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Specialist and Custom Designed Pumping Systems for the Recovery of Flammable Hydrocarbons, Corrosive Non-flammables and Caustic

*Operational Guidelines for
Environmental Applications*

Recovery of flammable hydrocarbons, corrosive non-flammables and caustic

The Airwell Group has developed a variety of recovery and remediation pumping solutions to deal with specific types of contaminants. These solutions have been achieved through practical experience in the field on projects carried out on behalf of environmental consultants and/or directly for some of the biggest companies in Australia.

The following information is intended as a guide to the types of recovery systems and methods Airwell has developed and refined over the last 30 years employing its direct air displacement technology in the recovery of the following:

- flammable hydrocarbons;
- corrosive non-flammables; and
- conductive liquid contaminated with caustic (Sodium Hydroxide)

Recovery of Flammable Hydrocarbons

The Airwell system works on the principal of direct air displacement of the liquid contents of a submerged vessel. Unlike a conventional bottom filling "Air-well" pump, these units are top filling for the recovery of floating hydrocarbons. Air pressure is the preferred choice for distributing energy around a flammable liquid hazardous area because of the greatly reduced fire risk and has therefore become the industry standard approach.

It is possible to have the entire hydrocarbon recovery system powered and controlled completely by air pressure. Although available, these air and mechanically controlled systems have no electronic aspect and tend to be very expensive, operationally unreliable, and inefficient and provide little control accuracy or data logging ability. **Therefore Airwell have developed an air powered, intrinsically safe (I/S) electronic controlled pumping system.**

The safety of the system, as far as the electronic control is concerned, comes from the use of **Intrinsic Safety technology**. The intrinsically safe barriers ensure that the level of electrical current leaving a safe area and entering a hazardous area is not great enough to generate an ignition spark. This safety feature ensures that should field signal cables or input/output devices be damaged or cut, there is no risk of an ignition spark.

Generally, manufacturers of similar pumps require a separate controller for each pump, turning the air pressure on when the vessel is full and then releasing the pressure when the vessel is empty. Even more common is they often simply operate on a timed cycle process, regardless of whether the pump is full or empty.

While we do have an intrinsically safe stand-alone controller option for each pump, the Airwell Group prefers to have one controller operating all pumps when multiple pumps are required. On many occasions Airwell have taken the responsibility of integrating all other associated treatment equipment into the one system. The core of the control is the PLC (Programmable Logic Controller).

The flexibility of these units provides several advantages, including:

- accuracy of control provided by electronics,
- the inherent reliability,
- ease of expansion
- capacity to control both simple and complex systems very cost effectively
- ability to log important data, or even allow for the remote monitoring and control of the system over the telephone line provides unlimited options to suit your project and your budget.
- the capacity of the controller is matched to the specific requirements of the project, and all PLCs are from the Allen-Bradley Micrologix or SLC500 ranges.

The PLC is generally situated in an area, which is zoned safe and housed in a "Rittal" AE style electrical enclosure, usually within a site office. The enclosure also contains other support equipment in the way of power supplies, terminal strips and optional telemetry modem.

The system involves the use of an Airwell total fluids pump, typically 3.5" OD and 2m long Top Filling (TF3520), giving a cycle capacity of 10 litres. These pumps suit most common bore sizes, however there is a smaller version at 1 3/4" OD available for the smaller 2" bore casing. Each total fluids pump has a level detection Reed Switch inside the top end of the pump, and is wired to the PLC via a length of screened (Two Pair) signal cable.

As the level of the fluid rises in the pump, a stainless steel float, which encloses a magnet, moves over the reed switch, and by the proximity of the magnet to the reed contacts, a circuit is made. The closure of this circuit is detected by an Intrinsically Safe input barrier back at the control location, which in turn provides the PLC with a contact closure to register that the pump is full and is ready to be pressurised.

The continuous monitoring of the PLC will instantly register this full signal, and will pressurise (empty) the pump in accordance with the PLC program. It is not always desirable to cycle the pump as fast as possible, particularly with product recovery. If the system pumps too quickly then there is a risk of pumping predominantly water, thus reducing the efficiency of the system.

The PLC program contains the ability to Hold Off that 'empty' cycle, reducing the drawdown effect, and maximizing product recovery. With the knowledge of quantity pumped per cycle, and the capacity to accurately vary the cycle times (and hence the number of cycles per day), the Airwell system can both monitor and control the amount of fluid recovered with a great degree of accuracy.

It is only when the PLC provides an output voltage to an Intrinsically Safe (I/S) output barrier (modifying the signal to ensure a spark free operation) that the signal to empty travels down the second pair of the screened cable to the bore site. It is important to note that all pump cycle times are programmed independently of each other, allowing greater control of the rate of recovery, matching the potential yield of each well.

At the bore site the safe electrical signal is used to power an intrinsically safe air pilot solenoid valve that are designed to operate on an extremely low level of electrical power. The I/S solenoid valves are very small, so it is necessary to use these I/S valves as pilots to a larger air valve in order to attain maximum efficiency of the pump. For protection from both the elements and possible chemical contamination, the valves are housed in a sealed stainless steel box. Even if the solenoid valve unit (SVU) is installed in an underground vault and this vault becomes full of water in a rainstorm no damage to the SVU will result.

The PLC is programmed to pressurise the pump for a pre-determined period. The pressure time is set slightly longer than the maximum time required to expel the contents of the vessel, but no air will follow the water / hydrocarbon up the riser pipe when the pump is empty due to a floating polyurethane or nitrile ball check. This ball closes the pump discharge outlet at the bottom of the pump when the pump vessel is empty. On completion of the pressure cycle, the solenoid is de-energized, allowing the pump to exhaust the air, and refill with product, starting the cycle all over again.

If vapour extraction of a total fluids bore is required, it will be necessary to connect the exhaust of the air piloted valves into the vapour extraction line. This is to compensate for the effect of the negative pressure preventing the pump vessels from filling.

Apart from the bottom ball check valve, the only other moving parts in the pump are two other solid (non-floating) polyurethane or nitrile balls, used as inlet and outlet check valves for the pump. These simple but effective valves are the key to trouble free, maintenance free operation, and keep the pump down the well, where it's supposed to be.

The contents of these total fluids pumps is usually carried by suitable pipes to elevated Oil / Water separators adjacent to the various storage and treatment / disposal tanks. From these raised positions the outflows from these Oil / Water separators can flow by gravity to their various tanks without the need of any extra pumps.

Any skimmer pumps required can be operated in two different ways. The first is to plumb each of these skimmers to a total fluids pump that is in close proximity to it. In this way, whenever that total fluids pump cycles it will cycle the adjoining skimmer pumps.

Alternately, groups of approximately six skimmers can be driven off one I/S solenoid valve unit, powered via an I/S output barrier from the PLC. The PLC only requires outputs for the skimmers, as they would have a timed fill and discharge cycle.

At the bore head, a specially designed "Well Head Attachment" seals the bore and provides support for the piping to the pump. This attachment allows the gases in the bore to be contained and, if required, connected to a vacuum extraction system.

Apart from operating the Airwell pumps, the PLC is often employed to monitor and control many other functions of the pumping and treatment system, and Airwell have developed the in-house expertise to assist our clients getting the most from their investment. All product and treated water tanks can easily be fitted with level switches, all valves can be fitted with direction indicators, and any pressures or temperatures can be monitored using 4-20mA transducers. Pulses can be monitored from flow meters (such as Mag-Flow meters) to determine flow rates and totals. Motor run status is also often required. With all these inputs the entire pumping and treatment system can be controlled and recorded. In short, once the system has a PLC as part of its operation there is an almost limitless choice of control and monitoring options available.

If a modem is then connected to the PLC, a pumping and treatment system as described above can be operated and monitored on a standard computer from the other side of the country as effectively as it can from a PC on the site. Security monitoring companies can be used. By linking outputs from the PLC to a monitored burglar alarm, you can be alerted to any failure or specified alarms in the system twenty-four hours a day, reducing the need for onsite monitoring and unnecessary, costly site visits.

Advantages of the Airwell system for the recovery of flammable hydrocarbons are:

- Greatly increased management control of the recovery process by being able to monitor and data log the flow rates of all bores individually
- Set maximum flow limits on each individual bore to prevent over pumping
- Maximize the recovery from each bore by the fact that the system adjusts itself to the production of each individual bore
- Product spill avoidance detecting monitors can be linked into the PLC to allow off site monitoring of tank capacity and provide plant shut down in the event of tank full indication
- Reduce the down time on any single bore due to the monitoring capabilities of the PLC. The control processor, by keeping a running flow rate record for each individual bore, can indicate which pump has failed or slowed. Then with a routine scan of the pump field via modem from the comfort of the office, a maintenance plan can be implemented immediately
- Greatly increased reliability and accuracy over pneumatic and mechanically operated systems due to electronic control and minimal moving parts.
- The ability to add or change almost any aspect of the control and data logging settings for all pumps. This can be done from a safe area on site or via a modem connection using the standard windows based program.
- Australian designed, manufactured and supported

Recovery of Corrosive Non-Flammables

The Airwell system works on the principal of direct air displacement of the liquid contents of a submerged vessel. For the recovery of highly corrosive and non-flammable liquids, either in suspension or "Free-Phase" and classified as "sinkers", the Air Well bottom filling pump has a unique advantage over rival pumping systems.

Airwell pumps are manufactured from stainless steel with corrosive resistant minor components. These pumps are capable of withstanding the harsh chemicals heavier than water, generally lying on the bedrock. The Air displacement pump can operate at controlled rates to maximise the product to water ratio thereby avoiding costly processing expenses where product recovery is slow.

Although commonly available, purely pneumatic and mechanically controlled systems tend to be very expensive, operationally unreliable, and inefficient and provide little control accuracy or data logging ability. The Airwell Group has developed an air powered, anti-corrosive, electronically controlled pumping system that provides all of these features not available in other systems.

Generally, manufacturers of similar pumps require a dedicated controller for each pump, turning the air pressure on when the vessel is full and then releasing the pressure when the vessel is empty. Even more common is simply operating on a timed cycle process, regardless of whether the pump is full or empty. This adds extra upfront expense and ongoing maintenance costs on more equipment than should be necessary.

While we do have an intrinsically safe stand-alone controller option for each pump, the Airwell Group prefers to have one controller operating all pumps when multiple pumps are required. On many occasions Airwell have taken the responsibility of integrating all other associated treatment equipment into the one system. The core of the control is the PLC (Programmable Logic Controller).

The flexibility of these units provides several advantages such as:

- Apart from the accuracy of control provided by electronics, the inherent reliability, ease of expansion and the capacity to control both simple and complex systems very cost effectively helps make them the ideal solution
- Couple this with the ability to log important data, or even allow for the remote monitoring and control of the system over a telephone line provides unlimited options to suit your project and your budget, and
- The capacity of the controller is matched to the specific requirements of the project, and all PLCs are from the Allen-Bradley Micrologix or SLC500 ranges.

The PLC is generally situated in an area, which is zoned safe and housed in a "Rittal" AE style electrical enclosure, usually within a site office. The enclosure also contains other support equipment in the way of power supplies, terminal strips and optional telemetry modem.

There is a variety of bottom filling pumps available to suit most standard casing sizes. The size of the pump, and hence the flow rate will be matched to suit the clients particular application. Although available 'off the shelf' to suit the more commonly recovered chemicals, we also have the flexibility to investigate and manufacture pumps to recover contaminants that are more exotic. We then provide dedicated hardware to suit the application, rather than the often-replaced standard pump.

Each total fluids pump has a level detection Reed Switch inside the top end of the pump, and is wired to the PLC via a length of screened (Two Pair) signal cable. As the level of the fluid rises in the pump, a stainless steel float, which encloses a magnet, moves over the reed switch, and by the proximity of the magnet to the reed contacts, a circuit is made. The closure of this circuit is detected by the PLC, registering that the pump is full and is ready to be pressurised.

The PLC provides an output signal (in accordance with the programming of the PLC) via pair two of the screened cable. This signal operates the Solenoid Valve Unit (SVU) at the bore. The SVU is mounted in small stainless steel sealed box either on a specially designed Well Head Attachment or on the wall of an underground vault if provided.

The Solenoid Valve Unit is used to direct compressed air to the pump to expel the contents via the delivery pipe to the surface and away. As well as providing compressed air to the pump, the SVU also exhausts the air in the pump thereby allowing the pump to refill with liquid.

The PLC is programmed to pressurise the pump vessel for a pre-determined period. The pressure time is set during commissioning. After the pressure time has elapsed, the PLC de-energizes the solenoid, allowing the pump to exhaust the air, allowing fluids to re-enter the pump, starting the cycle all over again.

The achievable flow rate is often many times more than that required, and in most situations, the pumps are programmed to provide a flow rate to suit the project. This is achieved by the PLC controlling the pump cycle rate, allowing only a set number of cycles in a given time period. The fact that the quantity of fluid moved per cycle, we can thereby control the amount of product captured.

In the case of the aquifer level in any bore dropping below the pump full level, the pump will not destroy itself but will wait in a 'sleep' mode for the level to rise again. This feature is used to great effect in the mining and agricultural industries. Again the PLC is monitoring and controlling each pump. This is also a benefit available to Technicians, who can monitor the state of the field via an optional modem connection, reducing the need for so many expensive site visits.

Suitable delivery pipes carry the recovered contents of these total fluids pumps to a holding tank. The level of recovered product and water can be monitored by the PLC by the provision of various level detectors. By monitoring these detectors, the PLC will shut down the pump field thereby avoiding a serious chemical spill. Individual pump product valves are provided to allow samples to be collected from each bore, allowing for exact monitoring of the recovery process.

At the bore head, a specially designed "Well Head Attachment" seals the bore and provides support for the piping to the pump. This attachment allows the gases in the bore to be contained, and if required, to be sucked away for treatment.

Advantages of the Airwell system for the recovery of corrosive non-flammables are:

- Greatly increased management control of the recovery process by being able to monitor and data log the flow rates of all bores individually
- Set maximum flow limits on each individual bore to prevent over pumping.
- Maximize the recovery from each bore by the fact that the system is self-adjusting to the production of each individual bore.
- Chemical spill avoidance detecting monitors can be linked into the PLC to allow off site monitoring of tank capacity and provide plant shut down in the event of tank full indication.
- Reduce the down time on any single bore due to the monitoring capabilities of the PLC. The control processor, by keeping a running flow rate record for each individual bore, can indicate which pump has failed or slowed. Then with a routine scan of the pump field via modem from the comfort of the office, a maintenance plan can be implemented immediately
- Greatly increased reliability of the system over fully pneumatic and mechanical operated systems due to electronic control and minimal moving parts.
- The ability to add or change almost any aspect of the control and data logging settings for all pumps. This can be done from a safe area on site or via a modem connection using the standard windows based program.

Recovery of Conductive Liquid Contaminated with Caustic (Sodium Hydroxide)

Airwell pumps have been used successfully to recover caustic from ground water in a number of scenarios but generally from under or near alumina refining plants and often along beachfronts adjacent to such plants.

The Airwell system lends itself to this application for a number of reasons including:

- its high tolerance to the caustic environment, achieved through using appropriate materials
- its ability to operate at low flow rates without the possibility of damage to the pump
- its ability to achieve any low flow rate with a high degree of accuracy, making it ideal for maximising product recovery; and
- its ability to handle grit that intrudes into the bore.

The Air-Well system works on the principal of direct air displacement of the liquid contents of a submerged vessel. For this application, we use conventional bottom filling pumps. These units are bottom filling to recover contaminants in suspension or heavier than, and lying beneath, the water.

The control system detects both when the submerged pump vessel is full and when it is empty by a pair of conductivity probes housed within the pump unit. The controller will not cycle the pump until it detects a full signal, at which it will allow air pressure to enter the pump, displacing the liquid contents of the pump up the delivery pipe. Pressurization of the pump continues until it detects that the pump has become empty, at which the controller will vent the air pressure from within the pump allowing the pump to refill.

A unique feature of the Airwell system is its ability to regulate or control the pump rate to suit the desired flow rate. The controller has an adjustable electronic timer, which accurately slows the cycle rate by providing a pause time between the start of each cycle so that even though the pump may have refilled, it will not allow the cycle to commence until the timer circuit permits.

Likewise, if the aquifer level drops in the field and the refill rate slows to a stop, the pumps will slow to a stop accordingly. Normally this would be fatal for most conventional pumps, however the Airwell pump will continue to operate without any damage to the pump or control equipment with no flow at all. Should fluid levels again flow to the bore, the Airwell system will automatically restart pumping.

Another unique feature of the Air Well pump is that it is able to operate in bores that contain high levels of silt and grit. The specially designed check valve configuration allows the silt to enter the pump and then be pumped away without damage or affecting the performance of the pump.

The Airwell pump consists of three basic components. The primary component is of course the submersible pump unit, which is connected to the surface by a delivery pipe, an airline and control cable. Then at the surface alongside each bore, there is a solenoid valve unit (SVU) and an electronic circuit to monitor the probes, mounted in a suitable enclosure attached to a post.

The SVU is there specifically to switch air pressure to the pump to displace the pump contents to the surface and exhaust used air from the pump vessel to allow re-filling with water. Connected to the SVU and the pump is the pump controller which monitors the probes and controls cycling of the SVU. Power is provided to the controller via a small solar panel and storage battery.

Where there are several pumps operating together in one location, the common equipment required to operate all pumps such as power transformers and airline manifolds are conveniently located in a control room for ease of maintenance and service. In this instance it is often beneficial to run all pumps from one central PLC controller which can be programmed for many sophisticated functions, and can easily be monitored remotely by means of a land line modem and PC.

Advantages of the Airwell system for the recovery of conductive liquid contaminated with caustic (Sodium Hydroxide) are:

- Greatly increased management control of the caustic solution recovery process by being able to monitor and data log the flow rates of all bores individually
- Set maximum flow limits on each individual bore to prevent over pumping
- Maximize the recovery from each bore by the fact that the system adjusts itself to the production of each individual bore
- Greatly increased reliability of the system over fully pneumatic and mechanically operated systems
- The ability of the pump to operate in reduced aquifer levels without damage; and
- Local manufacture and support enables the pump and associated product lines to be matched to suit the specific operating environment.

Other services provided by Airwell Group



Mobile sampling



Flow testing



Leachate recovery



Potable/process water

Airwell group also provides systems for and services including:

- Groundwater sampling and monitoring
- Bore flow testing
- Leachate recovery at tailings dams and landfill sites
- Potable and process water supply
- Salinity management
- Coal bed methane deliquification
- Supply and installation of all pump types

More information

To find out more about our services and products and to request a copy of our remediation and recovery technical data sheet please contact the Airwell Group Head Office

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