From the site of 300 billion yen in investment

A Central Hub for Mass Production of NOx Sensor Core Technology

Ishikawa Plant, NGK Ceramic Device

The NGK Group is currently working on enhancing the production capacity of its state-of-the-art NGK Ceramic Device Ishikawa Plant (referred to hereinafter as the NCDK Ishikawa Plant). The plant, which manufactures the ceramic elements that represent the core technology of NOx (nitrogen oxide) sensors, went on line in April 2017 and is currently being ramped up to its maximum production capacity. Last year the NGK Group began implementation of a planned 300 billion yen in capital investment over three years, and the NCDK Ishikawa Plant is a key, early priority of this plan.

Manufacturing state-of-the-art ceramics via an automated production process

The NCDK Ishikawa Plant occupies 32,100 m^2. It is comprised of two buildings: a Tape Building and an Element Building. The plant manufactures ceramic elements (shown at right) which detect NOx concentration in automobile exhaust. A ceramic material primarily comprised of zirconia is created into long thin rods by bake-hardening, and then equipped with multiple exhaust-absorbing cavities and various electrodes. Voltage is applied to the electrodes to break the NOx into N_2 and O_2, and the oxygen concentration is then

Ishikawa Plant, NGK Ceramic Device

The mostly automated printing process forms the electrodes and insulators

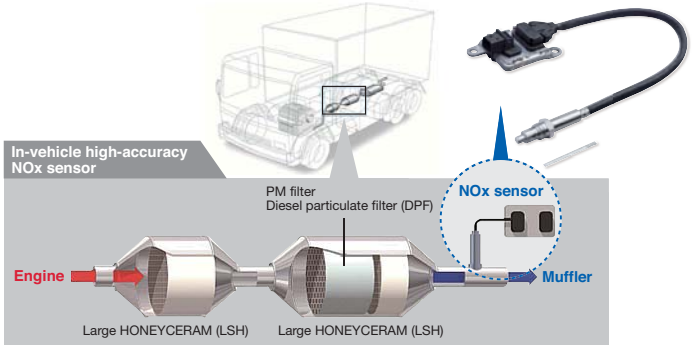
measured according to the principles used for oxygen sensors, thus allowing the volume of NOx in exhaust to be ascertained in real time.

Element production begins by stretching out a zirconia slurry into tape form. This is done in the Tape Building. A multitude of automated production machines work to produce this zirconia tape. Each part of this process requires an advanced level of expertise in order to ensure uniform thickness is achieved.

The finished tape is then sent to the Element Building where it undergoes a printing process which incorporates electrodes and insulators onto its surface. This process is also automated. Given the sheer number of times the electrode-forming paste must be printed onto the tape and dried, such automation is of great benefit as it enables a higher level of productivity.

Next, a laminating process is performed to create the element shape. This is done by layering and pressing the tape. Due to the thin, pliable nature of the tape, and the fact that even the slightest misalignment is unacceptable, this is an extremely difficult process.

After this is done, the laminated sheet is cut and fired at least 1,000°C, its electrical characteristics and other properties are checked, and then it is packaged up and sent to another plant where assembly is performed to create the finished product.



Kilns for high-temperature firing of ceramic laminates

Careful inspection prior to firing

Addressing the need for personnel and creating leaders from locally hired employees

Plant Manager, NGK Ceramic Device Ishikawa Plant **Kazuhiro Hasegawa**

The biggest difference between the NCDK Ishikawa Plant and conventional plants is the degree to which we incorporate automation. By introducing state-of-the-art automation equipment, we are able to achieve vastly improved productivity with high cost efficiency.

Our biggest struggle thus far has been with time constraints. In order to ensure the plant went on line by the scheduled date, members from engineering departments, quality assurance departments, and other departments met together daily for regular meetings and, somehow, we all managed to fulfill the plan without any delays.

Also, as we were completely unfamiliar with this area, we reached out to the local residents and government to engage in real communication that helped us integrate the Ishikawa Plant into the community. The plant is situated within a rural environment, so any discoloration in our wastewater or change in a nearby spring would be immediately noticeable. This keeps us particularly attentive to the environmental aspects of the plant.

Our primary goal is establishing mass production and supply stability. The idea from day one has been for the NCDK Komaki Plant, which is situated close to the head office in Nagoya, to serve as a research and development hub, while the NCDK Ishikawa Plant serves as a BCP (business continuity planning) and

production hub. We plan to more than double our current production volume to overtake the Komaki Plant in 2019, becoming the largest mass-production site for elements.

The biggest challenge we face in achieving this is securing the necessary personnel. Thus far we have been proceeding according to schedule; however, we will need to double our current number of employees if we are going to take the plant to full operation. We are considering a number of options, including financially compensating employees who commute via the expressway, providing support with accommodations, expanding the size of our recruitment area, and even outsourcing some processes to contractors.

My hope is that, in time, we will be able to run the plant with locally recruited personnel. We will choose 15 members out of the initial hiring group and carefully train and equip them with the expertise to make ceramic electrode components as well as provide them with a deep understanding about the manufacturing process. Once they have this, we will work on training them as leaders who can steadily rise up through management. I can envision all of this taking about 10 years to achieve.

Talking with Key Team Members

Ishikawa Plant

Growing production capacity and reaching even higher levels of productivity

I was assigned to the Ishikawa Plant when it was built in July 2016. I have had a hand in everything from starting up production equipment to overseeing mass production operations and handling quality-related issues. From the planning phase to the design and selection of equipment, as well as contributing to decisions about machinery numbers and installation, I have an intimate knowledge of the entire Ishikawa Plant.

As we are a fully integrated production plant for ceramic elements, my focus has been on tailoring the floor layout and production flow to optimize element production. For example, I have sought to increase productivity by taking three processes that have traditionally been distinct from one another and combining them into one.

Start-up was a challenge due to the particularly tight time frame we had to work with. We had very little time from when the building went up until when we had to start manufacturing elements. All of the arrangements associated with the equipment and facilities kept me racing against the clock as I hurried to coordinate the installation of machinery and perform countless other tasks within the short deadlines provided.

Now I am helping with the additional investments that are being made into the plant. My current goal is to enable the Ishikawa Plant to handle greater production volume and achieve even higher levels of productivity. By the time we begin our expanded production in January 2019, I want to see the same buildings housing even more equipment, which all run smoothly.

Element Engineering Group Ishikawa Team,
Process Engineering Department,
Sensor Division, NGK Insulators

Kota Iwasawa

Improving product quality through the work I do

I grew up in Ishikawa, went to university in Ishikawa, and now I am employed at the Ishikawa Plant. I joined the company in the spring of 2017 and, since October, have been responsible for analysis operations. My job is to check product quality by examining cross-sections of element test products under a microscope.

I use a digital microscope which allows me to enlarge and examine the internal structure of elements. Sometimes I also use an electron microscope. Through experience, I am learning more and more about this internal structure.

I get a great sense of satisfaction from the fact that I am improving product quality through my work.

I am keen to think up new analysis approaches and, in time, handle the same quality control duties as the senior analysts in my group.

Product Quality Management Group,
Ishikawa Plant
Sensor Element Manufacturing Department,
NGK Ceramic Device

Hajime Yoshida