

Case study

Verifying washcoat application efficiency with visual inspection

coating process

Company profile

Industry

Global leader in sustainable technologies, specializing in catalysis, precious metals, fine chemicals, and process technology.

Product portfolio

The company's offerings span clean air solutions, efficient natural resource catalysts, pharmaceutical ingredients, battery materials, hydrogen technologies, chemical catalysts, precious metal recycling, and sustainable technologies.

Location

Global with 30+ sites worldwide.

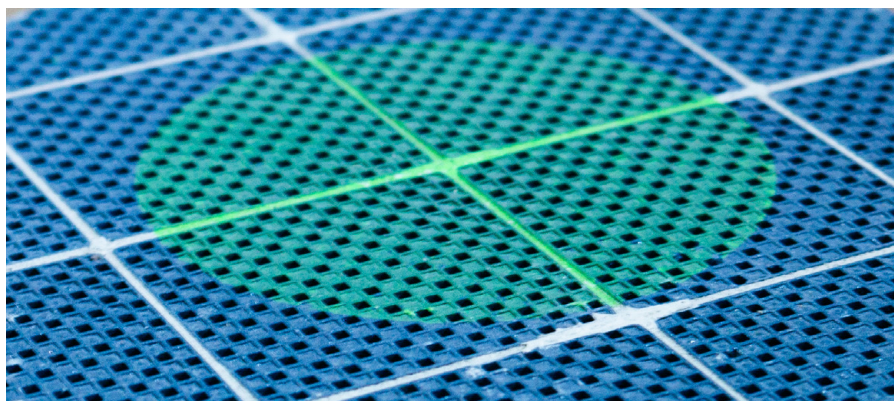
"With inSpect, we detect even the slightest deviations in coating process, preventing any impact on catalytic performance or unnecessary material waste."

- Lead Quality Engineer,
Emission Control Technologies

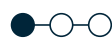
The implementation of an advanced in-line inspection system enables 100% substrate inspection, ensuring top-tier quality for Catalytic Converters (CATs) and Diesel Particulate Filters (DPFs).

The application of washcoat in catalytic converters, involving costly materials like precious metals, requires precise control to optimize efficiency and minimize waste. Any inconsistency in application can degrade CAT/DPF performance and compromise emissions compliance. To meet the stringent quality demands, coating specialists must ensure flawless washcoat deposition.

By integrating state-of-the-art industrial vision systems, the customer optimized the coating process for CATs/DPFs and ensured precise detection of optical leaks in DPFs. This non-destructive quality control solution enhances product integrity, minimizes scrap, and guarantees compliance with stringent environmental standards, all while accommodating various substrate geometries and sizes within a rapid cycle time of up to 2 seconds per part.



Challenge



The customer required an output control system capable of 100% quality assessment for all substrates, ensuring precise detection of coating integrity in CATs and identifying any defects leading to optical leaks in DPFs.

Given the high cost of washcoat containing precious metals in CATs, the customer required robust process management to optimize dosing consumption and efficiency, thereby minimizing scrap. The solution needed to accurately detect coating anomalies.

Key features



Speed and precision

To prevent bottlenecks, inspection is completed in mere seconds, requiring accurate, precise, and rapid quality checks. With conveyors operating at 450 mm/s, our system can inspect 160,000 cells per piece within a mere 2.5-second cycle.



Diverse geometries and sizes

Featuring servo-driven components, the system dynamically adjusts to the height of varying substrate dimensions, ensuring thorough inspection coverage across diverse geometries on a single production line.



Non-destructive quality control

By integrating industrial cameras and collimated lighting the quality of the entire batch is now thoroughly assessed without generating any scrap, effectively replacing the outdated practice of destructive testing on sampled portions.

malities, such as lumps, viscosity issues or uneven thickness, that could result in product rejection by their customer or even recalls.

For DPFs, optical leaks were a critical concern, as even a minor leak could allow particles to bypass the filter and enter the atmosphere, rendering the product non-compliant with environmental standards and regulations.

Solution

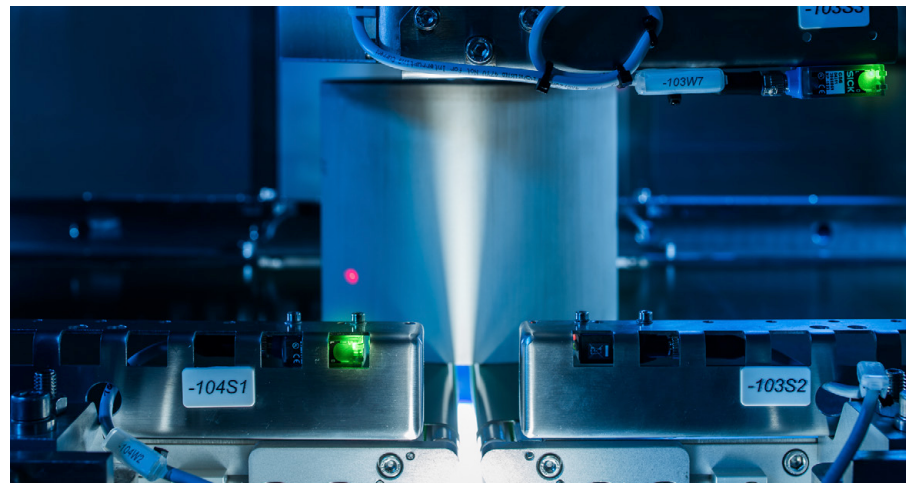


We developed and integrated an advanced end-of-line quality inspection system into the customer's production line for catalytic converters and diesel particulate filters. The system is designed to operate according to a specific recipe per batch, allowing it to automatically adjust settings based on the dimensions of the substrates. An adjustable linear module, equipped with a mounted camera, accommodates varying part heights, ensuring precise inspection across different batches.

To avoid bottlenecking the production line, cycle times needed to be well below three seconds, meaning that the quality checks need to be accurate, precise, and fast.

The solution needed to be integrated into the existing production line which was applied for substrates of different geometries and sizes. It was imperative that the cycle time would not surpass 3 seconds per substrate.

The system leverages advanced specialized technologies designed for 100% in-line, non-destructive inspections. For visual inspection, a 4K/8K industrial line scan camera is used in conjunction with collimated LED backlighting, which optimally illuminates parts from below to detect abnormalities in the washcoat, such as plugged cells in the honeycomb and optical leaks in DPFs.



Machine vision facilitates precise manipulations across different stages of production. Robotic arms, integrated through advanced communication protocols, facilitate gentle and precise handling and positioning of substrates across different production stages, minimizing the risk of damage.

Infeed and outfeed conveyors operate at high speeds, maintaining efficiency without disrupting production cycle times. Position-

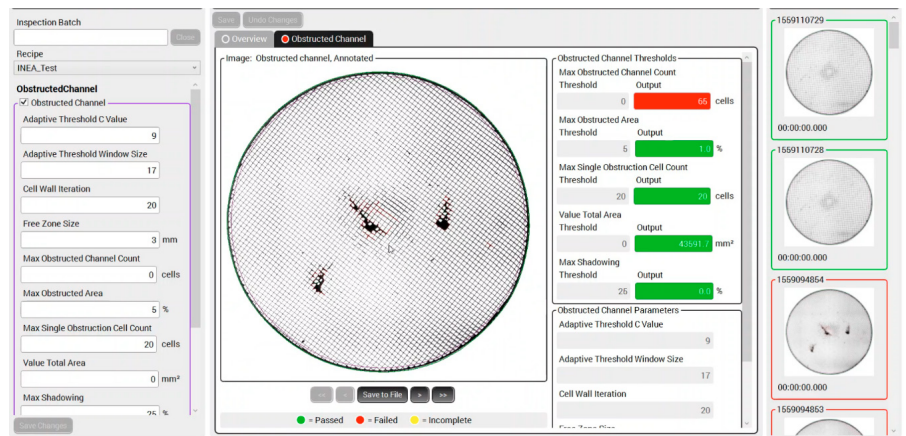
ing registration sensors provide accurate detection of substrate location and dimensions, enabling the system to handle various product geometries on a single production line.

After image acquisition, sophisticated image processing software analyses and detects anomalies directly on the coating line. The analysis leverages sophisticated algorithms designed to detect deviations from

predefined criteria based on variations in light transmission or reflection, identifying any irregularities within the structure.

As the individual substrates proceed through the inSpect module, the inSpect system finalized the analysis and communicates the pass or fail status to the system and the diverter accurately sorts the substrate to the pass or fail line.

The entire inspection process, including data acquisition, analysis, raw data storage, and communication, is completed within the customer-specified cycle time of 2.5 seconds per part. Despite the high throughput, the system ensures that all operations are finalized before the next part arrives.



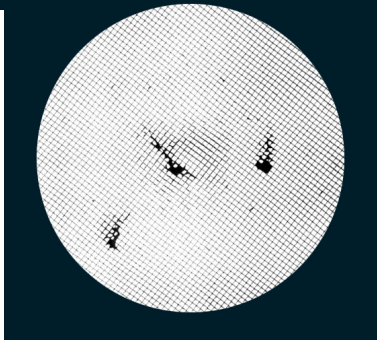
All inspection data, including images and parameters, are systematically stored, with automated reports generated to streamline documentation and quality assurance process. Fully integrated with the SCADA and MES system, the inSpect for CATs/DPFs

offers comprehensive control of both the inspection process and peripheral devices. The vision software interface is designed for user-friendly setup, enabling straightforward integration and reducing downtime during installation and commissioning.

"inSpect's real-time feedback enables us to continuously fine-tune the washcoat dosing process, ensuring uniform catalytic layer application, especially when working with expensive washcoat formulations."

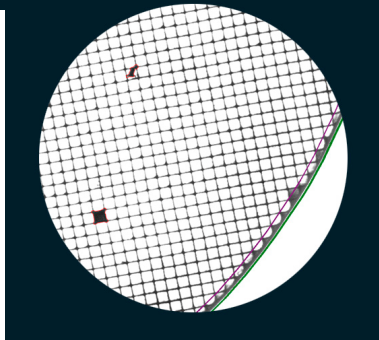
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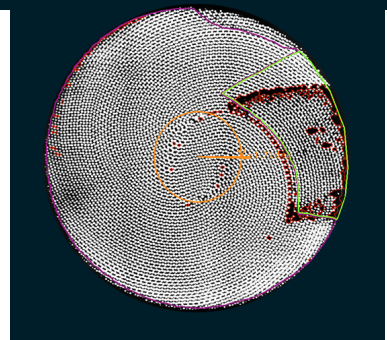
Line scan camera and collimated LED backlight

The catalytic honeycomb is inspected using high-resolution line scan cameras in conjunction with a strategically positioned LED backlight, enhanced by collimated optics to highlight cell details and detect even minor defects. The honeycomb is illuminated from below, allowing the line scan camera, equipped with telecentric optics, to capture detailed images at a resolution of 16K pixel cells. While area scan cameras are often employed for quality assessments, line scan cameras offer a more compact design, enabling seamless integration into production lines without compromising image quality.



Advanced image processing algorithms

After image acquisition, analysis and detection of anomalies are executed with image processing directly on the line. Accounting for variations in light transmission or reflection, inSpect pinpoints irregularities within the structure according to set parameters, achieving up to 3% at 300 plugged cells resolution in cell surface blockage detection for substrates with densities up to 1200 cells per square inch.



Multiple region control algorithm

The multiple region control algorithm detects obstructed channels in multiple regions of substrates, even with sensor hole cutouts. Leveraging AI technology, the algorithm accurately determines the part's orientation and positions masks to inspect different regions with tailored parameters, while excluding zones where inspection is not feasible. This advanced masking technique allows separate inspection of regions without any loss in processing time.

Results



By implementing automated in-line quality assessment with advanced industrial vision technology, the customer optimized their process management, improving dosing accuracy and efficiency while minimizing scrap. The system ensured strict adherence to environmental standards, provided efficient result auditing, and enabled

real-time rejection of defective components, all within the required 3-second cycle time per substrate. This automation also eliminated human variability, resulting in more precise and consistent quality control.

100%

products inspected

All substrates undergo full in-line inspection, ensuring complete quality control and adherence to stringent production standards.

60%

decrease in rejected products

The system has significantly reduced product rejections, enhancing overall production efficiency and reducing waste.

67%

operator time saved per production line

Enhanced resource utilization and efficiency reduced the number of operators per line, enabling more effective workforce allocation.

100%

pass rate in audits by customers

The inspection system has led to flawless audit performance, meeting the exacting requirements of automotive clients.