Overview of development of arc-type ladle heating system

1. Development setup

Toyota Motor Corporation

Location: 1 Toyota-cho, Toyota City, Aichi Prefecture, Japan

President & Representative Director: Akio Toyoda

Tokuden Co., Ltd.

Location: 2-2-27 Showa-dori, Amagasaki City, Hyogo Prefecture, Japan

President and Representative Director: Yoshiharu Minagawa

Chubu Electric Power Co., Inc.

Location: 1 Higashi-Shincho, Higashi-ku, Nagoya City, Aichi Prefecture, Japan

President & Director: Akihisa Mizuno

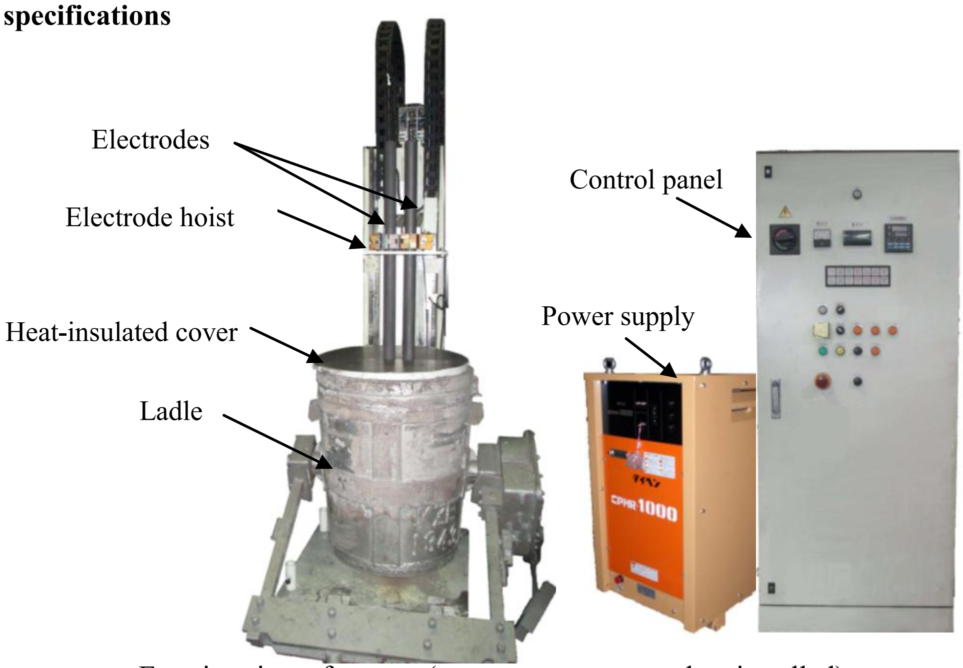
[Cooperation in field tests provided by]

Aisin Takaoka, Co., Ltd.

Location: 1 Tennoh Takaoka-Shinmachi, Toyota City, Aichi Prefecture, Japan

President: Toshiyuki Ishikawa

2. System specifications



Exterior view of system (system appearance when installed)

System specifications

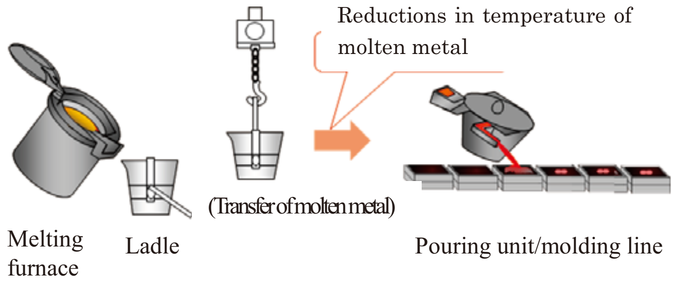
Item		Unit	System that has been developed	System that can be ordered
Ladle capacity		kg	300	100 to 3,000
Power supply		kW	61	61 to 250
Heating control method		-	Atmospheric temperature feedback control (PID control)	
Installation footprint (including ladle and power supply)		Width × depth × height (mm)	2,000 × 2,000 × 2,700	2,000 × 2,000 × 2,700 to 3,500 × 4,000 × 6,000
Carbon electrodes		Outside diameter × height (mm)	φ80 × 1,800	φ50 × 740 to φ100 × 2,700
Utilities	Electricity	-	AC 200V, 3-phase	AC 200 to 400V, 3-phase
	Nitrogen	Liters/minute	25	25 to 200

Note: Specifications are approximate and will differ depending on the shape of the ladle and heating capacity.

3. Key development points

(1) Ladle application

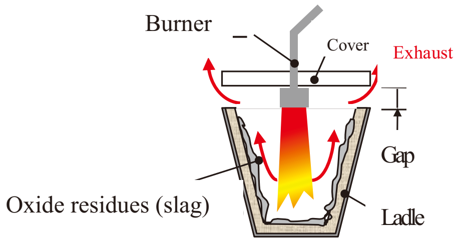
The ladle is used to transfer the molten iron or aluminum from the melting furnace to the pouring unit/molding line. In order to prevent any lowering of the temperature of the molten metal, which can cause quality problems, the refractory materials on the inside walls of the ladle must be preheated ahead of time.



Ladle transfer flow

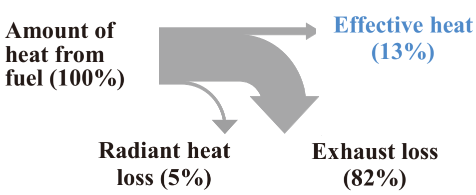
(2) Conventional system (gas burner-type)

Heating with gas burners results in a high exhaust loss so the effective heat remains at 13%, and large quantities of oxide residues are generated as well.



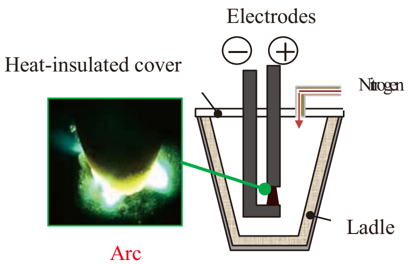
■High energy loss through exhaust
➡ Higher heating energy
■Oxide residues (slag) generated
➡ Increased maintenance costs
■Exhaust generated
➡ Worse conditions in work environment

▼Arc balance (arc heating)



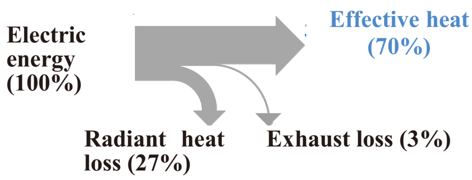
(3) Developed system (arc-type)

Arcs are generated by applying DC current to carbon electrodes, and the ladle is heated by radiant heat. By installing a heat-insulated cover and applying arc heat, the effective heat ratio is increased from the 13% of the conventional system to 70%, significantly reducing the energy consumption required for the heating.

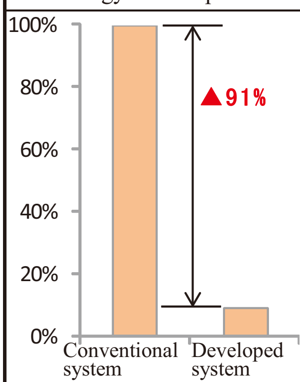
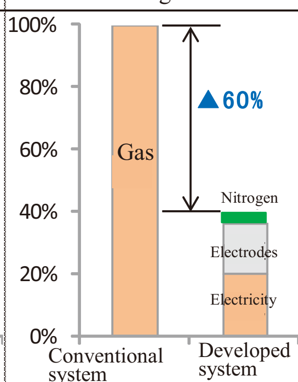
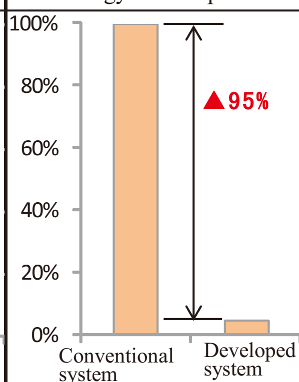
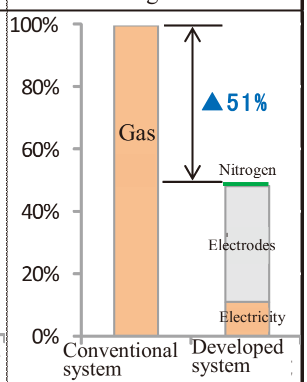


■Installation of heat-insulated cover
=>Higher effective heat ratio
➡ Energy savings
➡ Improvements in work environment
■Heating in a low-oxygen atmosphere
➡ Reduced oxide residues

▼Heat balance (arc heating)



4. Overview of field test results

Where tested	Head office and Takaoka Plant, Aisin Takaoka Co., Ltd.		Akechi Plant, Toyota Motor Corporation	
Application	Ladle preheating		Ladle drying	
	Energy consumption	Running costs	Energy consumption	Running costs
Evaluation results				
Reduction rates	- 91%	- 60%	- 95%	- 51%