News Release

March 17, 2020
Sanyo Special Steel Co., Ltd.

Superior High-Temperature Strength and High-Temperature Corrosion Resistance

Successful Development of Heat-Resistant Steel for Use in Next Generation Recuperators

-Contributing to reductions in fuel use and CO_2 emissions through optimization of energy consumption in various types of industrial furnaces-

Sanyo Special Steel Co., Ltd. (Representative Director: Higuchi Shinya, Main Office: Himeji) has successfully developed heat-resistant steel for use in next-generation recuperators, meant to help contribute to the optimization of energy consumption through reductions in fuel use and CO_2 emissions at various industrial furnaces.

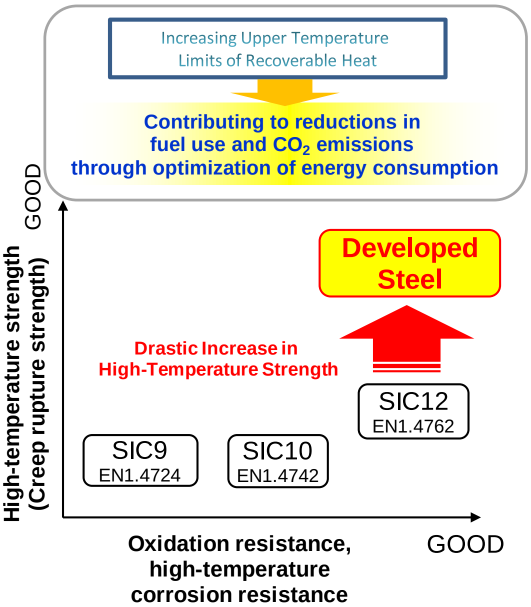
A recuperator is a device that collects wasted heat in order to optimize energy use in various industrial furnaces that utilize fuels such as LNGs. Our company develops, manufactures, and sells the "SIC series" of high chromium ferritic heat-resistant steels (SIC9, SIC10, SIC12) for use in the heat exchanger tubes of such recuperators, and we have established a strong reputation over many years with our customers, particularly heat-recovery device manufacturers, but the heat-resistant steel we recently developed is based off of the "SIC12," which boasts the highest oxidation resistance and high-temperature corrosion resistance of the SIC series, with the new steel exhibiting much higher high-temperature strength than the "SIC12."

By using this heat-resistant steel in the heat exchanger tubes of recuperators, we can contribute to reductions in fuel use and CO_2 emissions by increasing energy efficiency at all of the various industrial furnaces.

■Development History of Heat-Resistant Steel for Use in Next Generation Recuperators

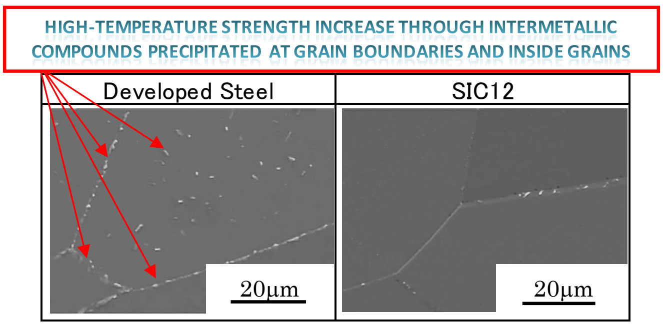
Industrial furnaces such as melting furnaces, heating furnaces, and heat treatment furnaces, which are used in the ferrous metals, non-ferrous metals, and ceramics industries, increase energy efficiency by recycling the heat of gases emitted after combustion as preheating for combustion air through the use of waste heat recovery devices.

Recuperators (heat-exchange types) are widely used in waste heat recovery devices, and users expect greater energy efficiency from such devices in order to further reduce fuel use and CO_2 emissions. As increasing a recuperator's ability to collect higher temperatures of wasted heat is an effective way to increase its energy efficiency, it is essential to increase the heat resistance of heat exchanger tubes. The SIC series, which has traditionally been our company's response to the need for heat-resistant steel in recuperators, ensures high-temperature strength that can withstand current usage environments through solid solution strengthening of added alloying elements, but in order to further increase energy efficiency, development of heat-resistant steel with high-temperature strength capable of withstanding even greater temperature of waste heat is necessary.



To that end, we focused on strengthening of material through the precipitation of intermetallic compounds, and by optimizing precipitation state of intragranular and intergranular intermetallics under high-temperature environments through our unique alloy design and structural control technologies based on developed experience and knowledge, we thereby successfully developed heat-resistant steel that retains the high-temperature corrosion resistance of the SIC12 while vastly expanding upon its high-temperature strength.

Note that high chromium ferritic heat-resistant steel is generally thought of as a difficult-to-work-with material given its large amount of alloying elements like chromium, silicon, and aluminum. Using the manufacturing technology and experience we have built up in developing our SIC series, we have established the technology to manufacture the seamless steel tubes appropriate for heat exchanger tubes in recuperators, and are in the process of preparing to supply our customers en masse.



Application of this steel will allow recuperators to collect wasted heat at even higher temperatures, further increasing the energy efficiency of each of the various industrial furnaces, thereby reducing both fuel use and CO_2 emissions.

By developing a new, specialized steel product through the use of our microstructural control technologies that realize high-performance capabilities in materials, and our manufacturing technology for difficult-to-work-with materials, we will contribute to the realization of a sustainable society and meet the varied and advanced technological needs of our customers.

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【Reference】

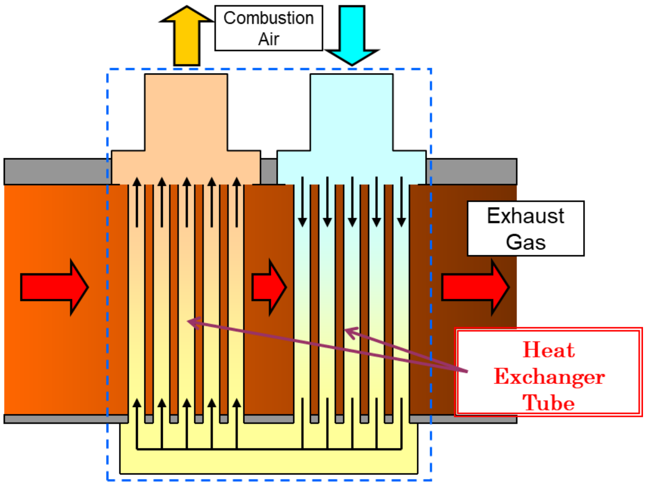
■Explanation of Terms

-Recuperator

Waste heat recovery devices are installed inside the flues of various types of industrial furnaces that use fuels such as LNGs, heavy oils, and cokes, and utilize the heat from emitted gases to preheat the combustion air.

Many of these waste heat recovery devices utilize "recuperators" (heat-exchange types) that collect heat by conducting the heat of emitted gases into combustion air through the use of heat exchanger tubes.

Heat exchanger tubes conduct the heat from emitted gases into the combustion air, and as such are exposed to high-temperature corrosive environments through which gases emitted after combustion travel; therefore, materials for such tube must possess high corrosion resistance against high-temperature gases and combustion ash, which contain substances such as sulfur and vanadium arising out of high-temperature oxidation and fuel combustion, as well as high-temperature strength that can withstand thermal deformation caused by high temperatures.



[Structure of Recuperators]

-SIC Series

High-temperature corrosion-resistant stainless steels developed by Sanyo Special Steel. This long-selling products contain alloy elements such as silicon and aluminum in high chromium ferritic stainless steel for excellent high-temperature oxidation resistance and enjoy extensive and wide-spread use as heat exchanger tube in recuperators. The lineup includes variants incorporating different quantities of chromium for use in different usage environments (maximum temperatures): SIC9 (13% Cr), SIC10 (18% Cr), and SIC12 (24% Cr) which are compatible with EN1.4724, 1.4742, 1.4762, respectively.

-Solid solution strengthening

A mechanism for strengthening metallic materials. With steel, solid solution strengthening refers to the material's resistance to changing shape caused by the strain, that can act as obstacles of atom movement, resulting from atom size difference when an alloy element is melted into solid iron acting as a solvent element (called the solid solution).

-Precipitation of intermetallic compounds

Generally speaking, most materials grow weaker in high-temperature environments due to an increase in movement of atoms within the material (the material is more likely to change shape), but by precipitation of fine intermetallic compounds with ordered crystalline structures, a pinning effect arises that controls the movement of atoms, thereby making it possible to strengthen materials.

-High chromium ferritic heat-resistant steel

A heat-resistant steel that has had its oxidation resistance enhanced by adding chromium (Cr) to ferritic stainless steel, of which Type 430 is a representative example. When compared to nickel-based alloys and austenitic heat-resistant steel, this material is cheap with high heat conductivity, and though the high-temperature strength is less robust, the smaller thermal expansion makes it harder for oxidation scale separation to occur within high-temperature environments, giving it strong oxidation resistance. Further, given the large amount of alloy elements contained, this material is classified as a type of steel that is difficult to manufacture or process (difficult-to-work-with material).

-High-temperature strength (creep rupture strength)

Creep resistance of a material under high-temperature environments. Creep refers to a phenomenon where an object changes shape over time due to a constant load (stress) applied to the object while under a high-temperature environment, and when creep sets in, the object's shape changes slowly over time until it ultimately ruptures.

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