Preface to Special Issue "Industrial Machinery"

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1. Introduction

Starting in the 18th century in Great Britain, the Industrial Revolution has transformed how people live and society as a whole, and is the foundation on which today's economic growth is built. The Industrial Revolution brought forth new forms of energy based on coal combustion and steam engines that ran on the same fuel. These innovations led to the development of various mechanical industries as well as distribution networks of railroads and ships, and marked the beginning of large-scale manufacturing. After spreading to parts of Europe, the Industrial Revolution reached Japan where factories were established in various sites, including the Tomioka Silk Mill established in 1872 (now a UNESCO World Heritage Site). These factories accelerated industrial development in Japan.

Shimadzu was founded in Kyoto in the same period in 1875. Since its foundation and thanks to the efforts of notable pioneers, Shimadzu has played an important part in the development of Japanese industry over the past 145 years by consistently delivering groundbreaking and leading-edge products to its customers under a corporate philosophy of "Contributing to Society through Science and Technology."

It has been over 260 years since the Industrial Revolution first began. Given the backdrop of ongoing changes in people's living circumstances, major socioeconomic developments, and a slowly changing global environment, in 2015 the United Nations adopted Sustainable Development Goals (SDGs) aimed at creating a better society where all people can live in dignity. In 2020, Prime Minister Yoshihide Suga also declared that Japan would become a carbon-neutral, decarbonized society by 2050, and Japan commenced efforts to reduce greenhouse gas emissions to net zero levels. These social shifts highlight the importance of moving away from the combustion-based industrial model that has supported us since the industrial revolution, and participating in a new industrial revolution under an industrial model that is not based on combustion. These social shifts also remind us of the impact that Shimadzu can have on the global environment through its efforts to create new technologies and new products.

This special issue of Shimadzu Review presents examples of industrial equipment and products developed by Shimadzu in the context of these major social trends.

2. Vacuum Pumps and Vacuum Systems

The properties of spaces under reduced pressure (vacuums) are very different from those of spaces under atmospheric pressure. The characteristic properties of vacuums have a wide range of industrial applications, from familiar products such as light bulbs and vacuum flasks, to essential technologies such as electron microscopes, particle accelerators, and semiconductor manufacturing.

These articles present two notable products and technologies from Shimadzu related to vacuum technology.

1) A dual-inlet turbomolecular pump developed for mass spectrometers
2) A vacuum oven mass production model with a large processing area and good temperature uniformity, which was developed for food processing applications

3. Industrial Furnaces

Industrial furnaces from Shimadzu Industrial Systems are in widespread use for the sintering of hard metals for cutting tool tips and for the sintering of fine ceramics. There are also an increasing number of industrial applications for additive manufacturing with metal 3D printers, a technology expected to expand to include general industrial applications such as automobiles, robots, and metal

molds. Industrial furnaces made by Shimadzu Industrial Systems are also used in these fields for the sintering of additive manufacturing products.

These articles describe notable industrial furnaces and industrial furnace technologies from Shimadzu Industrial Systems.

1) A sintering furnace with a temperature distribution width during rapid cooling that is just 1/3 the previous model
2) A compact furnace suitable for debinding and sintering additively manufactured parts that offers reduced contamination during debinding, excellent temperature control, and excellent production efficiency
3) Preventive maintenance software that can predict the deterioration of heaters, insulation, and other parts based on trends in data collected by a range of sensors, including the temperature inside the industrial furnace, pressure, electrical power, and cooling water flow rate

4. Gear Pumps for Manufacturing and Gear Pumps for Hydraulics

Shimadzu Group has a long history of producing gear pumps extending around 50 years. Shimadzu pumps are used throughout the world, including large pumps such as polymer gear pumps used to transfer high-viscosity molten polymers at high pressure through pipelines in polymer production plants, and small pumps such as hydraulic pumps used in forklifts and hydraulic systems for vehicles.

These articles describe notable gear pumps used in manufacturing plants and hydraulic packages produced by the Shimadzu Group.

1) SBJ-AA series molten polymer gear pumps offer reduced internal heat generation for control over heat-induced changes to molten polymers, improved production efficiency, and increased reliability
2) A power package with a brushless DC motor that offers excellent noise characteristics, durability, and control characteristics

5. High-Brightness and High-Power Blue Diode Lasers for Metal Processing

In recent years, the increasing power output of infrared lasers has allowed the laser processing of metals to enter a range of markets. There is also an increasing demand for copper material processing.

This article presents Shimadzu's range of blue diode lasers configured for copper material processing along with results from laser processing.

6. Industrial Testing Devices

Advanced measuring technologies are one of Shimadzu's core specialties and are used by many Shimadzu products with industrial applications. Here are presented eight notable examples of these Shimadzu products and technologies.

1) An automatic balancing machine for the smallest and lightest rotating components that weigh just 10 g and for a rotating assembly with an attached power supply harness
2) A highly sensitive leak testing system that addresses the helium supply problem
3) Elevator wire rope inspection technology that reduces workloads and applies the principle of magnetic flux leakage for greater sensitivity and reproducibility
4) A wire rope inspection system for rope production QC that offers high-precision performance and uses a non-contact method to identify internal wire breaks not detected by visual examination
5) An ultrasonic optical flaw detector that employs Shimadzu's unique non-destructive light and ultrasound-based inspection technology and meets a recent demand for increasingly sophisticated and diversified inspection techniques
6) A dimensional computed tomography (CT) system that meets a demand for industrial X-ray CT systems by offering highly accurate three-dimensional coordinate measurements for industrial products with increasingly complex shapes
7) An X-ray inspection system useful for QC in the manufacturing of lightweight die-cast aluminum parts, demand for which has increased with the growth of electric and hybrid vehicles
8) An online pure water TOC analyzer designed to support improved product quality in pharmaceutical production and sophisticated cleaning processes in semiconductor production

7. Conclusions

Technological development that supports the changing industrial model illustrated by Sustainable Development Goals (SDGs) and a carbon-neutral, decarbonized society requires a new perspective distinct from previous approaches, including the fostering of collaborations between companies and technological integration never previously considered. Keeping this in mind, we are committed to the development of new industrial instruments and the deployment of analytical technologies in industrial applications, and hope to make a positive impact on society through the adoption of these technologies by society.