

CASE STUDY

USING NEAR INFRARED THERMAL IMAGING BORESCOPE TO OPTIMISE PRODUCTION AND QUALITY FROM OXY-GAS BOROSILICATE FURNACE

INTRODUCTION

SGD Pharma, a global leader in glass pharmaceutical packaging, chose AMETEK Land's Near Infrared Borescope (NIR-B-656-GLASS) in-furnace thermal imaging system to replace its existing CCTV system and to optimise the production and quality of borosilicate glass from its newly rebuilt 50tpd oxy-gas furnace at its plant in St Quentin Lamotte, France.



ABOUT SGD PHARMA

SGD Pharma produces over 8 million vials and bottles per day at its five manufacturing plants in Europe and Asia. The company operates to the highest quality standards in line with ISO 15378 (Good Manufacturing Practices for primary packaging) certification, has a continuous

improvement culture and performs regular quality reviews using data analysis to define a quality roadmap. Each year the company sets targets to drive regular improvement of quality year-on-year, and part of this involves implementing technologies to increase process robustness.

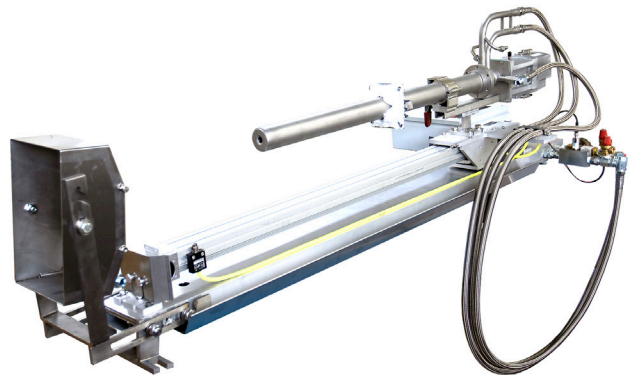
THE CHALLENGE

In the past, obtaining clear images from SGD Pharma's oxy borosilicate glass furnace from the CCTV system was challenging due to the highly aggressive furnace atmosphere. In such harsh environments, this often resulted in blurry images and inconsistent and inaccurate measurements.

As part of rebuilding the furnace, SGD Pharma wanted to progress from monitoring visual images to monitoring thermal images to ensure consistent temperatures and thermal profiles in their glass melt tank to help improve the overall efficiency of the process, maintain high-quality glass production and extend the furnace's campaign life.

"WE ARE VERY PLEASED WITH THE RESULTS WE HAVE ACHIEVED SO FAR FROM AMETEK LAND'S NEAR INFRARED BORESCOPE AS IT HAS ALLOWED US TO IMPROVE RESPONSE TIMES, IDENTIFY AND TROUBLESHOOT FURNACE OPERATIONS TO ACHIEVE IMPROVED YIELD AND HIGHER PULL, AS WELL AS LOWER SPECIFIC ENERGY USAGE. WE EXPECT THIS WILL MEAN HIGH COST AND EFFICIENCY SAVINGS OVER THE LIFETIME OF THE FURNACE."

Francois Deblock
Glass Melting Director,
SGD Pharma



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Accurate and repeatable temperature measurement is essential for efficient control and optimisation of glass manufacture and processing. This is even more important within an oxy-gas furnace where the flame's temperature is significantly hotter. Actual temperature measurements were typically only performed at critical locations, using thermocouples embedded in the walls or intermittently using a handheld portable infrared (IR) pyrometer.

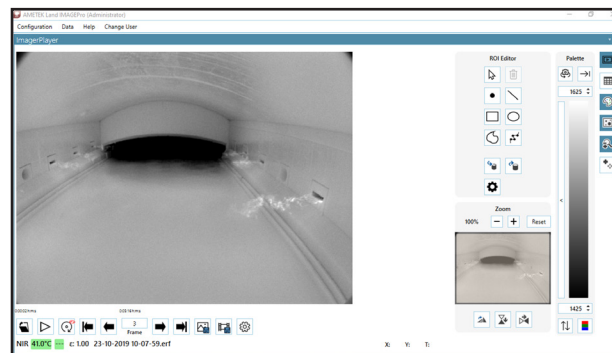
A key objective of SGD Pharma was to obtain clear, high-resolution images to monitor batch line/flow and improve the setup of the batch line. There is also an inherent risk of damage to burner blocks in oxy-gas furnaces when borate condensate/ rundown can deflect the flame and potentially damage the burner block, therefore monitoring hot spots and burners was also critical.

THE SOLUTION

AMETEK Land's Near Infrared Borescope (NIR-B) in-furnace thermal imaging solution provides SGD Pharma with a true-temperature radiometric image, so live continuous temperature values can be



Black and white NIR-B thermal image.



Lower Temp Band 200°C Greater Resolution shows rundown on L4 batch line is skewed and longer on LHS

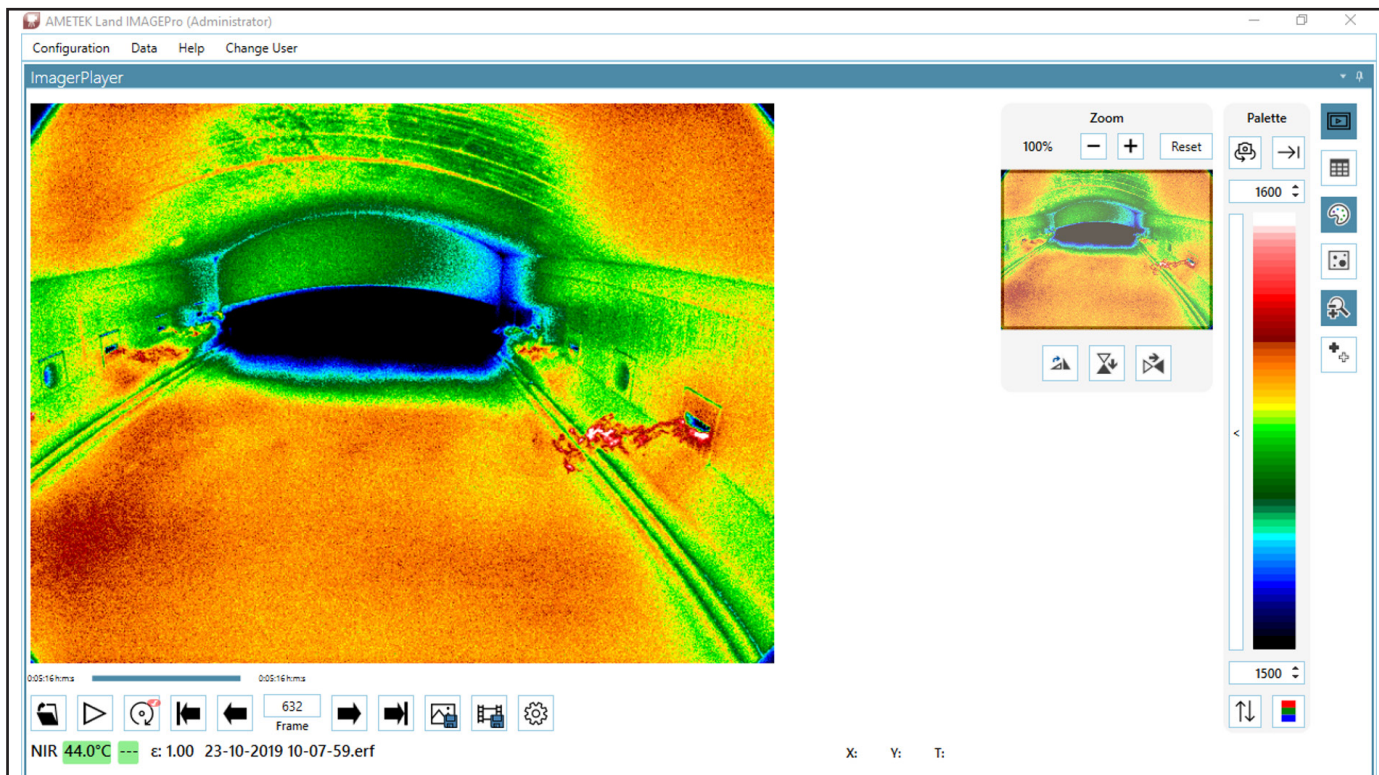
obtained 24/7 of the glass melt tank. The thermal images are an equivalent of 320,000 temperature data points which can be used to optimise the furnace and validate CFD models. Plus, it delivers a clear image due to the high quality of the purge applied on the lens and gives the operator the same views as their previous CCTV system.

Utilising the new IMAGEPro advanced thermal imaging software, it is possible to measure the temperature of the melt line, plus the batch coverage and batch transit time for recording and comparison.

The NIR-B-656-GLASS was installed above the throat in the furnace's centre line to provide a good view of the refractories, including crown, sidewalls, burner



NIR-B Glass inserted through the furnace wall



Colour NIR-B thermal image

blocks and batch line. Dedicated infrared shields protect the NIR-B's retraction mechanism against the infrared radiation coming from the hole camera block and the glass working zones around the instruments.

Since there are no regenerators with a reversal, the solution allows long term data trending for flames optimisation, plus enables thermal optical profiles to be measured continuously, ideal for oxy-gas borosilicate furnaces with continuous operation.

Isotherms provided by the NIR-B-656-GLASS are highlighted to show cold and hot locations. Alarms and temperature isotherms also provide SGD Pharma with long-term asset protection against over-heating and condensation zones.

On the firing side, burners block cleaning and inspection will be shown as the flame risk of impact on refractories. Utilising the over-temp alarm function can monitor hot spots and burner. Setting minimum or maximum temperatures triggers an alarm, and then a snapshot is taken of the whole image and stored for future analysis. An area function

of the software enables multiple areas to be configured. Examples could include the crown, port target wall, tuck stones, breast walls, and skew line.

THE BENEFITS

The most important benefit of the NIR-B-656-GLASS to SGD Pharma is obtaining a furnace thermal profile continuously in the oxy-gas furnace and confirming the hot spot locations are well aligned with the furnace design and batch line. A thermal profile is obtained continuously by drawing profile lines at desired points such as crown and/or skew. This is in marked contrast to previous manual measurement methods or through the thermocouples that can be checked and verified with the virtual thermocouples provided by the NIR-B-656-GLASS.

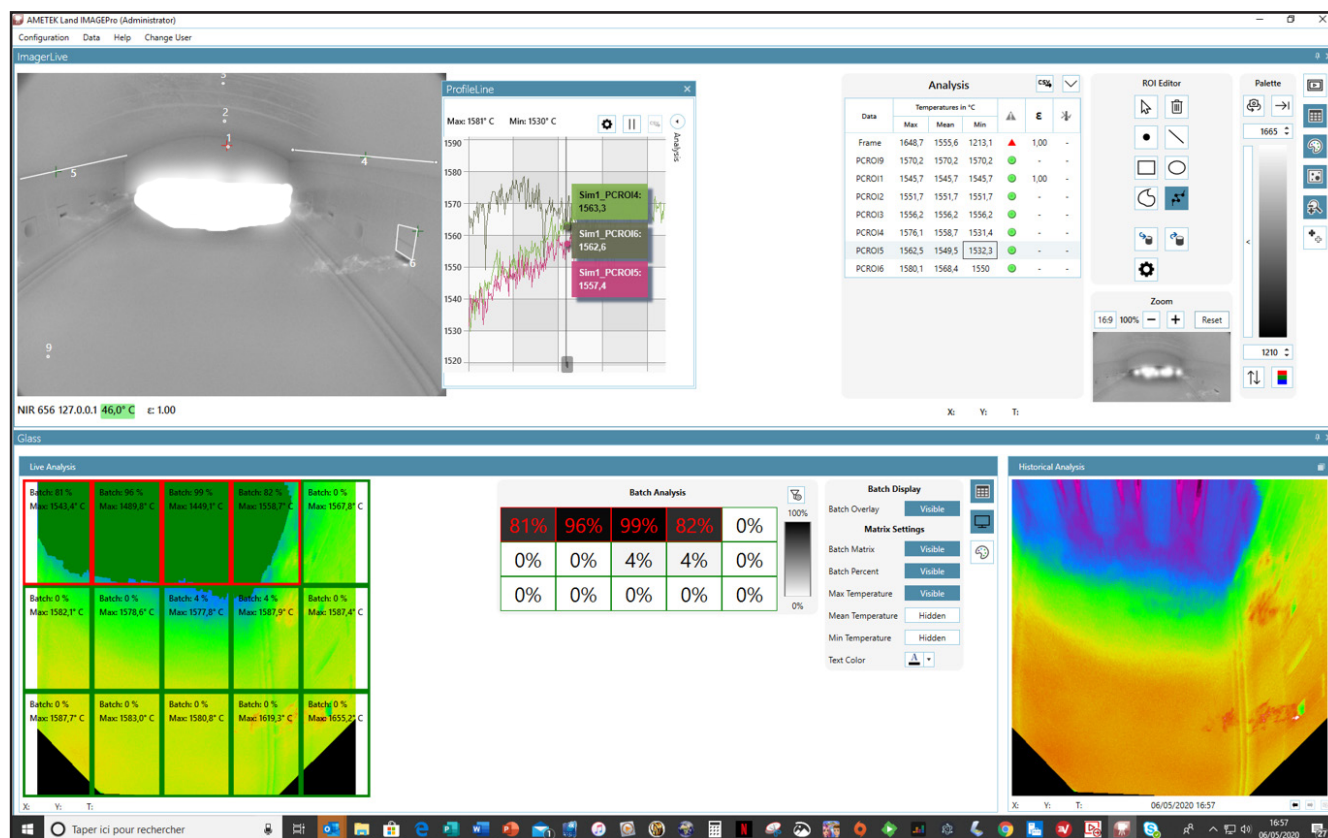
Additional benefits of using the NIR-B-656-GLASS for daily operation in an oxy-gas furnace include:

- Thermocouple verification
- Air ingress and batch control
- Combustion optimisation for energy efficiency
- Emission optimisation
- Same views as a conventional CCTV system

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KEY FEATURES

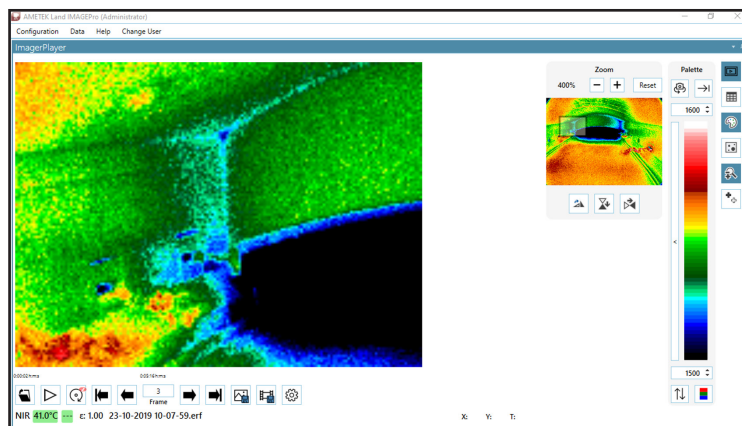
Batch Line Location - Batch flows are initially impacted by the charging control and potentially the flames. However, the flow patterns are driven by the thermal flows/convection currents. SGD Pharma uses the IMAGEPro software that provides batch coverage data based on a grid with rows and columns for better batch tracking. Since the image is based on thermal data, SGD Pharma can add areas and apply alarms if the cold batch reaches a certain point. Whenever an alarm is triggered, the image is recorded for QA and troubleshooting purposes. Utilising a specific thermal palette and adjusting the temperature bands can identify which flames and which blocks are the most intense or hottest, generating the best suitable flames pattern and heat transfers.



Batch line location and thermal profiling with IMAGEPro

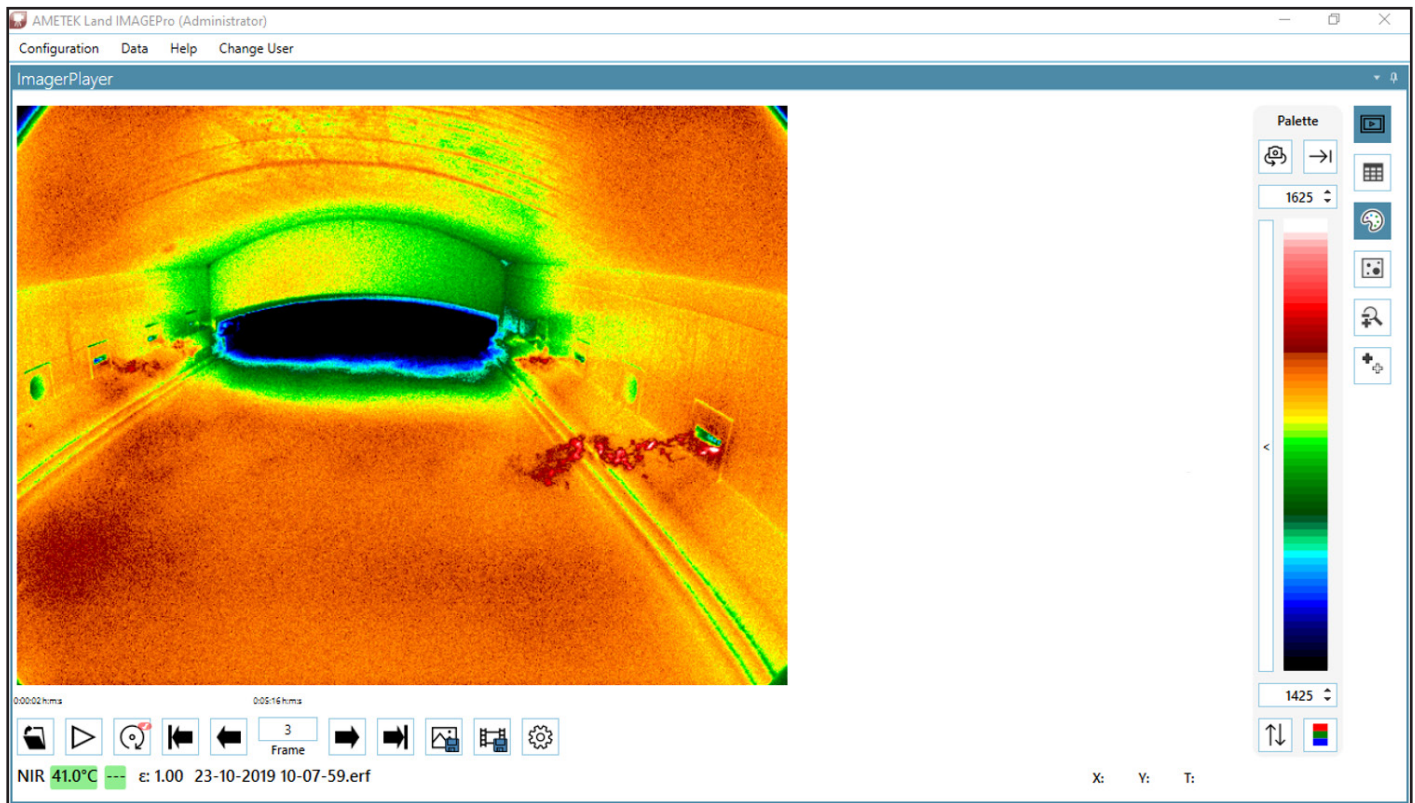
Isotherms for Hot and Cold Spot Locations

- From an asset protection perspective, one of the most important analytical tools is the negative image which can be instantly displayed. This function shows SGD Pharma the areas with the greatest cooling. Utilising the up to 400x zoom function, the NIR-B-656-GLASS can accurately determine the relative location of a small hole and assist in determining the absolute location. It can also identify the over-cooling of the metal line, leading to increased wear due to the Marangoni effect and cold batch piles scraping along the furnace length.



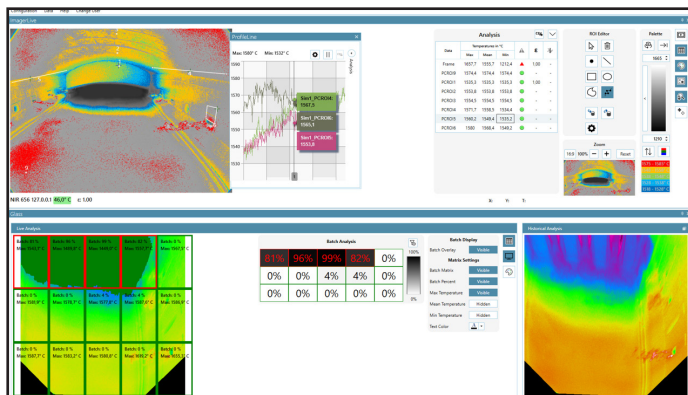
Batch line location and thermal profiling with IMAGEPro

Data Interpretation - One of the challenges of the NIR-B-656-GLASS system is the massive amount of data captured and how it should best be interpreted. Whilst it is suggested that SGD Pharma operators use some of the functions in real-time, other functions are better suited to off-line analysis by the batch and furnace managers. It is suggested that every day at some given times, snapshot images are taken of the furnace. By storing this data, it is possible to compare with data captured 24 hours, one week, one month, three months, six months, and 12 months previously to see short-term problems and long-term changes in the asset. With this data, it is possible to have a long-term preventative maintenance schedule but, more importantly, a short-term reaction.

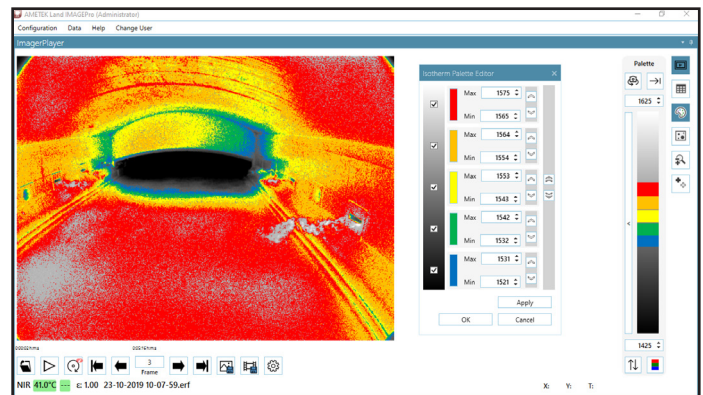


Rainbow Palette RHS glass flow hotter than LHS cold spot in the crown skew corner – cold spots on tuck stone joints

Isotherms for Hot and Cold Spot Locations - By utilising a specific thermal palette and adjusting the temperature bands, SGD Pharma can identify refractory temperature and see which flames and blocks are the most intense or hottest, and generating the best flames patterns and heat transfers.

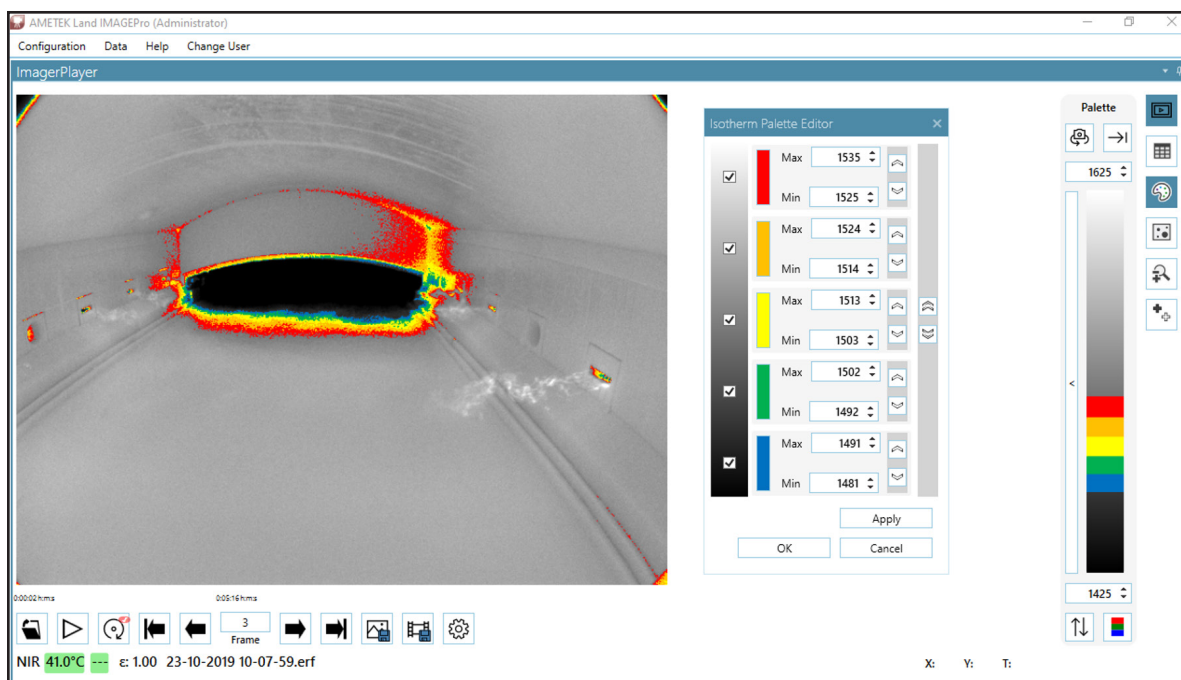


B&W Plus Isotherms Shows RHS Hotter Possible crown overheating above R2



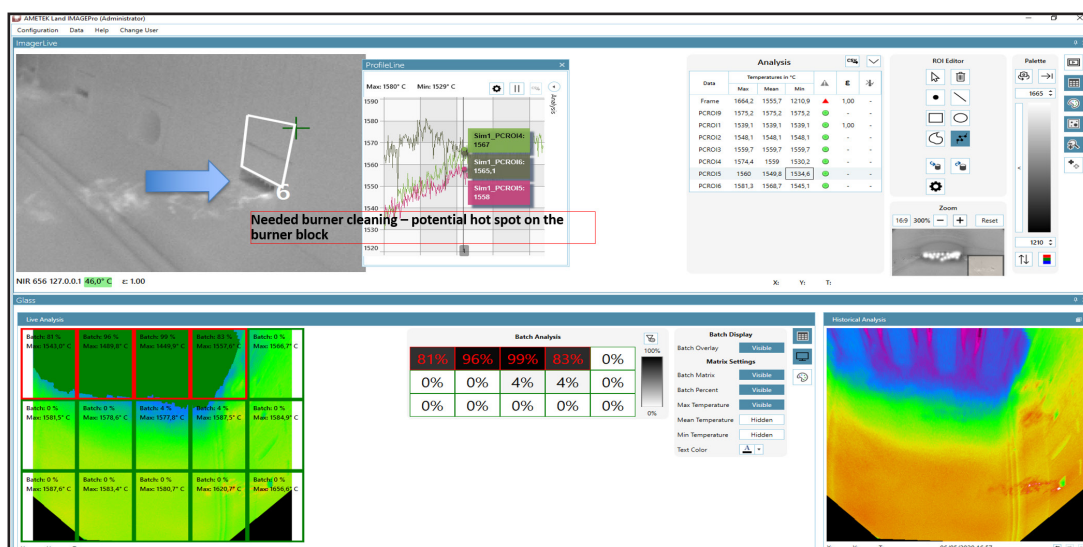
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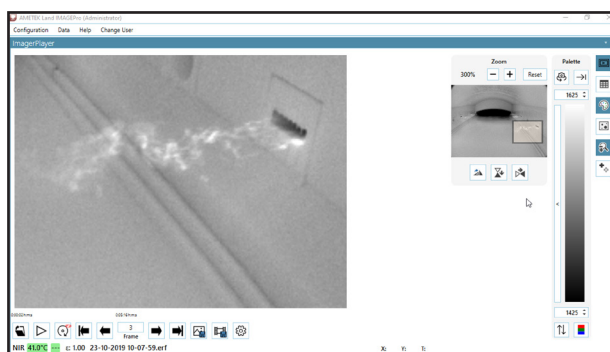


Refractory cold spots.

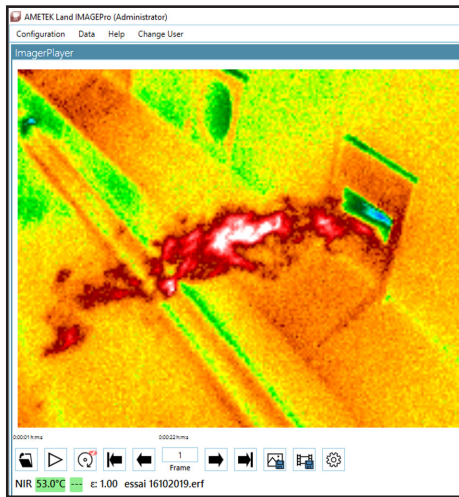
Burner Block Inspection – Using NIR-B-656-GLASS zoom functionality, SGD Pharma can identify potential refractory damages, especially on burner blocks and then take action to clean or repair.



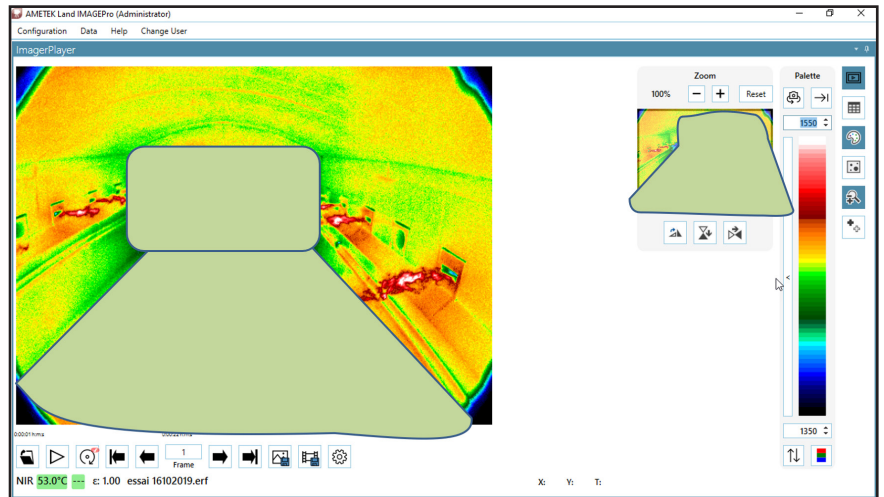
L4 Block 300% Zoom. Last frame – hottest part always on L4 Block! Continued operation will most likely see damage to L4 Block on the bottom downstream corner.



Furnace Heat-up - During heat up, SGD Pharma can review the expansion and gain reference images of the melt tank before and during filling.



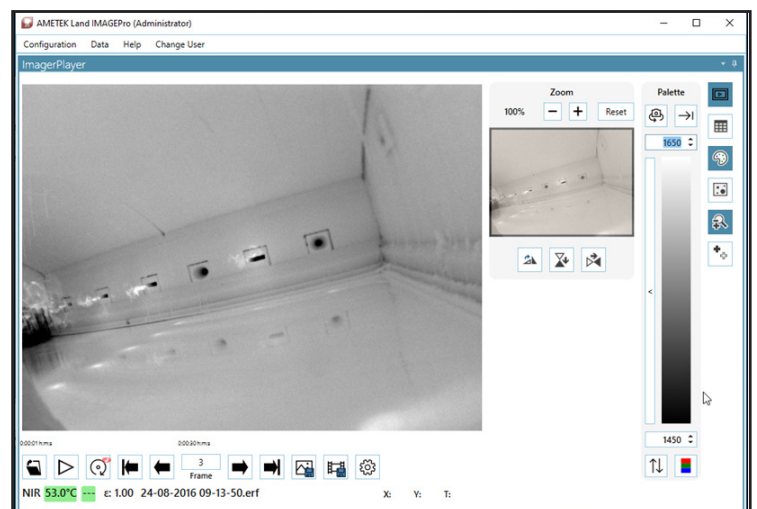
Heat-up fill showing early damage on L4.



Furnace heat-up start of fill.

Survey Mode from Existing Peep-Holes - A thermal survey, using a transportable NIR-B-656-GLASS, was used to explore other locations in the furnace. Using available peepholes, snapshots of the refractories and many other details are revealed on flames, batch pattern, electrical boosters, and glass temperatures.

DCS Integration - At this stage, SGD Pharma does not require direct data exchange for thermal zones of interest to the DCS (Digital Control System) of the furnace neither to an expert system for optimisation. The NIR-B can collect all the temperature data based on the 100 zones of interest and send all the data to any DCS or Expert Systems; this is a potential future option for SGD Pharma to implement and develop controls to meet the needs of industry 4.0.



Survey mode with Transportable NIR-B through one existing peep-hole.

CONCLUSION

Francois Deblock, Glass Melting Director of SGD Pharma said: *"We are very pleased with the results we have achieved so far from AMETEK Land's Near Infrared Borescope as it has allowed us to improve response times, identify and troubleshoot furnace operations to achieve improved yield and higher pull, as well as lower specific energy usage. We expect this will mean high cost and efficiency savings over the lifetime of the furnace."*

The use of AMETEK Land's NIR-B-656-GLASS can result in increased asset life for furnaces and potentially achieve future energy optimisation and cost reductions. What can clearly be seen is that temperature measurement at critical locations in SGD Pharma's production process is essential for efficient control and optimisation of the glass melt process – and today, the technology to enable glass producers to do this is better than ever.

SPECIFICATIONS

NIR-B-656-GLASS CAMERA UNIT

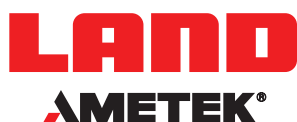
Measurement Range:	600 - 1000 °C / 1112 - 1832 °F 800 - 1400 °C / 1472 - 2552 °F 1000 - 1800 °C / 1832 - 3272 °F
Spectral Response:	0.78 to 1.1 µm
Frame Rate:	30 fps (Gigabit Ethernet)
Image Pixels:	656 x 494
Accuracy:	1%
Sealing:	IP65 / NEMA 4
Repeatability:	1 °C
Data Out:	Digital data over Gigabit Ethernet
Software:	Complete Land Image Processing Software (LIPS) package for Windows
Standard Accessories:	Power supply, cables, software, close up lenses, water cooled/purged mounting and tube
Field of View (Horizontal x Vertical):	44° x 33° or 90° x 67.5°
Instantaneous Field of View:	1.2 mrad (44°) / 2.4 mrad (90°)
Focus Range:	1000 mm to infinity
Probe Length:	305, 610 or 915 mm (12", 24" or 36")
Probe Diameter:	61 mm (2.4")
Mountings:	Choice of 3" ANSI 150 RF Flange & Gasket or PN16 DN80 Flange & Gasket with a 12" standpipe
Dimensions:	254 x 560 x 810 mm* (* or 1120 or 1420 mm) 10" x 22" x 32" ** (** or 44" or 56")
Power Rating:	24 V dc, 3 watts
Weight:	15 kg (for 24" variant)

POWER SUPPLY UNIT (PSU)

Components & Connections:	Power supply, Ethernet communications (switch), Fibre optic data connection (option)
IP Rating:	IP65 / NEMA 4
Size:	380 x 380 x 211 mm / 15" x 15" x 8.3"
Weight:	15 kg (33.07 lbs)
UL Approval:	Listed to UL508A & CSA-C22.2 No. File Number E499440

ELECTRICAL AUTO-RETRACT (AR) SYSTEM

Dimensions (Auto-Retract Mechanism & Borescope):	486 x 709 x 1900 mm/ 19 x 28 x 75 in
Weight (Auto-Retract Mechanism & Borescope):	95 kg / 223 lb
Dimensions (Control Box):	730 x 530 x 277 mm/ 30 x 22 x 11.5 in
Weight (Control Box):	28 kg / 61.7 lb



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