Assetivo

Case Studies

Case Study: Steam Trap Acoustic Emissions Survey

Introduction

This case study is intended to highlight the potential financial savings from the use of acoustic emissions technology to highlight failing or failed steam traps at a steelworks. Steam is generated on site at the Energy department and supplied to several works' areas around site at several different pressure levels. When using steam lines there is a need to have steam traps installed at regular intervals. These mechanical devices are intended to discharge hot condensate and non-condensable gases (such carbon dioxide) whilst retaining live steam from the process. The total quantity is unknown, but it is thought that there are hundreds – possibly- a thousand plus- steam traps around the site.

This case study concentrates on the 11 bar steam lines running parallel to the works reservoir as shown in Figure 1 and is a one-off *qualitative* analysis to identify steam taps with incipient failures or already in a failed state. The majority of steam traps encountered on site are of the thermodynamic disc type, and these steam traps can fail by blockage, fail totally open or partially open, i.e. 'passing' small amounts of live steam or repeatedly opening in rapid bursts also known as 'motorboating'. These leaks can also allow air to enter the system and pipework. A normally operating steam trap can usually be seen to release condensate and other non-condensable gases by opening for a few seconds and up to several times a minute in some instances. They should not be blocked and inactive or partially passing live steam. Failed open steam traps do not require sophisticated ultrasonic techniques to diagnose as they can be seen from considerable distance constantly blowing live steam into the atmosphere. They can also be heard at considerable distance.

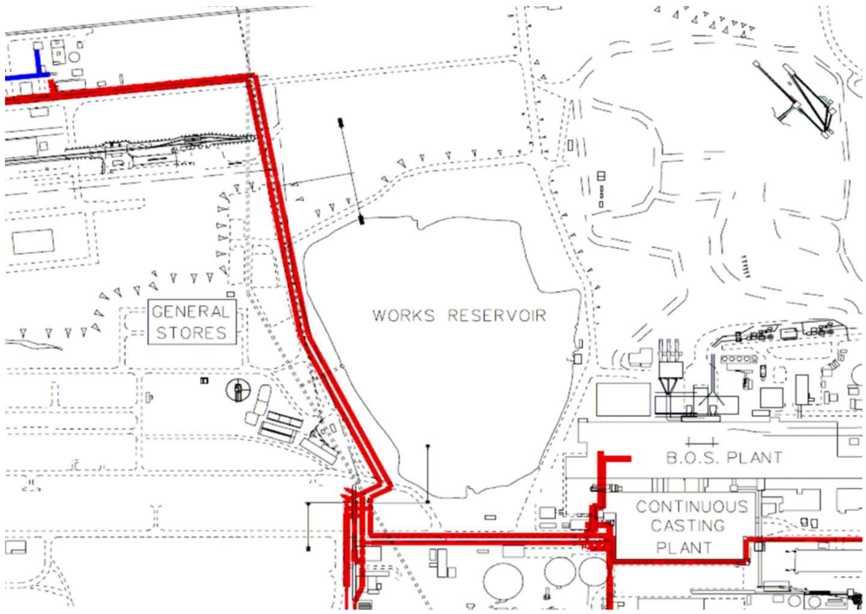


Figure 1: Site map

Technical Details

Plant: 11 Bar Steam Lines

Location: 11 bar steam lines running parallel with works reservoir at Steel & Slab.

From valves HPS1 & HPS 2 (not inclusive) to valves 15 & 6 (not inclusive).

Survey: Thermodynamic Disc Steam Traps.

Department responsibility: Energy Department.

Equipment: Ultraprobe 2000, contact technique. Flir i5 Thermal Imager.

Typical Ultraprobe settings: Contact probe - LOG, frequency 25kHz. Scanning module - LOG, fixed band, max. Sensitivity (10) and gross to fine method.

Limitations

Future studies would be optimised greatly with modern ultrasonic equipment (such as an Ultraprobe10000) that is able record and store sound files and also a magnetically mounted contact probe/sensor for repeatability: none currently owned by TSSPUK.

Results

Acoustic Emissions Report
The table below highlights the results of the acoustic emissions survey of approximately 25 steam traps encountered on the works reservoir 11 bar steam line route. Please note, only defective steam traps are shown in the table. Several thermal images were also taken of a selection steam traps.

Table 1: AE survey results

Equip. ID	Item	Settings: Frequency / Sensitivity	Meter (Lin, Log, Fxd Bnd)	Notes	Further action Required	Action Taken
HPST-12 EXAMPLE >>>	*Steam trap*	*20kHz / 5.8*	*Lin*	*NOK / Failed, continuously passing steam & water droplets*	*SAP notification required to replace.*	*Notification raised: 123456*
16" steam line, Sec. R-S, Loop 30, W001	Steam trap	Fixed band / 5	Log	NOK / passing steam & condensate droplets. **See Figure 2.**	50/50, schedule to monitor again	None
16" steam line, Loop 29, W-F 002	Steam trap	Fixed band / 5	Log	NOK / constantly passing steam & condensate droplets. **See Figure 3.**	Raise SAP notification to Replace	11732199
12" steam line, Sec. R-S, Loop 28, R-S 003	Steam trap	Fixed band / 5	Log	NOK / failed closed or blockage between prior shut-off valve & steam trap. **See Figure 4.**	Raise SAP notification to Investigate.	11732250
12" Steam Line, Loop 26, R-S 005	Steam trap	Fixed band / 4	Log	NOK / 'motorboating'. **See Figure 5.**	Raise SAP notification to Replace	11732331
16" Steam Line, Loop 26, W-F 005	Steam trap	Fixed band / 4	Log	NOK / Failed open. Considerable energy losses here. **See Figure 6.**	Raise SAP notification to Replace	11732335
12" Steam Line, Loop 24, R-S 007	Steam trap	Fixed band / 4	Log	NOK / intermittent 'motorboating'. **See Figure 7.**	Raise SAP notification to Replace	11732336
16" Steam Line, Loop 24, W-F 007	Steam trap	Fixed band / 4	Log	NOK / constantly passing steam & condensate droplets. **See Figure 8.**	Raise SAP notification to Replace	11732338
16" Steam Line, Loop 21,	Steam trap	Fixed band / 4	Log	NOK / passing	50/50, schedule to monitor again	None
16" Steam Line, W-F 010, at Concast carpark exit	Steam trap	Fixed band / 4	Log	NOK / constantly passing steam & condensate droplets	Raise SAP notification to Replace	11732396
16" Steam Line, T-U Loop 10, U-V 003	Shut off valve (prior to steam trap)	Fixed band / 4	Log	Failed at handle stem. Constant steam losses.	Raise SAP notification to Replace	11735677

16" Steam Line, T-U Loop 10, U-V 003	Manual relief valve (for bypassing steam trap)	Fixed band / 4	Log	Failed? Or left open due to prior shut off valve failed? Is the steam trap working?	50/50 Check again.	None
12" steam line, Loop ? T-U 014, (close to concast overspill car park exit)	Steam trap	Fixed band / 4	Log	NOK / motorboating	Raise SAP notification to Replace.	11735888

Infrared Inspections

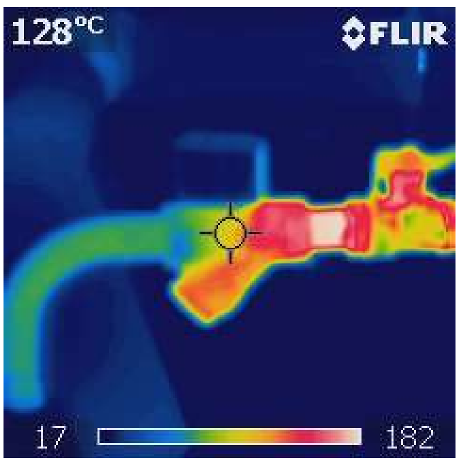


Figure 2

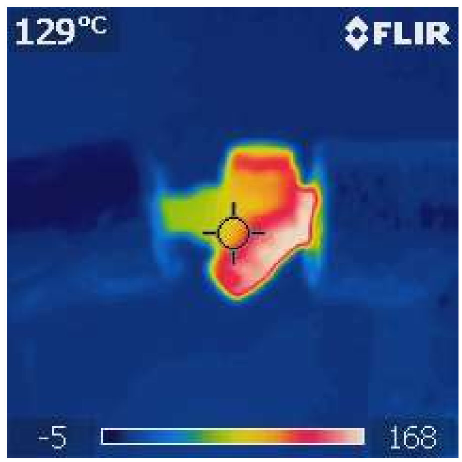


Figure 3

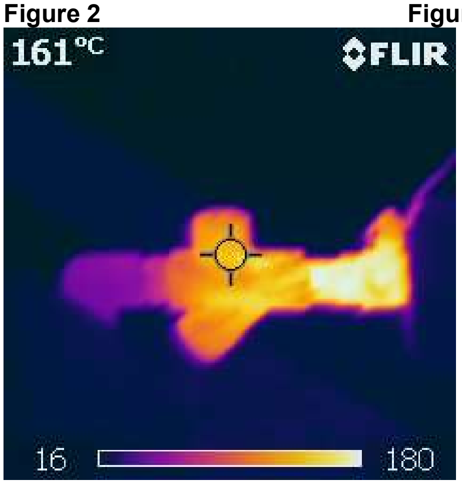


Figure 4

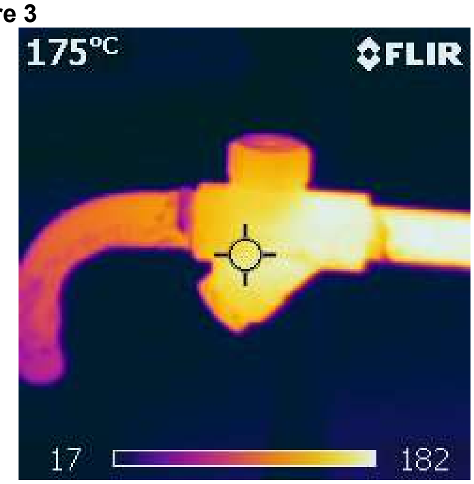
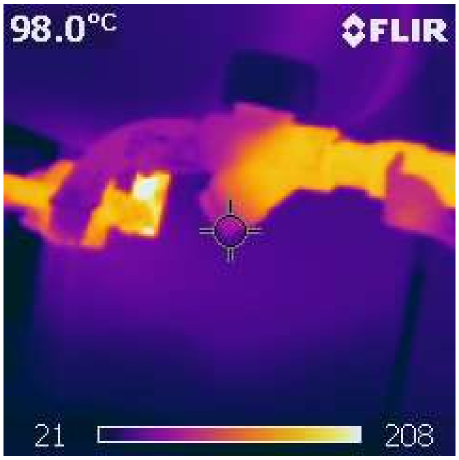


Figure 5



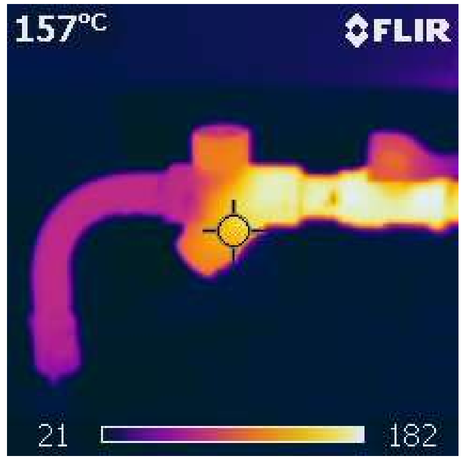


Figure 6 **Figure 7**

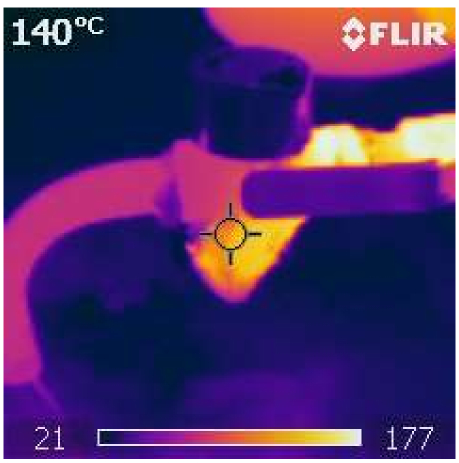


Figure 8

Financial cost of failing/failed steam traps

Given that most steam traps on the survey were manufactured by Spirax Sarco, it was decided to calculate the financial losses that the steelworks are incurring by using the Spirax Sarco literature (see reference 1). Please note that the costs calculated are only for steam traps that have *failed totally open* and are constantly blowing live steam into the atmosphere: these are the costliest failures by a considerable distance and require the most attention here:

The cost of ignoring leaking steam traps?

Steam leaks are costly in both a financial and environmental sense and therefore need prompt attention to ensure your steam system is working at its optimum efficiency with a minimum impact on the environment. For example, for each litre of heavy fuel oil burned unnecessarily to compensate for a steam leak, approximately 3 kg of CO_2 are emitted to the atmosphere.

Steam traps can have different sized orifices to suit different conditions. If a trap leaks steam, the amount wasted will depend on the size of the trap and the steam pressure. The cost of waste will also depend on the number of traps and the operating time. A simple example is given below.

Table 1 Typical steam wastage and annual costs due to leaking steam traps

Trap size	Average orifice size in steam traps (mm)	Steam loss (kg/ h)			Typical annual cost £000s		
		6 bar g	14 bar g	32 bar g	6 bar g	14 bar g	32 bar g
DN15	3.0	8	19	43	13	32	72
DN20	5.0	24	53	119	40	89	200
DN25	7.5	55	121	270	92	203	453
DN40	10.0	98	214	478	164	359	802
DN50	12.5	152	335	747	255	562	1 254

Example:
A process plant has 200 steam traps of which 10% fail annually. The average trap size is DN20 and the steam pressure is 14 bar g.

The plant runs 24 hours a day, 7 days a week for 50 weeks a year = 8 400 hours a year
Average number of traps failing over a year (10% of 200) = 20 traps
From the chart, the steam loss per trap = 53 kg/h
Steam loss per year for the total plant = 20 x 53 x 8 400 tonnes per annum
Steam wasted each year = 8 900 tonnes.

The cost of overlooking leaks: If the overall cost of steam for this plant were £10 per tonne, the direct cost of ignoring these leaking steam traps would be £89 000 each year, equivalent to well over a million litres of fuel oil!

The cost to the environment is that over 3 000 tonnes of CO_2 would be dumped into the atmosphere. The 'global 'Kyoto' Agreement is designed to curb environmental waste, and National agreements are designed to incur energy taxes on inefficient plant.

Note: Leaking steam also has to be replaced with chemically treated water. **A costly operation.**

The cost of ignoring blocked steam traps?

Water will not be removed from the process, with the result that both safety and performance are compromised. In the case of the latter, the cost will depend on the process. In the case of the former the cost can prove incalculable.

Calculations:

On the 11 bar steam lines at the steelworks, thermodynamic disc steam straps are either **DN 15** (1/2" pipe) or **DN 20** (3/4" pipe). From the table and recalculating (proportionally) for 11 bar:

Table 2: Steam losses by trap size

Steam Trap size	Average orifice size	Steam loss (Kg/h) for 11 bar steam line
DN 15	3mm	15
DN 20	5mm	41

The Energy Distribution Department suggests the cost of steam is £20 per ton produced. Therefore £20 / 1000 kilos = **£0.02 or 2 pence per kilo**. This means the steelworks is incurring the following financial costs when a thermodynamic steam trap is **failed open**:

DN 15 = £50.40 a week

DN 20 = £137.76 a week

Conclusion

This acoustic emissions survey has highlighted several failed/failing steam traps at the 11 bar steam line adjacent to the works reservoir. From 25 steam traps surveyed there are 12 in a failing/failed state (48%) with 9 requiring immediate replacement due to total blockage or being failed open.

The technique used was acoustic emissions to determine the ultrasonic frequencies emitted by steam leakage. The technique was found to be successful and several SAP notifications were raised to remedy the said leaks – though it must be noted that acoustic emissions techniques are *not required to identify the most concerning failed steam traps, i.e. those failed open*. These failures can be identified with a simple visual/audible inspection. The infrared thermal images can also be used to highlight anomalies in steam traps but is not a traditional or efficient use of this technology. The cost of failing steam traps was also highlighted and showed to be significant and wasteful bearing in mind that this survey was only on a small section of the entire site's steam pipelines.

Recommendations

This report has demonstrated that there is a clear need for regular works area surveys of the steam lines during the year to highlight and replace failed steam traps and thereby reduce energy wastage and the associated energy production costs.

It is unknown at present if these surveys are already scheduled and taking place in works areas or if they are being identified as part of the company's maintenance strategy development in each work area.

References

1. Spiratec Steam Trap Monitoring by Spirax Sarco, MI Issue 8, SB-S34-01. This document can be found at *www.spiraxsarco.com/pdfs/SB/s34_01.pdf*