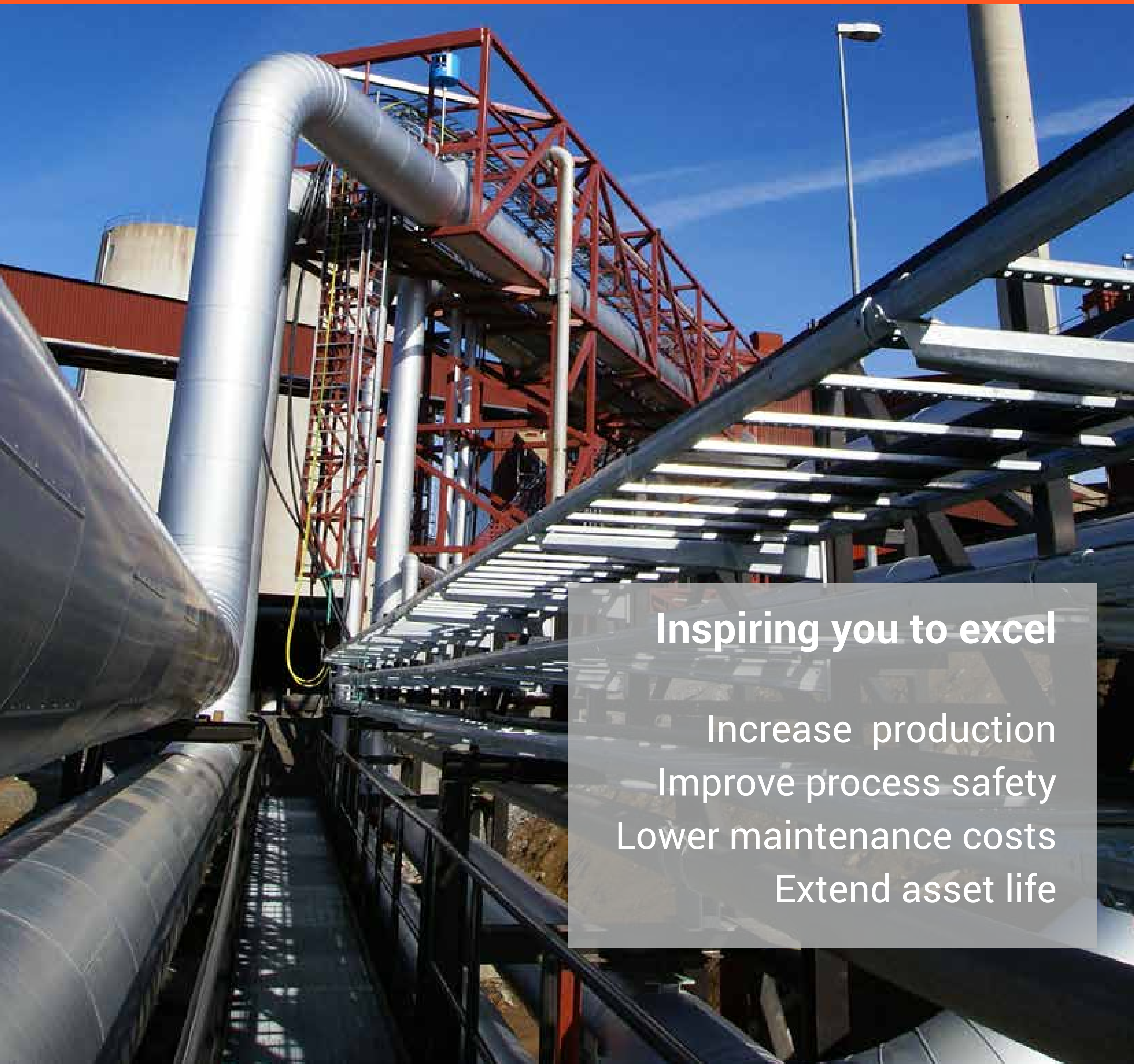
LineVu Data Sheet

Process Vision

Innovation in pipeline monitoring

DETECT LIQUIDS | DETECT HYDRATES | DETECT FOAM



Inspiring you to excel

Increase production
Improve process safety
Lower maintenance costs
Extend asset life

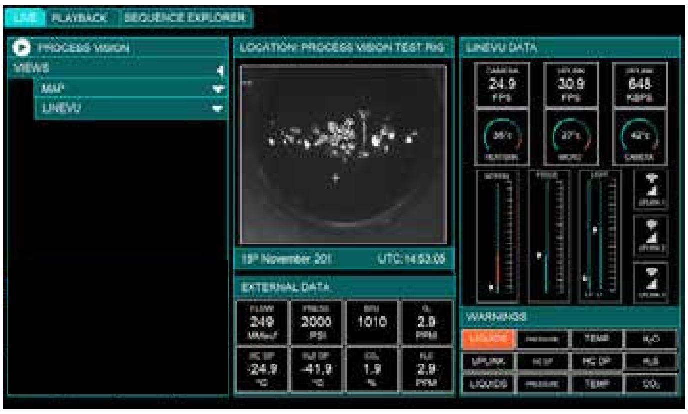
LineVu | The Concept

INSPIRING CONFIDENCE | IMPROVING PROCESS SAFETY

LineVu is a video-based system designed to detect contamination in high pressure gas systems, enable alarm notifications and allow access to live video to both office-based and field-based engineers.

By providing better data on which to base operational decisions regarding process safety and efficiency, the system improves accountability of gas suppliers to gas network systems and can boost production in gas treatment plants. With live data, immediate action can be taken to prevent or minimise further contamination entering a gas network system, and recorded data can be used as evidence to recover pigging and clean-up costs from suppliers who breach supply agreements.

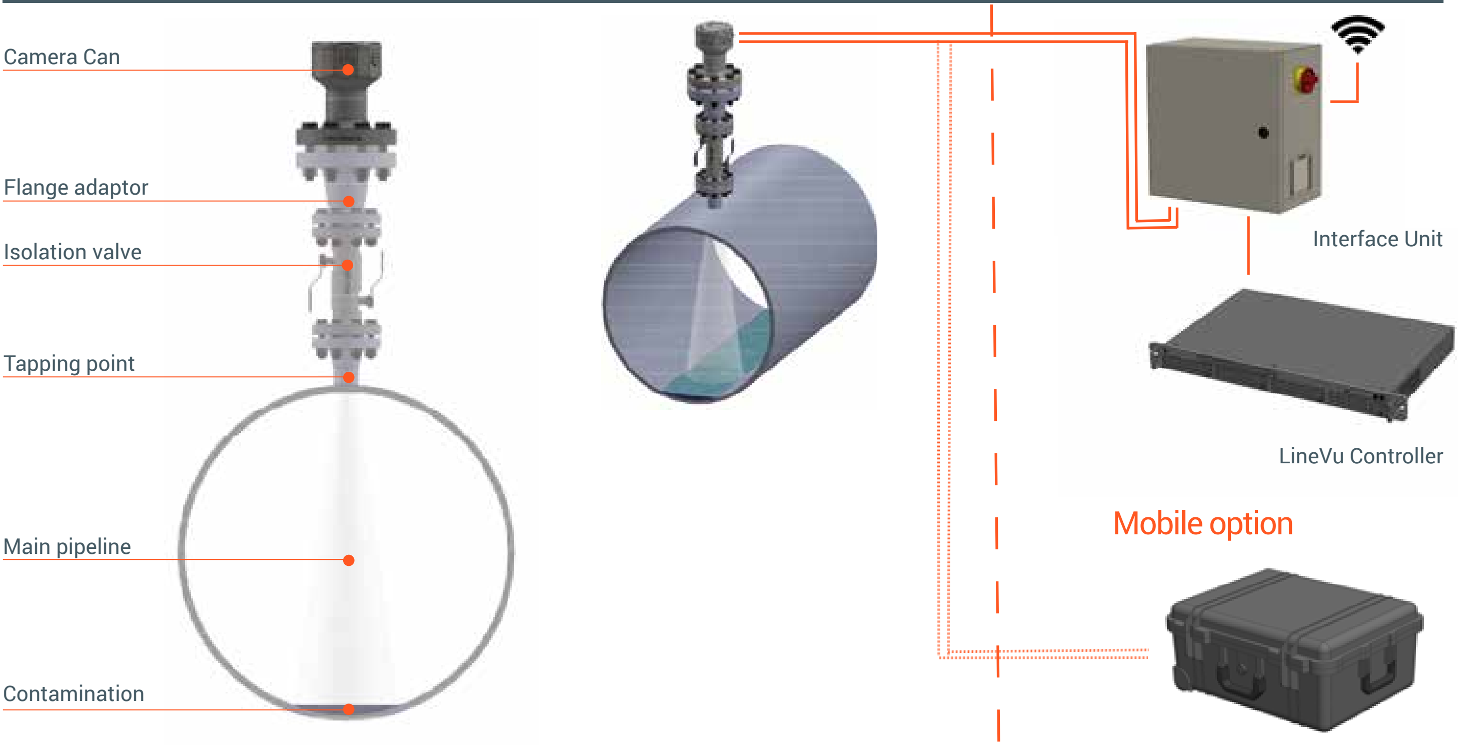
Everyone wants to get the most from the assets they have, but being able to see what is happening in a high pressure gas treatment plant or gas pipeline has not been possible until now. Liquid carry-over, foam or even hydrate formation are common problems that need attention as soon as they occur. Unexpected liquids appearing in gas systems are the cause of large-scale loss and process failures, and can have an impact on asset integrity.



LineVu is a high precision camera system which can be used to determine the real flow limits of a gas/liquid separator system to support and improve flow modelling of "as built" processing plants.

Permanent installation allows process failure events to be detected early, and prevent loss and damage of assets such as compressors or absorber beds, and foam control becomes easier to manage.

Hazardous Area | ATEX Zone 1 | Class 1 Div 1 — Safe Area



Process Vision

Design Technology

FLEXIBILITY | MULTIPLE APPLICATIONS

The information that LineVu delivers allows engineers throughout the gas and refining industry to make informed decisions. The confidence it brings allows engineers to find the real limits of gas/liquid separators, increasing production while remaining within safe operating limits.

Safety is our paramount consideration. A patented secondary containment system ensures no loss of containment, even under fault conditions. Design standards for the sapphire windows and secondary containment system use safety factors higher than industry standards. All ports are within the main process connection.

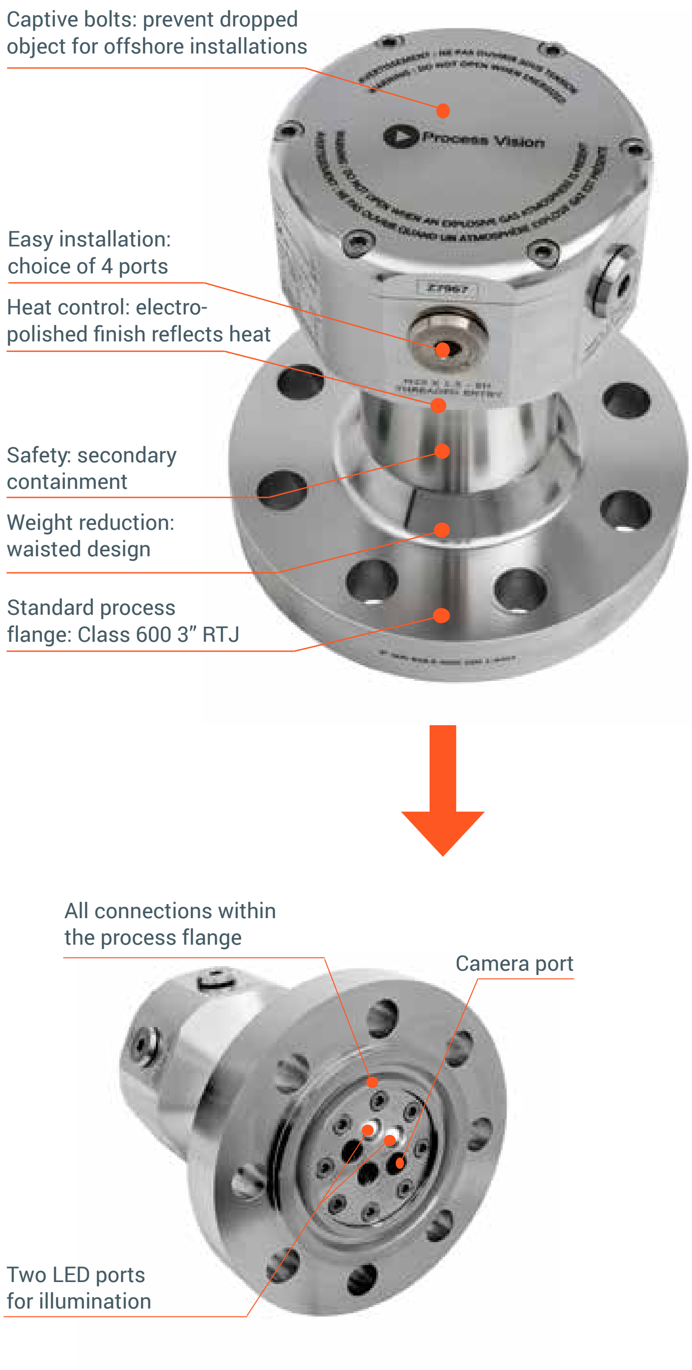
Connection to the safe area of the control room and beyond can be made via Ethernet.

ROBUST | HEAT MANAGEMENT

Experience counts: our dedicated team ensures that LineVu's robust design is suitable for installation on gas networks. A certified flameproof enclosure forms part of the Camera Can, mounted on top of the pipeline or pressurised system. Each LineVu system undergoes multiple pressure tests. A class 600 flange allows the standard system a maximum pressure rating of 1,500 psi (103.4 Bar). Alternative specification flanges, including higher pressure options, are available if required.

Built-in redundancy ensures long term unattended use. Heat management of the illumination system provides sufficient temperature elevation to avoid condensation on the optics, even when process conditions are saturated with respect to water vapour or hydrocarbons.

Installing the LineVu system behind an isolation valve means that it is set back from the contaminated flow, keeping the optics free from contamination.



> **"Safety is our paramount consideration."**

Integrated Situation Awareness

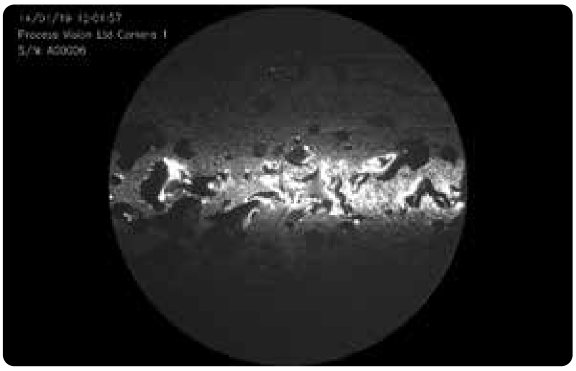
SUPREME SITUATIONAL AWARENESS

LineVu uses video management software designed to detect objectionable material in gas pipelines, and is designed to be scalable from a single operator/single camera system to global operators with multiple cameras at multiple sites. It employs end-to-end encryption for protection of video security, and boosts the overall performance of gas processing or pipeline network systems, enabling better communication and management of contamination incidents.

In addition to central management of all servers, Camera Cans and users in a multi-site set-up, where necessary, LineVu includes an integrated video wall for operators demanding dynamic situational awareness of any event.

Mission-critical installations require continued access to live and uninterrupted video recordings. Running on the industry's best performing recording engine with 24/7 operation requirements.

- High performance recording server
- High redundancy recording servers
- Unlimited number of cameras



CONNECTIVITY

With an unlimited number of cameras supported, users and sites have a centralized interface. The system management interface is optimised for different roles and levels of administrative users.

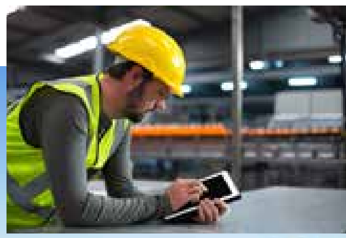
Interactive Smart Maps:
the ultimate map function allows an operator to navigate between sites, locations and cameras, in a smooth interface supporting GIS and CAD drawings as well as major online map services such as Google, Bing and OpenStreetMap. Operators can define process layout, upload plans, and enjoy a seamless user experience while responding to incidents quickly and efficiently.

Alarm Manager:
provides a variety of notification options: volt free relay operation, email, SMS text or push notification to nominated users.

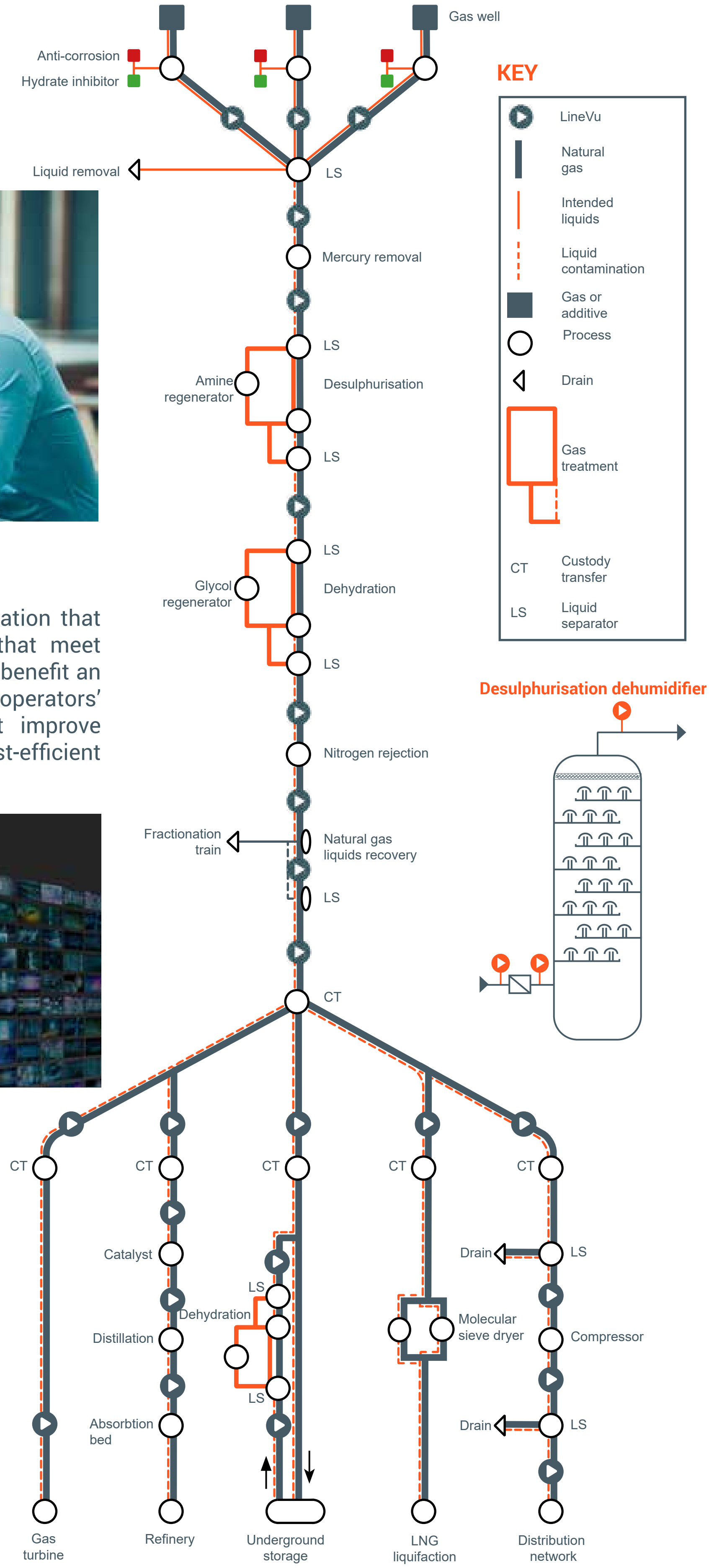
Bookmarking:
flags video sequences of particular interest and add descriptive notes, so users can easily share information. The system can be programmed to automatically bookmark certain events so users can quickly locate them during investigations.

Advanced search tools:
smart Search and Sequence Explorer allow users to quickly sort through large amounts of video.

DLNA support:
video can be displayed directly onto any supported TV screen with no computer or software needed.



From well to user

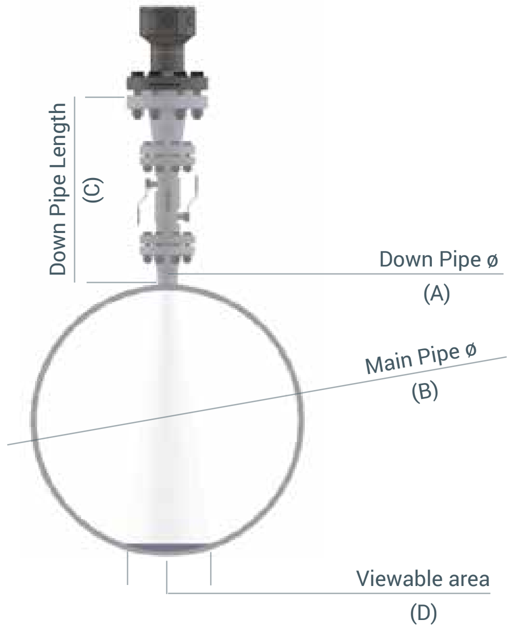


SMART WALL

Smart Wall is an advanced presentation application that enables organizations to create video walls that meet their specific security demands. Smart Wall can benefit an organization in three key ways: by increasing operators' situation awareness; by providing tools that improve decision making; and by creating a more cost-efficient security installation.

LineVu Viewable Pipel Area Matrix

FIELD OF VIEW CALCULATOR



A number of variable parameters affect the viewable area:

A. Down pipe diameter

B. Main pipe diameter

C. Down pipe length

This matrix is for guidance only; more precise figures for the viewable area (D) may be calculated when accurate dimensions are known.

				Main Pipe ø (B)							
				2"	4"	8"	12"	24"	36"	48"	52"
Down Pipe ø (A)	1"	C	mm	415	415	415	415	415	415	415	415
			Inches	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
		D ø	mm	28	31	37	42	60	78	95	100
			Inches	1.1	1.2	1.5	1.7	2.4	3.1	3.7	3.9
		D Area	mm²	616	755	1075	1385	2827	4778	7088	7854
			Inches²	0.95	1.17	1.67	2.15	4.38	7.41	10.99	12.17
	1.5"	C	mm	440	440	440	440	440	440	440	440
			Inches	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
		D ø	mm	41	46	54	63	87	112	137	145
			Inches	1.6	1.8	2.1	2.5	3.4	4.4	5.4	5.7
		D Area	mm²	1320	1662	2290	3117	5945	9852	14741	16513
			Inches²	2.05	2.58	3.55	4.83	9.21	15.27	22.85	25.60
	2"	C	mm	490	490	490	490	490	490	490	490
			Inches	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
		D ø	mm	52	59	70	80	110	139	169	179
			Inches	2.0	2.3	2.8	3.1	4.3	5.5	6.7	7.0
		D Area	mm²	2124	2734	3848	5027	9503	15175	22432	25165
			Inches²	3.29	4.24	5.97	7.79	14.73	23.52	34.77	39.01
	3"	C	mm	-	704	704	704	704	704	704	704
			Inches	-	27.7	27.7	27.7	27.7	27.7	27.7	27.7
		D ø	mm	-	85	95	106	138	170	202	212
			Inches	-	3.3	3.7	4.2	5.4	6.7	8.0	8.3
		D Area	mm²	-	5675	7088	8825	14957	22698	32047	35299
			Inches²	-	8.80	10.99	13.68	23.18	35.18	49.67	54.71
	4"	C	mm	-	950	950	950	950	950	950	950
			Inches	-	37.4	37.4	37.4	37.4	37.4	37.4	37.4
		D ø	mm	-	102	119	131	163	195	227	237
			Inches	-	4.0	4.7	5.2	6.4	7.7	8.9	9.3
		D Area	mm²	-	8171	11122	13478	20867	29865	40471	44115
			Inches²	-	12.67	17.24	20.89	32.34	46.29	62.73	68.38

Technical Specification

General		
Video output		Continuously available authorized user access to a web server via secure login with a web browser to access both live and historical data
		Export of still and video images possible
Alarm notification to authorized users		Image processing
Measurement principle		Volt free relay contacts available at the Interface box
Threshold and system alarm	Physical	Email notification to nominated authorized users
	Electronic	SMS text notification to nominated authorized users

Camera Can	
Certification	
ATEX - Zone 1 CE 2575 Ex II 2 G IP66 Ex d IIB+H2 T4	
UL/CSA - Class I, Division 1 Groups B, C&D T4 Class I, Zone 1 AEx d IIB+H2 T4 | Type 4x & IP66	
Physical	
Weight	Approximately 27kg (59.5lbs)
Material (wetted parts)	316L Stainless Steel (other materials optional) | O-ring- FFKM
Process connection	Class 900 3" RTJ (Standard); flange adapter required for other flanges types
Ingress protection	IP66/NEMA 4X
Ambient temperature	-10 to +30°C (standard) -40 to +50°C (optional)
Pressure rating	Standard Class 600 Flange (1,500 psiG or 103.4 BarG)
Electrical Connections	
Power	Power derived from Interface Unit
Data (to Interface Unit)	Ethernet (shielded Cat 5e or better) to Interface Unit
Port size	M25 Standard
Maximum cable length between Camera Can and Interface Unit	100 m (328 feet)

Interface Unit	
Certification	
Safe Area use only	
Physical	
Mounting	Wall mounting
Dimension	406Hx406Wx225Dmm (16x16x8.86")
Weight	Approximately 15kg (33lbs)
Operating temperature	0 to +50°C
Electrical Connections	
Power in	100/240V AC 50/60Hz | 2.8A max. @ 100V AC | 1.7A max. @ 240V AC
Power out (to Camera Can)	24V DC MAX @ 40W MAX
Data (from Camera Can)	Ethernet (shielded Cat 5e or better) from Camera Can
Data (to local LineVu Controller)	Ethernet (shielded Cat 5e or better)
Alarm threshold	Volt Free Alarm Relay
System alarm	Volt Free Alarm Relay
Modbus interface	Modus over RS485 (option)
Uplink module	External antenna maybe required

LineVu Controller	
Certification	
Safe Area use only	
Physical	
Mounting	Rack (standard), bench or wall mounting
Dimension	43Hx437Wx503Dmm (1.7x17.2x19.8") (rack mount)
Weight	Approximately 15kg (33lbs) (rack mount)
Operating temperature	0 to +50°C
Electrical Connections	
Power in	100/240V AC 50/60Hz| 4.2A max. @ 100V AC | 1.8A max. @ 240V AC
Signal out (to local LineVu Controller)	Ethernet (shielded Cat 5e or better)

Improving Foam Management in Gas Treatment

A collaboration project to improve gas treatment plant performance

Foaming

Foaming is a common problem in gas treatment, and is responsible for significant loss of production in many plants around the world. Now, a new system can prevent these losses, and help boost gas production to optimum levels.

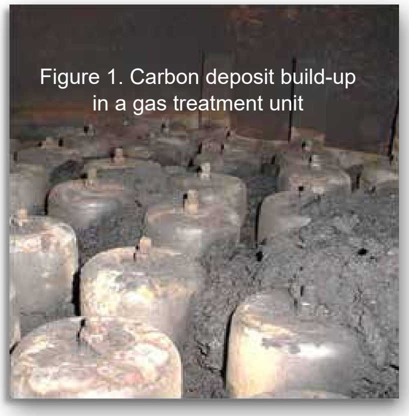


Figure 1. Carbon deposit build-up in a gas treatment unit

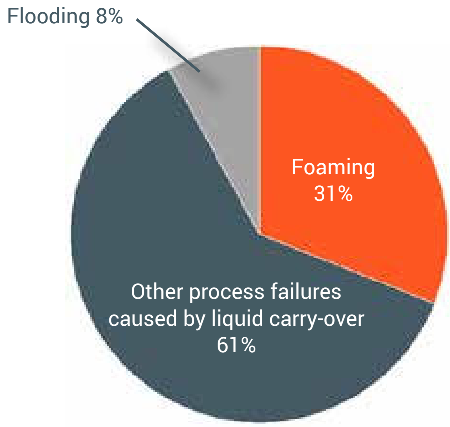


Figure 2. Process failures

In desulphurisation, amine-based liquids are used to remove acid gases. In dehydration units, glycol-based liquids (MEG or TEG) are used to remove water vapour.

Failure to remove liquids from the gas at the entry point of a gas treatment plant (the gas contactor) results in contamination of these processing liquids (amine or glycol) used to remove the acid gases and water vapour.

Liquids entrained in the gas entering the contactors build up in the amine or glycol and cause increasing problems:

- **short-term:** many of the liquids added at the well head are surfactants, which cause foaming and significantly reduces production.
- **long term:** hydrocarbon liquids can leave carbon deposits (shown in Figure 1.) that can build up inside the contactor and reduce its efficiency.

92% of process failures in gas treatment plants are due to liquid carry-over

A survey of 148 production failures in natural gas amine plants, undertaken by Amine Experts, shows that foaming caused by liquid carryover is a big problem.

31% of the failures were due to foaming. Normal practice at a foaming event is to reduce the production flow rate by 50 to 60% until de-foamer can be added and recovery is achieved. The relative frequency of their occurrence is shown in Figure 2.

Now, LineVu, a new detection system from Process Vision Ltd, can be used to provide an alarm when liquid carryover is seen in the gas entering a gas treatment plant. The alarm output from a LineVu system can be used as an early warning to improve on current practices, and trigger the injection of de-foamer before foam has built to a level where it is impacting on the plant efficiency, or gas flow has to be reduced to help recovery from a foaming event.

In addition to the alarm, LineVu provides operators with a live video stream of pipeline activity allowing extra confidence in process conditions. Closer monitoring of gas/liquid separator performance in this way can allow either an increase in production or diagnosis of separator problems.

Commercial

The commercial arrangements for the project are designed to lower client risk. At the start of the project, an eight-week Data as a Service (DaaS) contract is agreed.

A decision to return equipment or extend the contract is made at the end of the 8 week period. The project team has the option to extend the agreement from 6 months to 5 years at lower monthly fees. DaaS agreements include all software updates, support and warranty. If, at any time, the system uptime is less than 90% of any particular month (due to hardware, software or other issues within the control of Process Vision) the DaaS service is free for that month.

Project

<table>
<tr><td>AIM</td><td colspan="2">To use the liquid detection alarm of a LineVu system as an early warning to alert operators of a potential foaming event, enabling engineers to add de-foaming or anti-foam agent earlier than they can with current methods.</td></tr>
<tr><td rowspan="2">CAUSES OF LIQUID CARRYOVER</td><td colspan="2">The causes of liquid carryover can be divided into two categories:</td></tr>
<tr><td>Operational - temporary or occasional problem
• Coalescing filter cartridge failure: Fouling/flooding
• Coalescing filter cartridge failure: Mechanical damage
• Coalescing filter cartridge failure: Incorrect seating or sealing of filter cartridges
• Flow ramping: Start-up and shutdown</td><td>Design - constant or frequent problem
• Gas flows higher than design capacity
• Liquid loading higher than design capacity
• Incorrect design: sizing, type, insufficient straight run prior to separator
• Gas flow lower than design specification (cyclone filters)</td></tr>
<tr><td>CLIENT BENEFIT</td><td colspan="2">Lower risk of process failure - Early detection of, and response to, a liquid breakthrough lowers the impact of a foaming event.
Increased production - Gas flow can be optimised to maximum flow through filter system.
Lower maintenance cost - Filter cartridge performance can be monitored to extend cartridge life.
Provides evidence - Justification for filter improvements.
Optimisation - In-situ filter performance versus flow rate can be established.
Operator training - Video provides a greater insight and can be used to train operators.</td></tr>
<tr><td>DETAILS</td><td colspan="2">By installing a LineVu system before the gas treatment, plant operators will be provided with an alarm and a live video stream of separator performance. With this information, de-foamer can be added as soon as a liquid event is detected, improving on current practices of responding to a foam build up by monitoring differential pressure or liquid levels in downstream vessels.

The first stage of the project is to monitor and establish the level and nature of liquid carry-over and, if possible, establish a link between a liquid event and a foaming event. De-foamer can be manually added to establish the optimum timing for early application.</td></tr>
<tr><td>DATA</td><td colspan="2">The team will review historical data regarding the impact of foaming at the site then compare data with LineVu to determine the financial benefit for the site.</td></tr>
</table>

Application Note

Process Vision

Improving Flow Assurance

A collaboration project to improve gas network efficiency

Liquid Carryover

Liquid carryover into gas networks is a continuing problem around the world. Despite regulatory and commercial requirements dictating that gas at the entry point to a network should be free of liquids and solids, every year liquids cause significant damage to gas turbines and compressors on the network.

While water and hydrocarbon liquids are normally monitored; until LineVu, one of the most common problems, carryover of MEG or TEG from dehydrators, is not. These liquids (and compressor oil) pass through gas analysis systems at custody transfer points without tripping an alarm.

Figure 1 shows a typical result of pigging a “dry” gas network. Once in the network, low level liquid contamination moves along the pipewall and makes its way to the bottom of the pipe where it forms a small stream moving slowly through the pipeline until it reaches a low point in the network where it pools and accumulates. In order to maintain asset integrity, expensive pigging operations need to be regularly undertaken to avoid internal corrosion and ultimately pipeline rupture as in Figure 2.

Figure 1. Result of pigging a “dry” network

Figure 2. Pipeline rupture in New Mexico

Normal practice during pigging is to slow the flow to the pigs optimum flow rate of around 11 mph. On a 30” pipeline this results in **a loss in the region of $5.9M per day** for gas suppliers connected to the network. Without effective monitoring and evidence, there is no accountability for suppliers who are contaminating the network.

LineVu can detect liquid contamination in dry gas flows. When this occurs at custody transfer points, flow computers should make an allowance for wet gas in the calculations to ensure accurate flows are reported. With Sarbanes Oxley requiring due diligence on fiscal measurements, it is important for flow assurance engineers to be certain of the state of the gas that is being measured which could be 1% to 5% in error if the gas is wet.

When a LineVu is installed at the gas entry to a network, pipeline engineers can make better decisions regarding the acceptability of a supply, and either avoid a contamination event, or have good evidence and accountability regarding clean-up and recovering costs.

Commercial

The commercial arrangements for the project are designed to lower client risk. At the start of the project, an eight-week Data as a Service (DaaS) contract is agreed.

A decision to return equipment or extend the contract is made at the end of the 8 week period. The project team has the option to extend the agreement from 6 months to 5 years at lower monthly fees. DaaS agreements include all software updates, support and warranty. If, at any time, the system uptime is less than 90% of any particular month (due to hardware, software or other issues within the control of Process Vision) the DaaS service is free for that month.

Project

AIM	To use the liquid detection alarm of a LineVu system as a warning to pipeline engineers that a gas supplier is contaminating the gas network. The live video stream from LineVu will help determine the severity of the contamination and play a key role in the decision to accept or reject the supply of gas. This enables operators to have better accountability when gas lines have been contaminated and to optimise pigging operations.
CAUSES OF LIQUID CARRYOVER	The causes of liquid carryover can be divided into two categories: **Operational - temporary or occasional problem** • Coalescing filter cartridge failure: Fouling/flooding • Coalescing filter cartridge failure: Mechanical damage • Coalescing filter cartridge failure: Incorrect seating or sealing of filter cartridges • Flow ramping: Start-up and shutdown **Design - constant or frequent problem** • Gas flows higher than design capacity • Liquid loading higher than design capacity • Incorrect design: sizing, type, insufficient straight run prior to separator • Gas flow lower than design specification (cyclone filters)
CLIENT BENEFIT	**Lower risk of process failure** - Early detection of a liquid breakthrough lowers the impact of network contamination. **Better accountability** - With severe cases leading to a valve being slammed on a supplier, both parties can be provided with a live video stream of pipeline activity. A lower flow may resolve the situation until the filter system can be serviced. Better evidence lowers the risk of litigation. **Better flow assurance** - For the supplier, filter cartridge performance can be monitored to possibly extend cartridge life. **Provides evidence to justify suppliers filter improvements if necessary.** **In-situ filter performance versus flow rate can be established.** **Video can be used to train operators.**
DETAILS	By installing a LineVu system at the custody transfer point, operators will be provided with an alarm and a live video stream of gas quality. With this additional information, prompt action can taken to lower the impact of contamination. Improving on current practices of responding to a liquid carry-over event. Where liquid carryover is evident, flow tests can be performed to establish a link between liquid breakthrough and gas flow rate. Using this additional information, a lower flow rate can be agreed while filters are checked. Normal flow rates can be restored once the filter failure has been rectified.
DATA	The team will review historical data regarding level of use of MEG or TEG at the site and assess the impact of network contamination from the site to compare data with and without LineVu and determine the financial benefit for the site.

Application Note

Process Vision

Improving Condensate Recovery in Gas Treatment

A collaboration project to improve gas treatment plant performance

Liquid Carry-over

Failure to remove all liquids at the exit of a gas treatment plant (the gas contactor) results in contamination of the gas exiting the treatment plant. Even though the gas has been dehydrated and is therefore "dry", entrained glycol, used to remove water vapour (MEG or TEG), can impact on condensate recovery.

In a gas contactor used to dehydrate gas, liquids and gas are arranged in a counter flow configuration, with either bubble trays (shown in Figure 1) or packing, to increase the surface area of the gas/liquid interface and contact time. Before the gas exits the contactor at the top of the tower, entrained liquids are removed by a demister pad designed to coalesce liquid mist. In some cases, additional filters are installed to remove liquids. The effectiveness of these filters can now be monitored in real time by a LineVu system.

Over time, fouling can build up in the demister, concentrating the gas flow into a smaller area than the original design. This increases the flow rate of the gas and, therefore, decreases the effectiveness of the demister pad. In some cases, the differential pressure between the lower and upper surfaces of the demister is sufficient to damage the structure allowing gas to track through the demister.

Before leaving the treatment plant, high value condensate is normally removed by reducing the gas temperature to -20°C or below. At this temperature, heavier components of natural gas condense and should be removed from the gas stream prior to leaving the gas plant via the export gas line.

Carryover of MEG or TEG causes problems for the recovery of condensate. Glycol freezes at a temperature between -6°C and -12°C (depending on its water content) resulting in blockages and temperature control problems in the dewpointing equipment. This leads to disruptions in temperature control allowing a combination of glycol and condensate through to the export gas pipeline.

Now, LineVu, a new detection system from Process Vision Ltd, can be used to provide an alarm when liquid carry-over is seen in the gas exiting a gas treatment plant. The alarm output from a LineVu system can be used as a warning to improve on current practices.

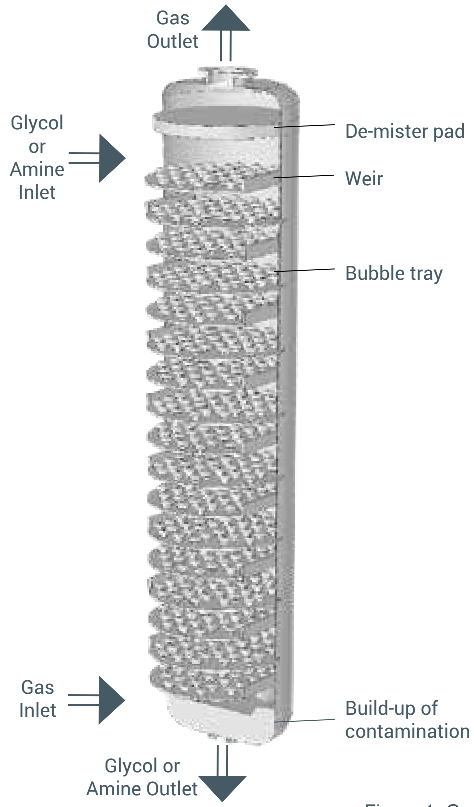


Figure 1. Gas Contactor

With a series of flow tests, an optimum flow rate/operating pressure can be determined that reflects the current state of fouling and filter efficiencies to maximise condensate recovery.

Commercial

The commercial arrangements for the project are designed to lower client risk. At the start of the project, an eight-week Data as a Service (DaaS) contract is agreed.

A decision to return equipment or extend the contract is made at the end of the 8 week period. The project team has the option to extend the agreement from 6 months to 5 years at lower monthly fees. DaaS agreements include all software updates, support and warranty. If, at any time, the system uptime is less than 90% of any particular month (due to hardware, software or other issues within the control of Process Vision) the DaaS service is free for that month.

Project

<table>
<tr><td>AIM</td><td colspan="2">To use the liquid detection alarm of a LineVu system as a warning to alert operators of a potential loss of condensate. This enables operators to highlight liquid carry-over events to limit condensate loss by improving maintenance of liquid filters more effectively than by using current methods.</td></tr>
<tr><td rowspan="2">CAUSES OF LIQUID CARRYOVER</td><td colspan="2">The causes of liquid carryover can be divided into two categories:</td></tr>
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Coalescing filter cartridge failure: Mechanical damage
Coalescing filter cartridge failure: Incorrect seating or sealing of filter cartridges
Flow ramping: Start-up and shutdown</td><td>Design - constant or frequent problem
Gas flows higher than design capacity
Liquid loading higher than design capacity
Incorrect design: sizing, type, insufficient straight run prior to separator
Gas flow lower than design specification (cyclone filters)</td></tr>
<tr><td>CLIENT BENEFIT</td><td colspan="2">Lower risk of process failure - Early detection of, and response to, a liquid breakthrough lowers the impact of loss of condensate.
Increased production - Gas flow can be optimised to maximum flow through the filter system.
Lower maintenance cost - Filter cartridge performance can be monitored to extend cartridge life.
Provides evidence - Justification for filter improvements.
Optimisation - In-situ filter performance versus flow rate can be established.
Operator training - Video provides a greater insight and can be used to train operators.</td></tr>
<tr><td>DETAILS</td><td colspan="2">By installing a LineVu system at the exit of a gas treatment plant, operators will be provided with an alarm and a live video stream of separator performance. With this additional information, prompt action can be taken to lower the impact of a foaming event, improving on current practices of responding to a liquid carry-over event.

The first stage of the project is to monitor and establish the level and nature of liquid carry-over and, if possible, establish a link between a liquid event and flow rate. Then using the additional information from LineVu, checking the condition of existing liquid filtration and performing a series of flow & pressure tests to establish the optimum performance of the system.</td></tr>
<tr><td>DATA</td><td colspan="2">The team will review historical data regarding the level of condensate recovery versus flow and pressure to assess the impact of condensate foaming at the site then compare data with LineVu to determine the financial benefit for the site.</td></tr>
</table>

Process Vision

LineVu Uses and Benefits

	Problem	Process	Location	Comment	Improves process safety	Improves profit	Reduces use of chemicals	Reduces downtime	Reduces risk to asset integrity	Challenge process limits to be challenged	Evidence for pipeline entry agreements
UPSTREAM											
1	Hydrates	N/A	Well head	Allows correct dosing of MEG or Methanol	✓	✓		✓	✓		
2	Hydrate and HC Liquids	Desulphurisation	Amine contactor inlet	HC liquids contaminate the Amine and cause foaming	✓	✓	✓	✓	✓	✓	
3	Foaming and blockages on bubble trays	Desulphurisation	Between bubble trays in amine contactor	Early detection of foaming and blockages	✓	✓	✓	✓	✓	✓	
4	Amine Carry-over and foaming	Desulphurisation	Amine contactor outlet	Allows quick diagnosis of process problem so that operators can take action	✓	✓	✓	✓	✓	✓	
5	Amine and HC liquid carry-over and foaming	Dehumidification	Glycol contactor inlet	Allows quick diagnosis of process problem so that operators can take action	✓	✓	✓	✓	✓	✓	
6	Foaming and blockages on bubble trays	Dehumidification	Between bubble trays in glycol contactor	Early detection of foaming and blockages	✓	✓	✓	✓	✓	✓	
7	Glycol carry-over and foam	Dehumidification	Glycol contactor outlet	Allows quick diagnosis of process problem so that operators can take action	✓	✓	✓	✓	✓	✓	
8	Liquid Carry-over causes bed to “concrete” and fail	Removal of Mercury	Mercury absorber bed inlet	Alarms upon liquid event to protect the asset and reduce downtime	✓	✓	✓	✓	✓		
9	Glycol carry-over freezes in DP unit	Removal of NGL	Dew pointing equipment inlet	Alarms upon liquid event to protect the asset and reduce downtime	✓	✓	✓	✓	✓		
10	Fouling and scaling build up	Cooling or heating of gas	Heat exchangers	Allows optimisation of scale inhibitor and de-scaling operations	✓	✓	✓	✓	✓		
11	Investigate process limits	Various	De-bottlenecking projects	Allows safe observation of processes to allow increase in production		✓	✓		✓		

12	Numbers from liquid measurement system are not always believable	Liquid Level alarm	Vessels containing combustible liquids	Provides operators extra confidence by being able to see inside vessel	✓				✓		
13	When extra wells come on stream. Only CFD models are used to determine if the current assets will cope with higher flows	In-situ flow tests	Gas/liquid separator outlet	In-situ flow tests can be performed to establish maximum flow and alternative options		✓			✓		
14	Dew point detection	Various	Various	Alarms when gas hits either the water or HC dew point and shows operators how much free liquid is present	✓	✓		✓	✓		✓
15	Ensures gas meets pipeline entry requirements for entrained liquids	N/A	Export Line	Provides proof to customer that gas is clean - Allows operators to take rapid action when a liquid event occurs	✓				✓		✓
MIDSTREAM											
16	Gas containing liquids breaks tariff agreements and safety standards	Purchase/Sale of gas	Custody transfer points	Buyers have indisputable evidence on which to base a compensation claim or renegotiate price	✓	✓			✓		✓
17	Orifice plate flow meter over-read if gas is wet	Flow Measurement	Custody transfer points	Buyer can correct flow rates for wet gas when system is in alarm		✓			✓		✓
18	System needs to be de-pressurized to remove orifice plate for audit	Audit orifice plate dimensions in-situ	Custody transfer points	A LineVu system can permanently monitor orifice shape and dimensions in-situ	✓	✓		✓	✓		✓
19	Liquids at inlet, or in the gas seal, will cause major damage to compressor	Increases line pressure for better gas flows	Compressor station inlet	Allows rapid action to prevent damage to compressors	✓	✓		✓	✓		
20	Dew point detection	Various	Various	Alarms when gas hits either the water or HC dew point and shows operators how much free liquid is present	✓	✓		✓	✓		✓
DOWNSTREAM											
21	Gas is bought on a “dry gas” basis. Problems can occur for the buyer of the gas is wet	Purchase of gas	Custody transfer points	Buyers have indisputable evidence on which to base a compensation claim or renegotiate price	✓	✓			✓		✓
22	Wet gas can cause major damage to turbine blades	Purchase of gas	Gas turbine entry	Buyers can take immediate action to avid damage and claim compensation or renegotiate price	✓	✓			✓		✓
23	Many catalysts suffer major damage by liquids or the combination of liquids and acid gases	A variety of catalysts are used in refineries and petro. chem plants	Entry to catalyst bed	Alerts operators to take rapid action to avoid damage	✓	✓	✓	✓	✓		
24	Mol. Sieve suffers major damage when liquids are present at the entry point	Gas drying to below 1 ppm water vapour	Entry to Molecular sieve beds in LNG plants	Alerts operators to take rapid action to avoid damage	✓	✓	✓	✓	✓		
25	When liquid water is present in superheated steam, large amounts of carbon are produced and cause blockages	Ethylene cracker	Steam inlet to cracker	Alerts operators to take rapid action to avoid damage	✓	✓		✓	✓		
26	Foaming and blockages can reduce efficiency	Distillation	Between bubble trays	Alerts operators to take rapid action to avoid damage	✓	✓	✓	✓	✓	✓	
27	Popcorn butadiene causes damage to plant and loss of containment	Production of Butadiene	Various	Alerts operators to take rapid action to avoid damage	✓	✓		✓	✓		
28	Benzene and other liquids can cause blockages	LNG Production	Liquefaction inlet	Alerts operators to take rapid action to avoid damage	✓	✓		✓	✓		
29	Numbers from liquid measurement system are not always believable	Liquid Level alarm	Vessels containing combustible liquids	Provides operators extra confidence by being able to see inside vessel	✓	✓		✓	✓		
30	Fouling and scaling build up	Cooling or heating of gas	Heat exchangers	Allows optimisation of scale inhibitor and de-scaling operations	✓	✓	✓	✓	✓		
31	Investigate process limits	Various	De-bottlenecking projects	Allows safe observation of processes to allow safe increase in production		✓	✓		✓	✓	
32	Dew point detection	Various	Various	Alarms when gas hits either the water or HC dew point and shows operators how much free liquid is present	✓	✓		✓	✓		✓

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