# AIRWELL OIL & GAS Pty Ltd

ABN 61 132 153 505

# Case Study

## Introduction to the Airwell “Positive Direct Gas Displacement” pumps

**Pic 1. Airwell Pump Solar Powered Control and SCADA System**

# Project

## De-liquefaction of vertical shallow gas wells in Saskatchewan, Canada
## Depth 400 metres

**Introduction**

The Airwell “Positive Gas Displacement” pumping method has been trialled and tested in a wide variety of stripper oil well and shallow gas well applications.

The oil & gas pumps work on fundamentally the same operating principal as the standard Airwell pumps that The Airwell Group Pty Ltd has been manufacturing in Australia for over 28 years. The new Airwell Oil & Gas pumps are designed to operate at significantly higher pressures to achieve much deeper operating depths.

The “Positive Displacement Pumps” have the ability to fully adjust themselves from no flow up to their maximum flow rate ability which is typically around 90 barrels (14.3 kiloliters) per day. The amount of energy consumed is proportional to the amount of pumping done, in very low flow pumping situations, the energy consumption is minimal. One of the unique features of the Airwell Oil & Gas pump is that it will not commence a cycle until the pump chamber is full, only then will the pump commence a cycle. Fill rates will vary over time with the Airwell oil & gas pump self modulating to the amount of liquid available at any given period.

## Case Study - Saskatchewan, Canada.

## Project:

**De-liquefaction of vertical shallow gas wells in at a depth of 400 metres for a major Canadian Gas production company.**

## Background:

De-liquefaction of gas wells in Canada has been a major issue for gas companies over many years with no real means of economically removing liquids from gas wells at this time.

Numerous Canadian Operators, who have had the opportunity to witness the Airwell system in action, believe the Airwell pumping methodology offers the only real solution to this very critical liquid loading problem. There are currently thousands of gas wells experiencing liquid loading problems that threaten their very viability and many more wells will experience this same serious problem in the very near future.

Not only has the Airwell system overcome the known problems with pumping under these conditions but through the many trials and clever innovation and design modifications Airwell now offers the gas operators not only a pumping solution but some real cost saving initiatives through the use of the Airwell Oil & Gas technology.

**Pic 2. Coiled Tubing Well Head**

## The Issues:

- **The Harsh Canadian Environment**
- **High Volume of Extremely Abrasive Sediment**
- **Silt build-up under the pump intake**

**The Harsh Canadian Environment**

In Canada, the big enemy is the freezing temperatures during winter. A major expense for the Canadian operators is Methanol which is used to stop the well head equipment from freezing. You will notice in the photo on the front page, that each well in Canada typically has a Methanol tank.

Airwell believes that it will be able to eliminate this major expense all together. By producing gas from the casing itself rather than a velocity string, the gas is therefore as dry as it can be coming from the well. We are then re-distributing dry gas (- 35 degrees due point at 1,000 psi) back to all well sites from the gas lease compressor stations, this gas cannot freeze. Apart from operating our pumps this gas is used for all gas instrumentation requirements at these wells.

It is our expectation that we could also eliminate the necessity of having an insulated and heated hut located at each well site to house the instrumentation components. Heating and other associated expenses would also be eliminated.

Both of these theory's will be put to the test during the fast approaching Canadian winter.

**High Volume Extremely Abrasive Sediment**

It should be noted that the gas well featured in our photos actually produces a slurry of mud not water (see photo below). When given a few days to settle out, the mud (98% fine silica) will settle out to approximately 20% to 30% solids. These solids are very abrasive and therefore have proven impossible to pump with conventional pumping methods.

**Pic 3. Six daily samples** (right to left) **in various stages of 'Settling Out'**

There are approximately 210,000 shallow gas wells in Western Canada with approximately 80,000 of them producing a similar percentage of solids as this well and will do so for the entire life of the well. This mud is produced in volumes of 5 to 30 barrels (0.8 to 4.7 kiloliters) of fluid per day per well.

Airwell's unique approach to pump design to abate the silt abrasion issue included the use of tungsten balls on a tungsten seat but resulted in excessive wear to the top and bottom ball & seats. The second trial pump was equipped and installed using existing Airwell technology to produce its own unique combination of balls and seats. After the same testing duration and conditions, the second pump was pulled from the well for evaluation and showed no visible wear to the new ball & seat combination.

For the success of trial it was imperative to resolve this abrasion issue. The implementation of Airwell manufactured balls and seats have comprehensively addressed this critical issue. No other pumping method has been able to demonstrate its ability to handle pumping in this abrasive silt environment.

**Silt build-up under the pump intake:**

Early trials in the Milk River/Medicine Hat formation indicated that over time silt would build up under the pump and ultimately prevent the liquid from being able to enter the pump (plugging the pump intake).

The solution to this issue was to redesign the pump to allow an additional tube to run through the middle of the pump unit and out the bottom of the pump. Periodically, short blasts of high pressure gas are injected down this tube to agitate the silt beneath the pump intake.

The added agitation has not only overcome the plugging problem but has also provided a very useful side benefit. An additional small “bubble” of gas is continuously injected down the agitation tube which enables us to determine and monitor true bottom hole pressure on a continuous basis.

Being able to accurately monitor the bubble gas pressure at the surface in real time allows the Airwell system to calculate true bottom hole pressure at all times. Knowing the true bottom hole pressure assists greatly in reservoir analysis calculations.

## The Product and Components

### Pumps

Our uniquely designed and patented Airwell Oil & Gas pump is manufactured in either Australia or its factory in Texas. The pumps are manufactured from 316 stainless steel and tested for quality assurance. Over the three years of field testing the pump has been modified and retested on a number of occasions to ensure the final version provides long lasting and reliable results.

**Pic 4. An Airwell Pump with Umbilical Coiled Tubing attached**

### Airwell Consolidated Valve Box - Recent Improvements

The first installations of Airwell positive displacement pumping systems had all the equipment gas flow meters individually mounted on the well head itself. This was a time consuming task conducted in the field and did not allow for pre-installation testing of all instrumentation. These components are now pre mounted into an insulated enclosure (see picture below) and can be tested prior to installation in the field. The insulated enclosure is connected to the SCADA box by a 16 core cable with sealed stainless steel plug ends.

These changes have greatly improved the time required for onsite installation process.

All equipment in this enclosure is rated Class 1 Division 1.

**Pic 5. Quick install consolidated valve box 24 x 24 x 12 inches**

**The SCADA Device**

Each Airwell system comes complete with SCADA centralized monitoring and control. Each pump can be controlled remotely and has the capability to record real time gas production, casing & line pressure, actual bottom hole pressure, liquid level in well and the amount of produced liquid.

**The SCADA of an Airwell system provides the operator with remote monitoring of the following conditions.**

1. Total volume of fluid pumped
2. Casing line pressure
3. Pressure and temperature corrected gas flow rate and production
4. True bottom hole pressure
5. Liquid level in well
6. Solar battery voltage
7. SCADA enclosure temperature
8. Alarm conditions

As the Airwell pump operates a 'cycle' at a time and these cycles are always the same fluid volume, it is simply a matter of counting the number of 'cycles completed' to get an accurate measurement of total liquid pumped. The ability of the system to give accurate real time bottom hole pressure is uniquely useful in reservoir 'reserve analysis' calculations.

**The Energy Source for Pumping**

The energy used to operate the pumps in this gas lease application comes from the existing gas compressors on the lease. In this area, large high pressure compressors are required to compress the gas to the required pressure to pump into the sales line pipes, pressures in this line could be as much 1,200 psi. The pressurised gas from these compressors is sufficient to operate the Airwell pumps at these depths.

Essentially Airwell takes a small percentage of the compressed gas before passing through the gas sales meters. This gas is re-distributed back to all well sites on the lease to operate the Airwell pump. Once we have used this high pressure gas to operate our pump, we vent the 'used' gas back into the existing gas gathering lines. No gas is lost or consumed during this pumping process, only the energy to compress it.

In Pic 2. above you can see that the gas compressors are very close to the newly engineered well head. Often these compressors will be many several kilometres away from the wells which does not create a problem for Airwell as we have redistributed gas as far as 10 kilometres away previously. The above gas lease has 800 gas wells with 7 compressors at 4 compressor sites.

**Gas Lines**

Airwell Oil & Gas has engineered and developed an economical small diameter high pressure gas re-distribution line to connect remote wells to centralized gas compressors. The Parflex division of Parker Hannifin USA have been contracted to produce this high pressure line. The first production run of the gas line has been successfully run and is currently being tested to confirm compliance with all relevant CSA standards for gas distribution (composite gas lines). Gas re-distribution line lengths of 10 Kilometers are expected to be quite common.


**Pic 6. High Pressure 1/2" ID _ 1" OD Redistribution Line with Airwell fitting** (un-crimped)

The high pressure gas line is constructed with Polyethylene PE4710 (ISO PE 100) core tube, Polyester braided reinforcement and Polyethylene PE4710 (ISO PE 100) outer protective jacket. This hose was designed with a generous wall thickness to provide for a very robust pipe construction so it can be easily and safely direct buried using industry standard pipe laying ploughs.

This high pressure gas line has a minimum burst pressure in excess of 8,000 psi (550 bar) and a maximum safe working pressure of 1,450 psi (100 bar). Maximum continuous lengths available are 2,500 feet (762m) long.

This gas line has been designed to fully conform to the requirements of CSA standards Z662-07 (Oil and Gas Pipeline Systems) and specifically sub section 13.1 (Reinforced Composite Pipelines). Initial burst tests using Airwell's 1/2" fittings have been completed and the results have yielded hose rupture results of 10,000 psi to 10,500 psi with no ruptures occurring at the fittings (see photo). Another independent testing company is also in the process of completing similar independent tests.


**Pic. 7 Photo of initial "Burst Test"**

The Airwell Positive Displacement pumping system requires at least 10 kpa to raise SG1 water to a height of 1m (44 psi per 100 feet). This pressure will overcome the static weight with an additional allowance of 10% to overcome any friction. For example if a gas well is 400m (1,312 feet) deep it will require approximately 4,400 kpa (640 psi) at the well head for the pump to function correctly.

Though the required pressure is quite high, the volume of gas required is very low. Therefore a gas line as small as ½" ID will service a number of wells dependant on the well depth and the amount of fluid required to be pumped out of each well.


**Pic. 8 Reels of High Pressure 1/2" Redistribution Line** (approximately 11,500 feet)

**Multi Line Umbilical**

Airwell Oil & Gas has engineered and developed a Multi Line Umbilical. The Parflex division of Parker Hannifin USA have also been contracted to produce this multi line umbilical.

The gas well pictured below has an Airwell pump suspended from a multi line umbilical. This allows all the system down-hole components to be installed by a coiled tubing unit into a live well environment.

**Other Riser Options**

Airwell pumps can be run in on Airwell ¾" API production pipe, coiled tubing or on an umbilical.
All of these options provide speed and convenience of installation with the umbilical option allowing the pumping unit to be installed and retrieved on a live well.

**Executive Summary**

After 5 years of development and 1 year of full trials, Airwell Oil & Gas is pleased to announce that they are now in a position to offer all clients a full range of equipment required to install and operate an Airwell "Positive Gas Displacement" pumping system. We are now actively seeking new clients, both international and local to undertake their own commercial trials of the Oil & Gas technology.

- All down-hole stainless steel pump components are welded and assembled either in our Australian or Texas manufacturing facilities.
- All SCADA control enclosures and valve enclosures are assembled in our Texas facility.
- Airwell now has production contracts with several leading manufactures in America for the production of our gas distribution lines, umbilical and other associated products.

"From thirty years of pump development and manufacturing experience & five years of specific product development for applications in the Oil & Gas Industry, have culminated in a comprehensive alternative solution to the enormous liquid loading problems affecting both shallow and deep gas wells worldwide".

**Alan K. Brown**
Managing Director
Airwell Oil & Gas Pty Ltd