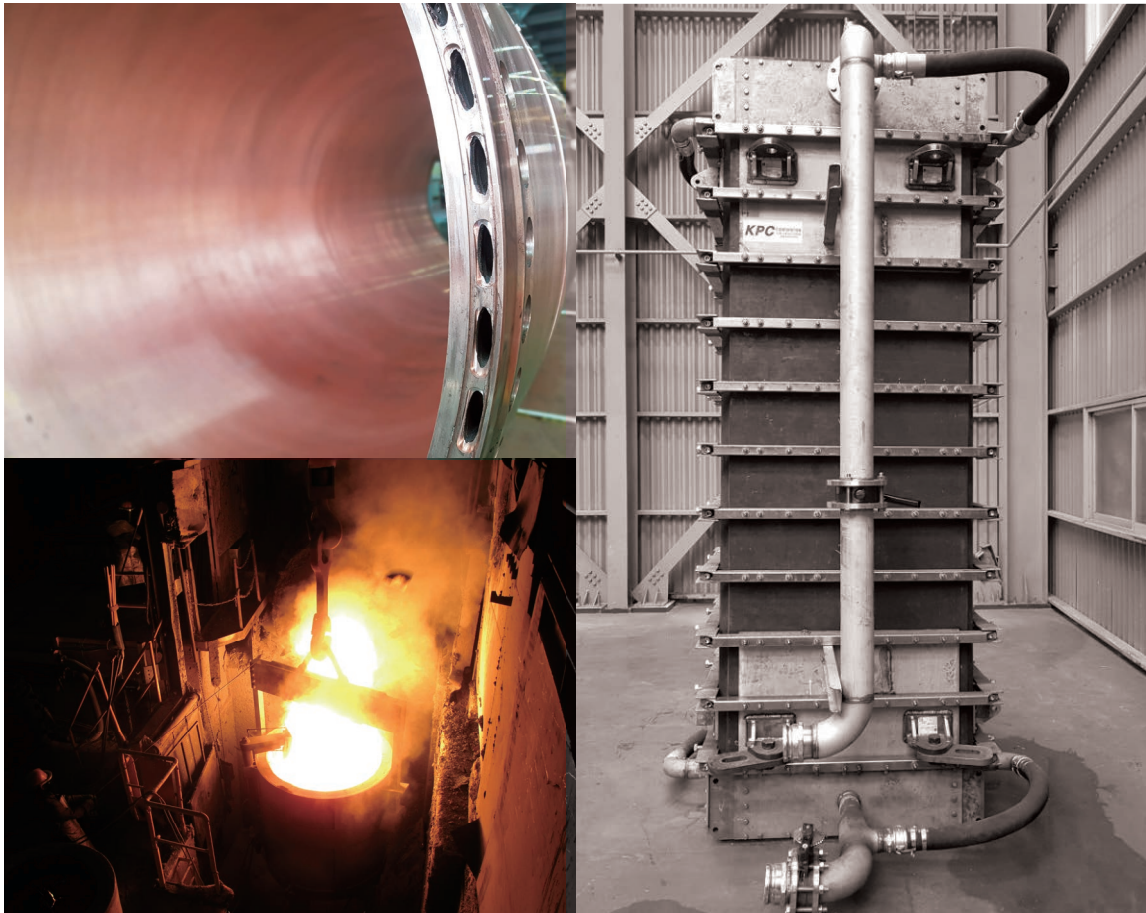


HIGH PERFORMANCE JACKETLESS
COPPER CRUCIBLE FOR ESR



KPC CORPORATION

COMPANY HISTORY

- 1977. 10.** Established Korea Precision Casting Co.
- 1982. 03.** Started Ball Valve Division
- 1987. 09.** Started Special Alloy Casting & Forging
- 1988. 06.** Started Vacuum Arc Re-melting Division
- 1997. 12.** Started Titanium Casting & Forging
- 1998. 08.** Reactive Metal Research Institute Registered
- 2004. 03.** Operated Wachon 1st Factory (Vacuum Melting, Open Die Forging)
- 2006. 11.** Operated Deokchon Factory (Machining, Welding)
- 2007. 05.** Operated Sowol 1st & 2nd Factory
(Rolling Mill, Extrusion, Radial Forging, Centrifugal Casting)
- 2010. 12.** KPC Metal Co., Ltd. Spun off from KPC Corporation
- 2015. 10.** Awarded the Gold Tower Order of Industrial Service Merit from the Korean Government
- 2016. 02.** Started Special Copper Alloy Division
(Producing Copper Mold and Crucible)



JACKETLESS COPPER CRUCIBLE FOR ESR

Leading Casting Technology in the Forefront

Since its inception in 1977, KPC has continued to supply the highest quality of both forged and casted products to oil and gas, petrochemical and power generation industry. Through assiduous R & D and investment in melting and refining equipments such as VIM, VAR, AOD and ESR, KPC has broadened the product spectrum from stainless steel to high performance alloys. Today KPC is one of the world's most renowned manufacturers of the highest quality super alloys and titanium.

Based on a unique combination of experience in melting of super alloy and titanium and expertise in precision machining, KPC leads technology for the production of high-performance copper crucibles.

KPC's patented jacketless body with elliptical cooling holes technology sets forth a new quality and productivity standard for copper crucibles.



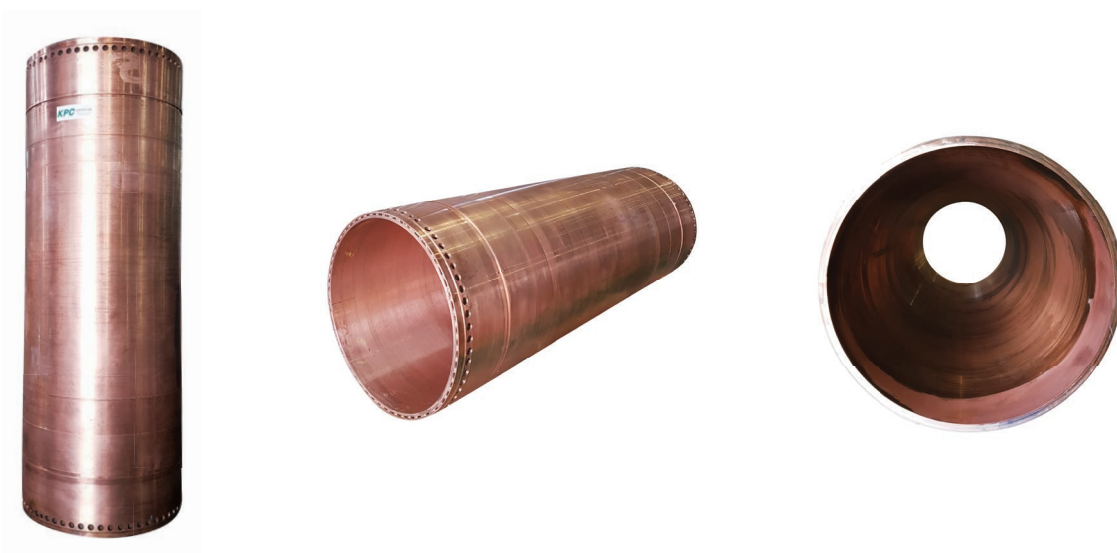
Product Range

Type		Use	Shape	Size(mm)	Remark
Solid	Seamless	ESR	Round / Square	> 600 ø > 4000 L	• Production Efficiency & Superb Quality guaranteed through : · Jacketless Type · Elliptical Cooling Holes
		VAR			
	Welded	ESR	Round / Square	> 600 ø > 3500 L	
		VAR			
Fabrication		ESR	Round / Square	> 600 ø > 3500 L	
		VAR			

Major Breakthrough from Coventional Crucibles

KPC's patented Jacketless Crucible, jacketless body embedded with elliptical cooling holes, drastically increases flow speed of cooling water throughout melting and refining process, and greatly enhances production efficiency. Increased flow speed of cooling water minimizes thermal deformation, enhances homogeneity of ingots, and ensures superb quality of alloy products. Jacketless Crucible also offers a real time view of the crucible body during melting or refining work, and contributes to prevention of metallurgical deficiency caused by thermal deformation of crucibles. This is an epoch making breakthrough from conventional crucibles with which thermal deformation is invisible until the jacket is uncovered after melting or refining process.

Jacketless Crucible..... the key equipment to enhance the productivity and quality of alloy products to a level that a quality manufacturer aspires.

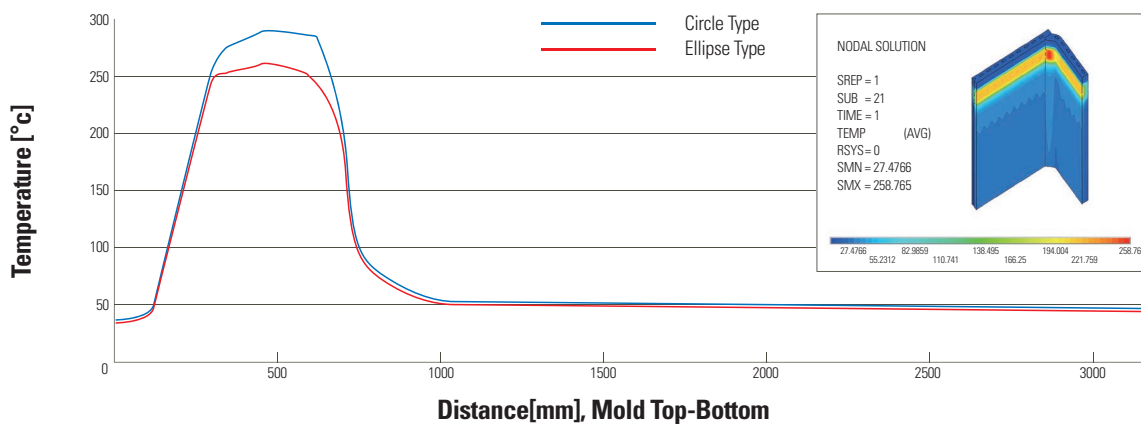


Higher Heat Transfer Coefficient

Thermal conductivity of KPC's patented Jacketless Crucibles with elliptical cooling holes is 5% higher than conventional crucibles with circle cooling holes, due to the increase in hydraulic diameter generated by shape.

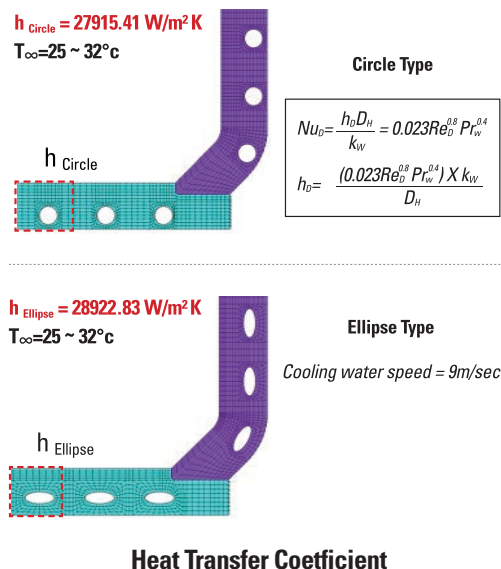
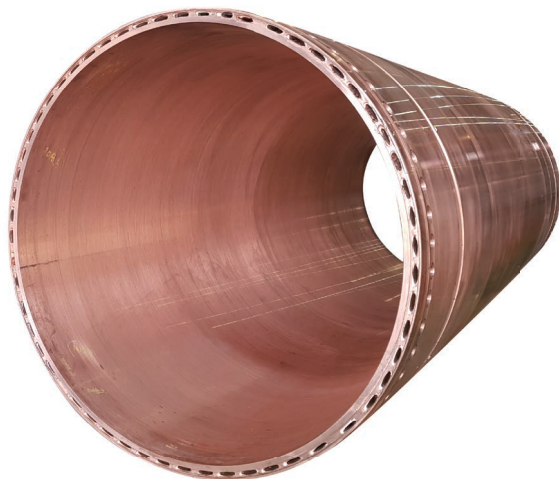
Enhanced thermal conductivity of elliptical cooling holes leads to faster cooling speed. Wall temperature of Jacketless Crucibles with elliptical cooling holes is 10% lower than that of crucibles with circle holes.

• Temperature [Crucible Wall(Hot Face)]



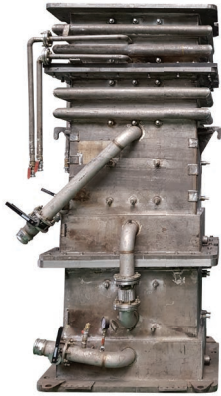
Decrease in Thermal Deformation

Faster cooling speed generated by elliptical cooling holes directly embedded in the crucible minimizes thermal deformation.



Extended Crucible Lifespan leads to Enhanced Productivity

Decrease of thermal deformation guarantees longer lifespan of crucibles and less amortization cost, and enhanced productivity in remelting process with longer maintenance intervals.



[A]



[B]



Comparison of conventional type (A) and Jacketless type crucibles(B).

Ribs on the body side of the Jacketless type crucibles offer protection from thermal deformation.



[A]



[B]

High Performance Copper Alloys

Exposed to elevated temperatures from direct contact with molten metal, ESR crucibles for remelting industry require high heat and deform resistance and high thermal conductivity simultaneously. The copper alloy used for remelting crucibles requires material properties at elevated temperature, stability to thermal shock.

KPC offers a wide range of high performance copper and copper alloys suitable for copper molds and customized solution to meet demands of customers' applications. Range of production includes : CuP, CuAgP, CuCrP, CuCrZr, vacuum and air melting.

Properties and applications of crucible materials

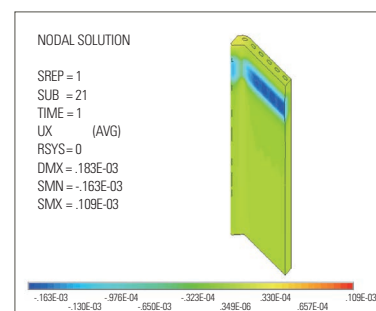
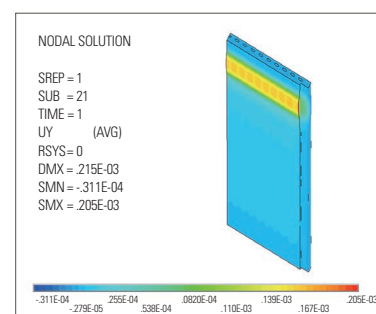
Material	CuP	CuAgP	CuCrZr
Thermal conductivity	Very high	Very high	High
Softening / Recyst. temp.	Medium	Good	Very high
Strength / Hardness	Good	Good	Very high
Application	Crucibles, longitudinally welded of forged, base plates	Crucibles, longitudinally welded of forged, base plates	Forged high-performance crucibles, base plates

Design and Performance Analysis

Performance and service life of ESR crucibles also depend on the crucible design. KPC offers comprehensive engineering service to provide customized solution to suit different concept and operating conditions of customers' plants, ensuring optimum quality and service life.

KPC provides designs based on operational parameters of the plant, simulated long-term behavior of ESR Crucibles, and calculation of processes and material properties. The advanced design technology will optimize cooling and operational condition, reduce common causes of failure in increased use such as distortion and constriction of crucibles, and thereby greatly enhance the quality and productivity in remelting process.

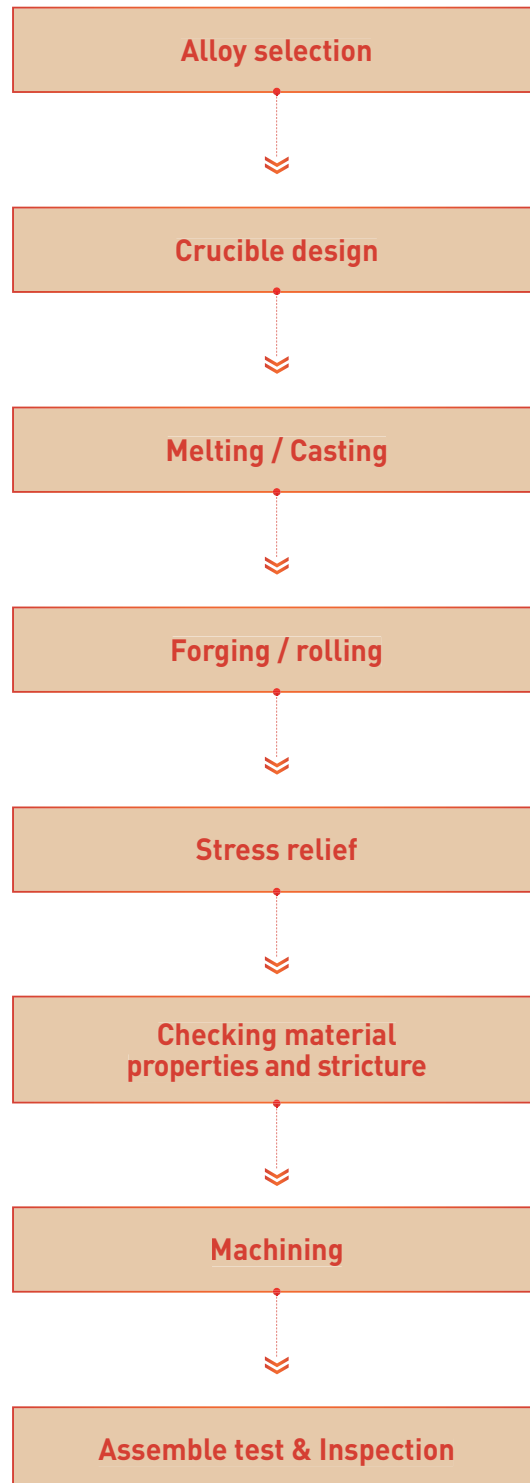
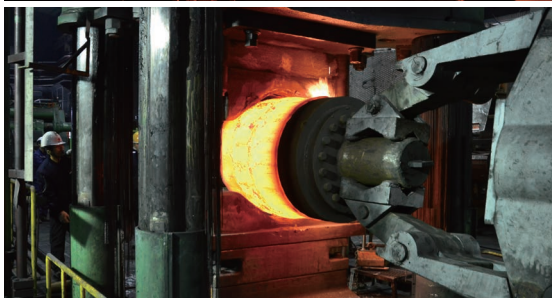
Deformation



Production Facility

Production Process

Based on its 40 years' melting, forging and machining technology accumulated in super alloys, KPC manufactures durable, thermal deformation resistant and efficient copper crucibles for ESR and VAR in remelting industry.



Quality Control

Throughout all production process from raw material to final shipment, KPC's ESR Crucibles are subject to rigorous quality control, including chemical analysis, physical and mechanical properties test (refer to the table on page 9), measurement of dimension, coating thickness and NDE.

ISO 9001



ISO14001



BSOHSAS 18001



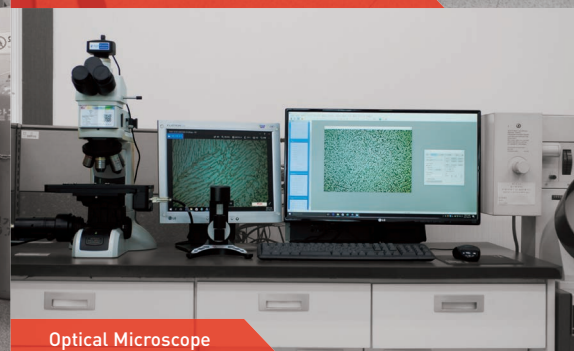
3D Coordinate Measuring Machine



X-ray Fluorescence Spectrometer



Optical Emission Spectrometer



Optical Microscope

KPC Materials for crucibles and longitudinally welded crucibles

Material Properties*	Temperature	Units	CuP	CuAgP	CuCrZr
Chemical composition (without copper)		%	0.004P	0.09 Ag	0.6 Cr
				0.006 P	0.1 Zr

Physical Properties	°C	°F	Units	CuP	CuAgP	CuCrZr
Electrical conductivity	20	68	S·m / mm ²	57	55	49
			%IACS	98	95	84
Thermal conductivity	20	68	W / (m·K)	395	375	350
Coefficient of thermalexpansion	20-300	68-572	10° / K	17.7	17.7	18
Recrystallisation temperature	-	-	°C	250	370	700
Softening temperature***	-	-	°C			590
Modulus of elasticity	20	68	103 / MPa	120	125	128

Mechanical Properties	°C	°F	Units	CuP	CuAgP	CuCrZr
0.2% Proof stress R _{p0.2}	20	68	MPa	50	50	280
	200	392		45	40	260
	350	662		(35)	(30)	260
	500	932		(25)	(20)	(200)
Tensile strength R _m	20	68	MPa	200	210	390
	200	392		160	170	340
	350	662		(120)	(120)	290
	500	932		(70)	(80)	(230)
Elongation A ₅	20	68	%	45	50	25
	200	392		45	45	24
	350	662		(45)	(40)	22
	500	932		(55)	(50)	(22)
	20	68	2.5 / 62.5	50	50	120

Units: 1 MPa=1 N / mm²=0.102kgf/mm²0.145 ksi; 1W/(m·k)=2.388·10³cal/(cm·s·°C)

* Values may change with varying thermal and mechanical treatment due to geometry and manufacturing procedure

** Values can be modified to customer's demands

*** Measurement according to DIN ISO 5182

() Limited reproducibility of measurement due to softening/recrystallisation

NOTE



KPC CORPORATION

KPC

Automated ball valve

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Fax. » 82-53-963-6386
URL » www.kpccorp.co.kr

Seoul office

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Seoul, 100-736, Korea
Tel. » 82-2-2637-9188
Fax. » 82-2-2637-9118
URL » www.kpccorp.co.kr
» www.kpctitanium.com

KPC Metal

Vacuum Melting

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Gyeongsan-si, Gyeongsangbuk-do, 712-843, Korea
Tel. » 82-53-852-4839
Fax. » 82-53-853-6386
E-mail » kpcm@kpccorp.co.kr
URL » www.kpctitanium.com / www.kpcmetal.co.kr

VELOX

Radial Forging Rolling

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URL » www.velox.co.kr