Infrared Thermography in the Process Gas Plant

Randy Gates
Senior I&E, Lost Cabin Gas Plant, Burlington Resources

ABSTRACT

Burlington Resources uses infrared (IR) thermal imaging to inspect electrical connections throughout their process gas plant for predictive maintenance, greatly reducing plant downtime and unscheduled shutdowns, and thereby leading to the realization of huge cost savings. The thermography program is used in conjunction with the newly implemented vibration preventive maintenance program. The Sour Gas processing plant takes natural gas from 9 deep wells in the Madden formation in central Wyoming, each approximately 25,000 ft. deep. The wells produce shut in pressure of 10,000 lbs at approximately 290 deg F., and the gas obtained contains sulfur and hydrogen sulfide, which have to be processed out of the natural gas prior to sale to the end user. Burlington Resources processes approximately 220 million cubic ft. of salable natural gas through their three plants, and removes approximately 2400 long tons of liquid sulfur per day. Thermography is a vital component to help them keep the plant operational.

This paper will describe some of the uses we have found for the infrared camera and will detail some of the cost savings we have realized since the implementation of our IR program in January of 2004.

INTRODUCTION

This is a paper highlighting specific uses that we have implemented in our plant using the infrared camera. I am a senior Instrument/Electrician for Burlington Resources at a sour gas plant in Lysite, WY. We employ approximately 85 people at the plant on a 24/7 schedule.

We purchased our infrared thermal imaging camera in January of 2004, and the uses we have found for it are amazing. At first, some people were a little reluctant to purchase the infrared camera because of the cost. People no longer have any issues after seeing the things it can do. The cost savings have been phenomenal for our plant.

We use the IR camera for checking all electrical connections in our main control centers, all of our medium and high voltage connections in switchyards and station service transformers. We also use it to monitor bearing temperatures on our motors and compressors. The thermal imaging scans show us, prior to failure, when our compressor valves need changing, thus limiting down time extensively.

The downtime of our plant due to unscheduled outages has been significantly reduced since implementing our infrared program. This is used in conjunction with our newly implemented vibration preventive maintenance program. Time will tell, but to date we have realized more cost savings with our IR program.

Our ratio of inlet gas to outlet gas is approximately 67%. The inlet flow is approximately 330 million cubic feet per day. In addition to our gas sales, we process approximately 2400 long tons of liquid sulfur per day. This sulfur is sold and transported from our plant by rail. Due to our sulfur unit we are governed closely by environmental standards and cannot afford to be out of compliance with any emissions. Fines could be levied on any non-compliance issues.

A byproduct of the refinery process is hydrogen sulfide, a very deadly gas even at small quantities of 50 PPM. At the wellhead there can be H_2S present in excess of 120,000 PPM or 12%.

These issues all come together to let you realize how important it is to keep all gas inside our pipes and our vessels to prevent any and all upsets from causing a shutdown.

In the event of a plant shutdown, it takes approximately 12 hours to restart and sweeten the sour gas and get back to normal production.

We are, as I stated earlier, a sour gas processing plant. We take natural gas from 9 deep wells in the Madden formation in central Wyoming. These wells are approximately 25,000 feet deep, and produce shut in pressures to 10,000 psi at approximately 290 degrees Fahrenheit. The gas contains sulfur and hydrogen sulfide; these byproducts need to be processed out of the natural gas prior to the sale of the gas to end users. Burlington Resources processes approximately 220 million cubic feet of saleable gas through our three plants per day.

Plant 1	Plant 2	Plant 3
45 mmcfd	45 mmcfd	130 mmcfd

Table 1: Plant output in millions of cubic feet per day

Our process involves towers that are used to separate and strip the byproducts out of the natural gas, through patent-protected chemical processes. We have trays in these towers and we can tell when there is a problem with the process.

Case History

I am now going to cover the greatest cost savings to date that we can attribute to the infrared thermal imaging camera. In September 2004 we noted that we had to cut rates on Plant Three due to blockages or problems with one of our towers. When this has happened in the past, we would have to schedule a plant shutdown to determine if the trays in the tower were broken and had fallen, blocking the flow.

The tower in question is approximately 130 ft high with 13 rows of trays. Since the gas is at 290 degrees Fahrenheit, it takes quite some time to cool the tower enough to let personnel enter and see what the problem is. To complicate matters further all trays have to be removed starting at the top and progressing downward until the bad trays are found. You still have to go all of the way down, even if the bad trays are found on the third level to ensure that there aren't lower trays with problems. In the past this procedure has required a 10 to 14 day turnaround.

With the use of infrared camera technology, as shown in Figures 1A through 1C, there were no problems with the trays, but there were some blockages. We were able to determine that these could be corrected by an acid wash rather than a shutdown, due to the use of IR technology.

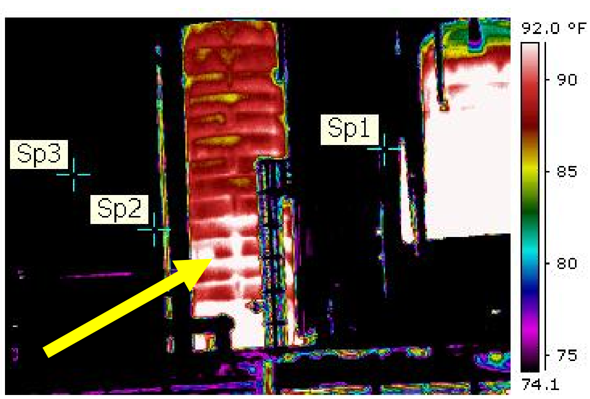

Figure 1A. IR scan of absorber tower.

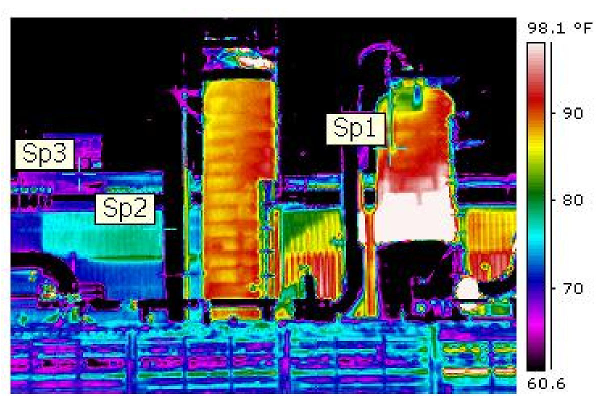

Figure 1B. IR scan of absorber tower using a different palette.

In the above pictures you can see the channeling in the lower part of the tower due to blockage from sludge and buildup that created uneven solvent distribution. You can also see that all of the trays are intact.

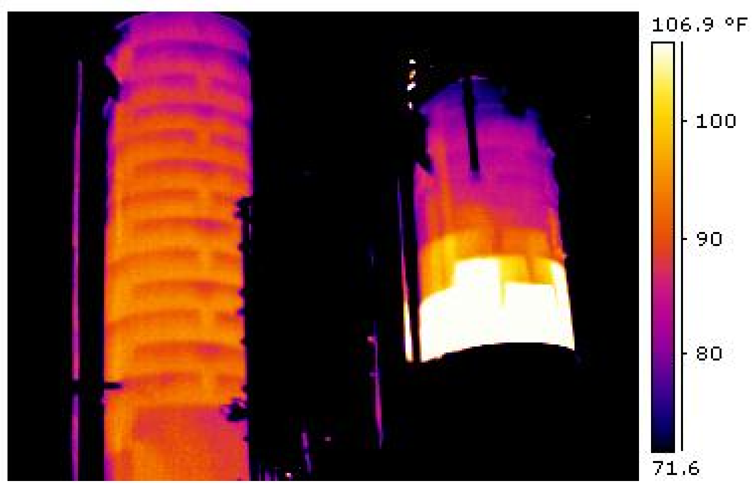

Figure 1C. This is a thermal image of the absorber tower following the acid wash. The buildup and sludge are gone and the flow through the tower was back to normal. This image also proves that the trays remained in place during the wash, saving many man hours.

The acid wash took 48 hours and we were able to complete it by only a slight flow reduction through the plant. The cost savings are as follows and these are very conservative estimates: revenue attributed to our plant is approximately $750,000 per day and of that Plant Three accounts for $500,000 of that. A ten day turnaround from lost production would cost us approximately $5,000,000 in lost revenue. We are in a very remote location so the mobilization for a shut down and to bring crews and added man power costs an addition $500,000. There could be more variables factored into this equation and more saving realized, but example clearly shows the impact of the use of the infrared camera.

ACID WASH	VERSUS	TURNAROUND
+ No removal of trays necessary to inspect trays		- Total plant shutdown, LOTO and opening of tower
+ 48 hours (start to finish)		- 10-14 days turnaround
+ Reduced rates		-Total Train III shutdown
+ Production loss		- 10 days would have production loss of $5MM
+ 10-12 Contractors on-site		- Mobilization of numerous contractors
+ Acid wash cost		- Contractor and material cost of turnaround

Table 2. Comparison of work involved using IR technology (acid wash) vs. traditional methods.

Other Testing and Applications

The following are some other applications that we use the infrared camera for:

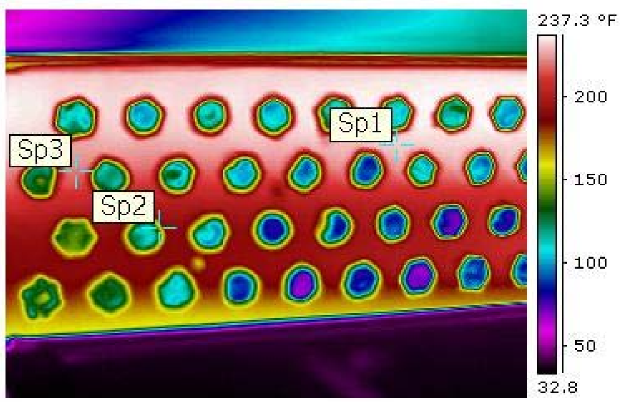

Figure 2A. IR scan of aerial cooler header box.

Figure 2B. Digital shot of aerial cooler header box.

Infrared scanning has made it possible to readily detect cooling tubes that are getting corroded. It has also given us a record of which tubes have failed and been taken out of service, thus not having to rely on memory of which tubes have gone bad (Figures 2A&B).

Figure 3A. Hot bearing on incinerator blower

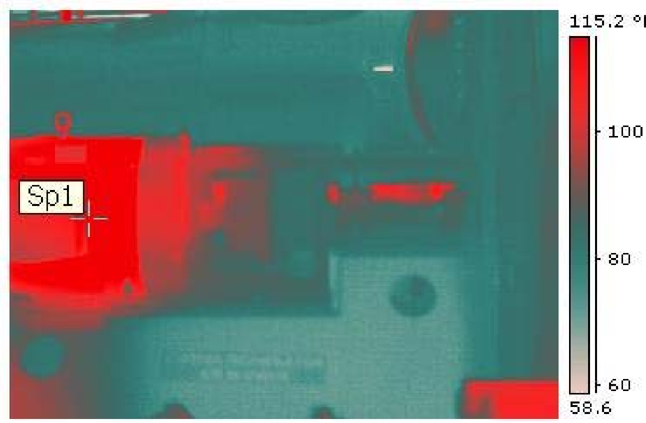

Figure 3B. Slight misalignment of coupling on incinerator blower

Monitoring bearing temperatures along with our newly implemented vibration program has helped immensely by reducing unscheduled downtime (Figures 3A&B).

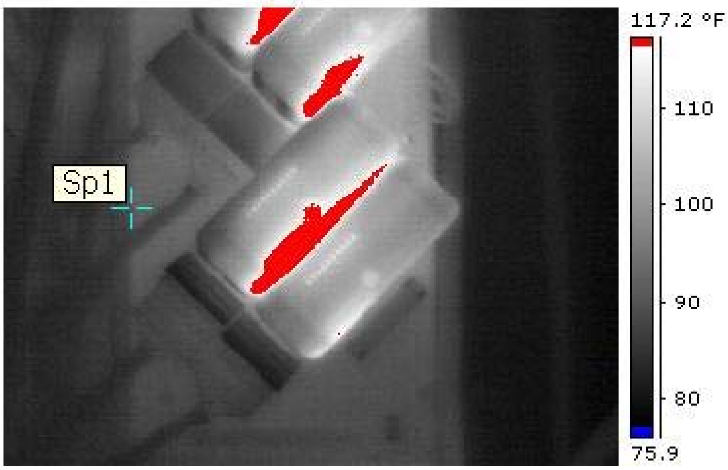

Figure 4. H1 cards on our digital control system

We have started monitoring the H1 cards on our digital control system to predict if temperature will let us know when the cards are going to fail. We have not compiled enough data to know the temperature when the cards fail, but we will have this soon. New cards do not show signs of excessive heat like the card shown above. We will monitor these and watch for a rise in temperature (Figure 4).

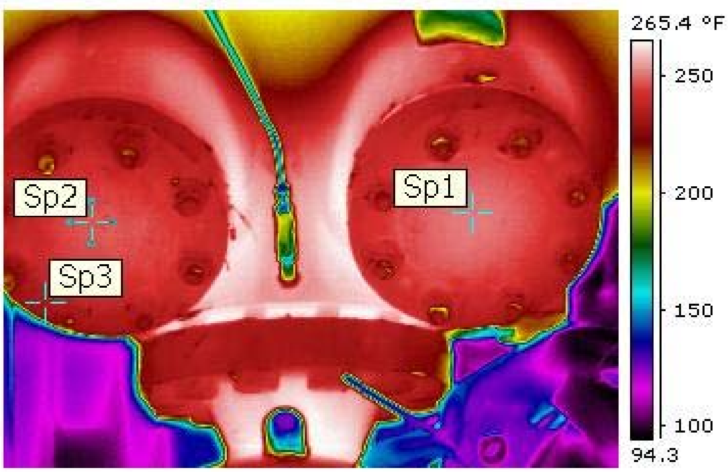

Figure 5: Compressor valves

Figure 5 is an infrared image of valves on our large compressors used for processing gas at our plant. We use the IR camera to monitor temperature changes between the valves. When there is a 10°F temperature difference or more, experience has shown us that the internal valves are letting gas flow back through, which causes overheating. The valve is then replaced prior to failure, thus eliminating costly unscheduled downtime.

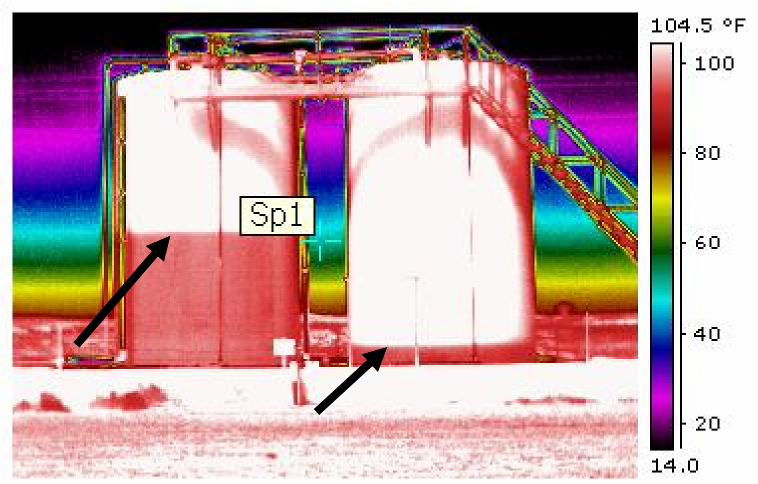

Figure 6: Condensate tank levels

Figure 6 depicts condensate tanks that need their levels checked to prevent overflow and spillage, as this would require contacting environmental agencies and possible fines. This particular tank's level indicator was not working and showed a 2-foot level. We were able to scan the tank and correct the problem with the level indicator prior to any environmental impact.

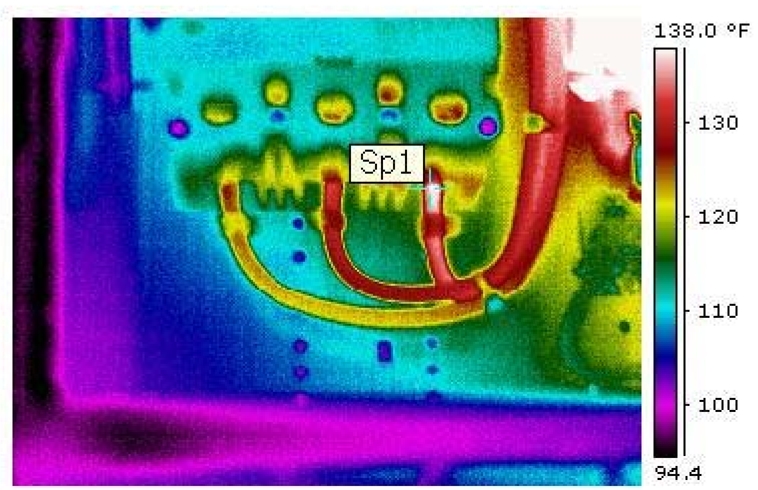

Figure 7: Electrical connection heating

Figure 7 shows electrical connections for our main boiler feedwater pump. The amperage was high and on further examination it was discovered there were loose connections and overheating in the electrical bucket in the main motor control center. The connections were tightened and the problem was corrected.

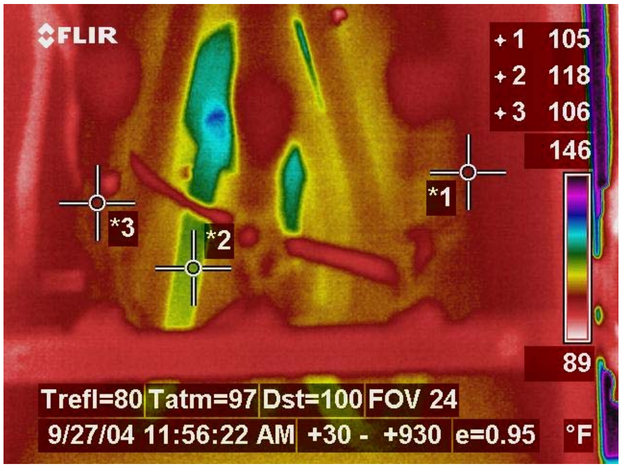

Figure 8A. IR scan of loose high-voltage terminations

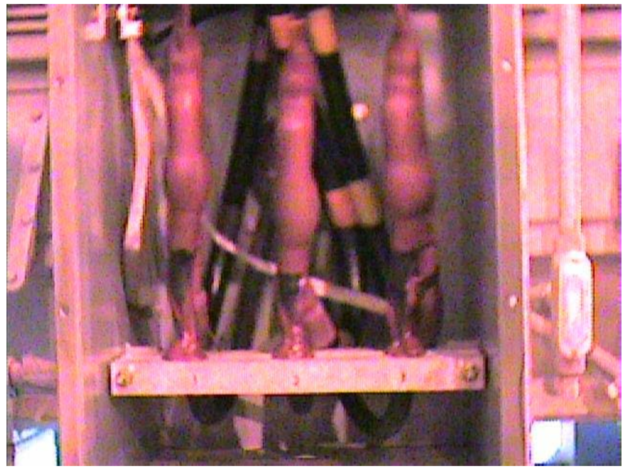

Figure 8B. Digital image of same terminations

Figures 8A and 8B show infrared and digital pictures of the leads on one of our compressors. The compressor was tripping offline due to over-current. We located the hot leads in the motor termination box and discovered that the terminations were loose on two phases. We re-terminated the problem leads and the amperage returned to normal for what the full load current should have been.

SUMMARY

The use of the FLIR infrared camera and IR thermal imaging technology has been a great asset to our company and will continue to be so in the future. We are constantly finding new uses for this technology and expanding from plant usage, into field and production facility applications.

We are continually upgrading and setting up our equipment to optimize our scans, such as painting surfaces (that we scan frequently). Flat black paint is used so we have a consistent emissivity and don't have to worry about different operators using the wrong settings. We now have a Level II Thermographer and two Level I Thermographers on staff. The program will continue to improve as our experience does, and it has already saved Burlington Resources millions of dollars.

ACKNOWLEDGEMENTS

Special thanks need to go to Brent Lohnes, our Plant Manager for having the foresight and past experience with IR technology to realize what a great asset it would be for our plant. Special thanks to Elizabeth Whitmore who provided assistance with the PowerPoint and the Word presentation. I would like to extend a special thanks to Dr. Bob Madding and all the fine instructors at FLIR for their tutelage, without which I would not have been able to take these great images nor decipher them.