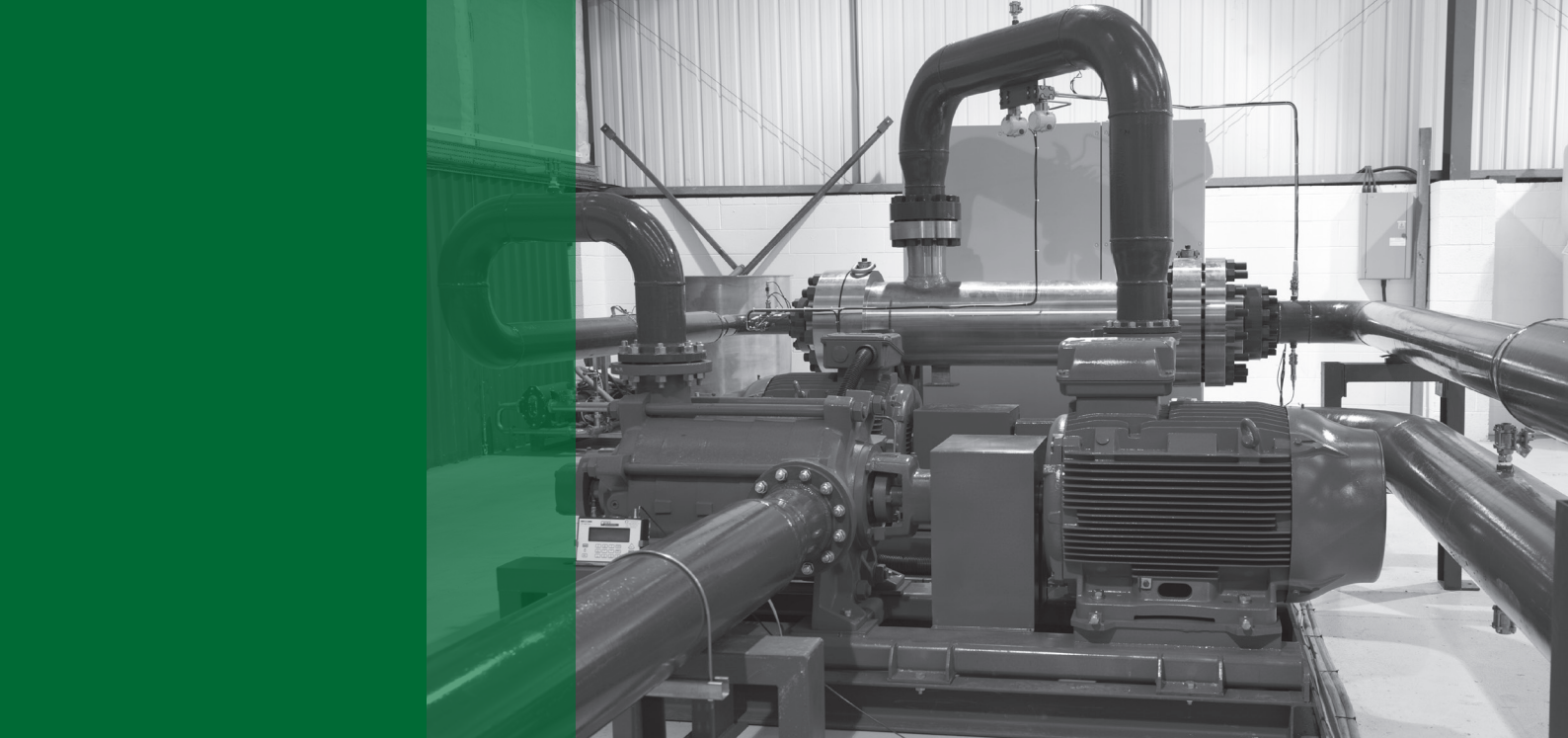
Sand slurry to replicate nuclear slurry



A Nuclear Ejector during testing

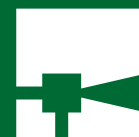


Ceramic internals subjected to thorough testing to prove durability



Test Facilities

- ▶ 9 x flow loops
- ▶ 9 x VSD water pumps
- ▶ Pump pressure up to 300 barg
- ▶ Liquid flows up to 700 m³/h
- ▶ Sand slurry flows up to 60 m³/h [up to 60% SVF]
- ▶ Nitrogen 320 barg @ 200 kg/h
- ▶ Gas (inert) flow > 2000 m³/h
- ▶ 400 KvA stand alone generator
- ▶ Stainless Steel Test Rig - 60 m³/h up to 25 barg motive
- ▶ 2 x 9 m³ clean water tanks
- ▶ 1 x 35 m³ slurry / water tank
- ▶ 1 x 6 m³ calibrated weigh tank
- ▶ 7 x Coriolis meters (liquid / gas) 1/2" to 4", 5 to 150,000 kg/h
- ▶ Gas heater 150°C at 500 kg/hr
- ▶ 17m³ x 27 barg rated separator tank
- ▶ Fully automatic control and data acquisition system using ASi field bus system (LabView)
- ▶ Flow assurance : flow accuracy 0.1 - <1.0 % FS / Pressure Accuracy 0.1% or better
- ▶ 7m² vertical CFU pressure tank
- ▶ High speed video recording 400,000 fps



About Us

Transvac has been providing Ejector solutions since 1973.

As both a designer and a manufacturer of Ejectors, Transvac has full in-house control over process and mechanical design, supply of raw materials, manufacturing, scheduling and testing. With all of our procedures certified to BS EN ISO 9001:2015 the quality of the final product is assured.

Transvac is accredited to Module H of the Pressure Equipment Directive (PED) and our products are CE marked where appropriate.

All products are custom designed to suit the process and mechanical requirements of each application to ensure maximum operating efficiency.

Transvac offers standard and exotic materials of construction including Hastelloy, Duplex, Super Duplex, Titanium, 6MO etc.





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