Phoenix Engineering

Control Systems Specialists

Hunters Lodge, Virginstow, Beaworthy, Devon EX21 5EA

[redacted]

PLANT:

REVIEW OF TRIAL ON SCALE REDUCTION

[redacted] off [redacted] Road

www.phoenix-engineers.co.uk

A REPORT BY PHOENIX ENGINEERING

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[redacted] STRIPPING PLANT:

REVIEW OF TRIAL ON SCALE REDUCTION

[redacted] Site [redacted]

Prepared on 15th August 2023

By Terry Trewern

Reviewed by Ryan March

QUALITY CONTROL SHEET

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1. Sequence of events

1.1. Design

Phoenix Engineering designed and built the [redacted] Stripping Plant in 2020.
The plant design was to reduce dissolved Methane in the leachate to below 0.14mg/l before discharge down an existing gravity pipeline.
Air is bubbled through the leachate in a cascade four tank reactor sequence (half-life principle) to progressively reduce the dissolved Methane level.
Testing after the plant was in operation proved the design to be working successfully and reducing the dissolved Methane to below 0.14mg/l consistently.

1.2. Scale

A hard deposit build up was observed after the plant had been running for some weeks which eventually resulted in restricting the discharge pipeline, coating the discharge pumps and reactor walls.

After removal a sample was sent to ALS Laboratories for analyses and stated to be largely Calcium Carbonate.
Laboratory results in Appendix 11.

On plants with light scaling a chemical additive is often used to remove or reduce the scaling. Phoenix conducted trials on dissolving the [redacted] scale with chemical additives in their laboratory but concluded that the scaling at [redacted] was so severe as to render scale reduction by chemicals impractical and very costly.

1.3. Scale control by electronics

Scale control by using ionising of particles in the liquid is offered by many companies.

After discussions and investigating the options, it was agreed to install the Vulcan system on the pipeline at [redacted] The MSP was drained and cleaned before the trial started.
The system is a control panel with electronics attached to pads wrapped around the pipeline. The system remains on 24/7,
Scale continued to build up after the system was set to work and after the trial period there was no reduction in the scale build-up, and it remained hard and difficult to remove.
Further searching found FlowScience had a similar system but with documented successful results when used on Leachate plants.
It was agreed between [redacted] Phoenix and FlowScience to install their system at [redacted] on a trial basis to see if scale buildup could be reduced with their system.
Phoenix removed the system and installed the FlowScience system when it arrived from Canada. The FlowScience system includes pads on pipelines (inflow and outflow), pads around discharge pumps and a free-standing pipe suspended in one reactor with pads.

1.4. First Trial

The MSP was observed over the next months to determine what effect the FlowScience system had on the scale buildup.

Whilst there were signs of less rapid buildup and that the scale was no longer a hard deposit it still resulted in the flow through the plant failing. Flow rates dropped throughout the trial period and discharge pumps had burnt out.

It was felt the trials showed a partial success but had not controlled the problem of Calcium buildup inhibiting the plant. Discussions concluded that a second trial would be worthwhile with an additional pad unit on the final discharge point, an additional suspended pad unit in the third reactor tank and replacing the pumps with plastic units instead of the original stainless-steel pumps. It was felt that the stainless-steel pump jackets were inhibiting the pad pulses from entering the pump.

1.5. Second Trial

Phoenix prepared a statement for the pump change and installation of the additional controls and a trial format that included regular observations and tests by Phoenix engineers.
It was agreed that the trial should have an eight-week duration during which testing would be photographed for the records with some video as appropriate.

Some Photos per visit in Appendix 1 to 10

This second trial was managed to reduce the impact on other Phoenix commitments and therefore was agreed as a random attendance to site to work around these other commitments. Attendance dates therefore vary.

RAMS and outline were submitted to [redacted] along with the Phoenix "Buddy" system details for lone working. issued approval providing that [redacted] were informed before each visit. This could be a simple phone call or email.

At each visit the flow out was checked on the SCADA for consistency. This was also monitored remotely by Phoenix. Some inconsistency in the flow rate was noted but felt to be caused by the gravity discharge pipeline. Overall discharge flows remained constant throughout the trial.

On each visit all pad functioning was checked with the Gauss meter to prove to be working.

Photos are on the Phoenix server but not added to this report.

To achieve testing of pads on the suspended pipe / pads they were lifted, scale visually checked, and a Gauss meter reading observed.

The discharge pumps were also lifted on each visit to check the pads were functioning and observe the scale build up.

The discharge header tank was checked on each visit and whilst some scale was visible it was minimal and soft. There was no sign of any scale build up in the discharge pipe mouth.

On the final visit our engineer lowered the leachate level in the final reactor chamber to investigate scale build up on the walls. Some scale had formed 5 to 10mm thick. The engineer used a rod to scrap the scale which was soft and came away easily exposing the tank wall.

2. Inspection after trial

2.1. Pipeline inspection 8th September 2023

On 8th September [redacted] had the discharge line inspected. The flow during the trials was constant but lower than expected. Inspection indicated that whilst there is some build up of soft scale flow was not inhibited by the scale. It is thought the main flow inhibiting was caused by a partial block from a harder substance, possibly some of the original scale that remained in the system and has worked loose.

The photograph below shows the blockage at the joint before the bridge over the river.

Other photographs show a build up of slimy scale which partially restricts flow and would indicate a periodic pressure washing of the discharge pipe may be required.

Since removal of the blockage discharge flow rates have doubled.

Longford discharge pipework

2.2. Before trial November 2022

For comparison these photographs show hard scale further downstream in the sewer from Nov 2022. There was no investigation in this section of the sewer after the trial, but it is felt that if similar conditions exist now then it would have been reported to [redacted]

2.3. Reactor tanks after trial before cleaning 11th September

The photographs below show soft scale on the walls of the reactors.

Tank 1

Tank 2

Tank 3

Tank 4

Discharge Tank

3. Summary and Conclusions

3.1. Results - mainly using pumps as guide.

Shortly after start-up a very slight deposit can be seen on the pumps -21-06-2023.

Two days later showed little change on the pumps.

2nd visit - no change

3rd visit - no change

4th visit - slightly more scale but reported as soft.

5th visit – no change

6th visit – no change

7th visit – no change

8th visit – no change on pumps. Discharge tank shows slight soft scale buildup and no restrictions to the discharge pipe.

9th visit – no change

10th visit – During this visit the reactor chamber level was lowered to observe the tank wall scale. A video was taken to show the deposit was thin and soft.

Prior to the 10th visit one discharge pump had failed. Our engineer removed the volute, and it clearly shows there is no [redacted] cause is a capacitor failure not related to the [redacted]

3.2. Conclusion

The plant is running as per design with no signs of scale inhibiting performance.
Some scale has appeared during the trial but is slight and soft and therefore not inhibiting the plant operation.
Ongoing it is recommended that checks are undertaken, as in the trial, during the maintenance visits.

Note ; Whilst the control panels are rated at 10amps each the running current is under 1 amp. Running costs are therefore minimal.

It is therefore considered the trial was a success and proved that the FlowScience system works at [redacted] and will enable the plant to operate without costly strip down cleaning cycles.

3.3. Recommendations

That [redacted] consider accepting the system as a working solution to the operating problems at [redacted]

That Phoenix undertakes a simple wash of the pumps during maintenance visits and check the FlowScience system is operating correctly.

Spare 3m tape is purchased to be kept in the control room. This is required to reinstate

the
FlowScience system pads on pipe and pumps when/ if needed.
A copy of how to apply the tape be printed, laminated, and put on the wall of the control room. This will eliminate any problems that may occur with personal changes.

3.4. Notes

Phoenix has several photographs and some video taken during the trial visits.

They are too numerous to include in this report.

However, if anyone would like access, we can forward a link to view the folder.

The Gauss meter detects the magnetic field. When close to the pads it reads OL (overload) as seen in the photographs.

Appendix A Photograph Selection

A.1 Visit 21-06-2023 – day after start-up.

A.2 Visit 2 23-06-2023

A.3 Visit 3 26-06-2023

A.4 Visit 4 29-06-2023

A.5 5th Visit 02-07-2023

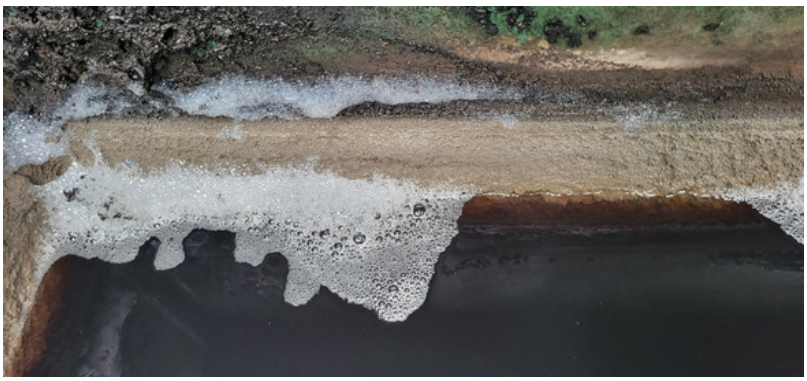
A.6 6th visit – 03-07-2023

A.7 7th visit 12-07-2023

A.8 8th visit – 24-07-2023

A.9 9th visit – 31-07-2023

A.10 10th final visit – 11-08-2023



Inside of reactor with level lowered. Deposit was scrapped and found to be soft. Similarly in discharge tank.

A.11 Laboratory analyses

Results Legend # ISO17025 accredited. M mCERTS accredited. aq Aqueous / settled sample. diss.filt Dissolved / filtered sample. tot.unfilt Total / unfiltered sample. * Subcontracted - refer to subcontractor report for accreditation status. ** % recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery (F) Trigger breach confirmed 1-4♦§@ Sample deviation (see appendix)		Customer Sample Ref.	Longford Depth Probe	Longford Header Tank	Longford In	Longford Out
		Depth (m)	.	.	.	.
		Sample Type	Soil/Solid (S)	Soil/Solid (S)	Process Water (PR)	Trade Effluent (TE)
		Date Sampled	29/09/2021	29/09/2021	29/09/2021	29/09/2021
		Sample Time	.	.	.	.
		Date Received	05/10/2021	05/10/2021	05/10/2021	05/10/2021
		SDG Ref	211005-66	211005-66	211005-66	211005-66
		Lab Sample No.(s)	25095493	25095492	25095494	25095495
		AGS Reference				
Component	**LOD/Units**	**Method**				
Alkalinity,TotalasCaCO3	<2mg/l	TM04				252
OrganicCarbon,Total	<3mg/l	3				0
Ammoniacal Nitrogen as N	<0.2mg/l	TM09				452 2
COD, unfiltered	<7mg/l	0				414 2
Conductivity@ 20 deg.C	<0.02	TM09				143
Manganese(diss.filt)	mS/cm <3 µg/l	9				0
Zinc (diss.filt)	<1 µg/l	TM10				7.72 2
Sodium (Dis.Filt)	<0.076 mg/l	7				54 2
Magnesium(Dis.Filt)	<0.036 mg/l	TM12				148 2
Potassium(Dis.Filt)	<0.2 mg/l	0				0 2
Calcium (Dis.Filt)	<0.2 mg/l	TM15				104 2
Iron (Dis.Filt)	<0.019 mg/l	2				0 2
Chloride	<2 mg/l	TM15				102 2
Alkalinity,TotalasCaCO3	<2 mg/l	2				301
OrganicCarbon,Total	<3 mg/l	TM15				68.9
Ammoniacal Nitrogen as N	<0.2 mg/l	2				1.07
COD, unfiltered	<7 mg/l	TM15			3230	154
Conductivity@ 20 deg.C	<0.02	2			489 2	0
Manganese(diss.filt)	mS/cm <3 µg/l	TM15			462 2	
Zinc (diss.filt)	<1 µg/l	2			1520 2	
Sodium (Dis.Filt)	<0.076 mg/l	TM15			8.96	
Magnesium(Dis.Filt)	<0.036 mg/l	2			333	
Potassium(Dis.Filt)	<0.2 mg/l	TM15			<10 2	
Calcium (Dis.Filt)	<0.2 mg/l	2			1130 2	
Iron (Dis.Filt)	<0.019 mg/l	TM18			109 2	
		4			315 2	
		TM04			274 2	
		3			0.25 2	
		TM09			1 2	
		0				
		TM09				
		9				
		TM10				
		7				
		TM12				

Chloride	<2 mg/l	TM18			1630	
MoistureContentRatio (% of as receivedsample)	%	4	8.4	0		
Sulphide,Easilyliberated	<15 mg/kg	PM02	42.6	163		
Iron	<1000 mg/kg	4	@ M	@ M		
Manganese	<0.13 mg/kg	TM18	1890	16900		
Calcium	<21 mg/kg	0	#	#		
Sodium	<7 mg/kg	TM18	959	2060		
Magnesium	<8 mg/kg	1	M	M		
		TM18	327000	265000		
		1	1410	1110		
		TM22	3720	7340		
		4				
		TM22				
		4				
		TM22				
		4				

END OF REPORT