

RAUTOMEAD UPWARDS VERTICAL CASTING MACHINES

COPPER CATHODE FEEDSTOCK

Introduction

Rautomead upwards vertical casting machines have been designed to accept copper cathode as the feedstock in production of oxygen-free copper rod and certain copper alloys. In all but the smallest models, the cathode sheets are fed (without pre-cutting) into the machine and are melted and cast in a single furnace.

Where a manually operated cathode feed is specified, the cathodes must be stacked vertically adjacent to the machine and from that position they are lifted by pneumatically-operated gripper jaws suspended from an electric hoist, advanced and lowered into the furnace crucible under the control of the operator.

Where an automatic cathode feed system is specified, the pallets of horizontally stacked cathodes are loaded into a cathode stacking bin on the floor at rear of the operating platform from where they are fed automatically to the casting machine without manual attention.

Quality

The Rautomead process is metallurgically a very clean system and is designed to remove residual oxygen from the copper. On the other hand, the process is not a refining one. Thus, it is important that the specification of the cathode used is carefully considered, having regard to the properties required in the cast rod.

Grade A Cathode

It is **strongly recommended** that only cathode conforming to the London Metal Exchange (LME) 'Grade A' **electrolytically refined** specification is used. This material specification conforms to British Standard BS EN 1978:1998. The cathode grade designation is Cu-CATH-1. See chemical composition Appendix I. The equivalent American standard is ASTM B 115-72.

Units of Quantity

Cu-CATH-1 is available in lots of 25 tonnes. Individual bundles are of not more than 4 tonnes.

COPPER CATHODE FEEDSTOCK (cont'd)

Cathode Sizes and Weights

Cathode sheets vary in dimensions and weight. Most cathodes are nominally 1.0 metres square, though this can range from 0.9 metres up to 1.2 metres. Cathodes larger than 1.1 metres in either dimension are not recommended for use with the automatic cathode feed system. Cathode weight varies from approx. 50 kgs up to approx. 160 kgs, cathodes within this weight range may be used with either cathode feed system.

Electrolytically Refined versus Electro-won (SXEW) Cathode

Care must be taken to specify electrolytically refined cathode. Electrolytically refined cathodes may be either ISA Process type or "full deposit" type.

ISA Process

Copper Refineries Pty Ltd, a subsidiary of MIM Holdings Ltd of Queensland, Australia developed the ISA Process, of plating copper on to a stainless steel sheet as an improved cathode production process.

The ISA Process is used in both electrorefining and solvent extraction (SX Electrowon) cathode manufacture.

Though it is still grouped under the generic term 'Grade A', the electro-refined ISA process produces a particularly pure type of copper cathode - see examples of chemical compositions compared with Standard (copy follows).

The individual copper cathode sheets are thinner and lighter (typically approx. 60 kgs) than traditional "full deposit" cathode. They have no suspension lugs and are relatively smooth surfaced.

Brands

A listing of cathode brands and cathode type (ER or EW) follows. This includes the ISA Process brands (see above). It should be noted that not all Grade A cathode brands are ISA process electro-refined cathodes.

Availability

The LME maintains warehouse stocks throughout the world. Rautomead can assist with introductions to cathode brokers and suppliers around the world.

COPPER CATHODE FEEDSTOCK (cont'd)

Recommendations

1. Rautomead strongly recommends the use of electro-refined Grade A cathode produced by the ISA Process in all applications. This recommendation is made on the basis of:

chemical composition	simpler automatic handling
reputation	consistency
smooth unoxidised surface	free of suspension lugs with their attendant problems of trapped electrolyte
convenient size	
lower trapped impurities	

2. Other types of electro-refined Grade A cathode are also suitable, but care must be taken to ensure that metallic contaminants or heavy oxidation are not present on the surface and that moisture is not trapped either in surface “bubbles” or in the suspension lugs.
3. Careful attention should be paid to levels of impurities in different brands of Grade A cathode. Conformity with the standard specification does not represent an adequate guarantee of success in drawing to fine wire. The presence of bismuth, tellurium, selenium or sulphur, even in small amounts is detrimental to performance.
4. The automatic cathode feed system is suitable for use with either ISA process or full deposit electro-refined cathodes :

Maximum cathode size : 1100 x 1100mm square
 Maximum cathode weight : 160 kgs
 Typical cathode weight : 45 – 100 kgs
 Cathode surface to be dry, clean, bright, flat, unoxidised and free from electrolyte nodules. Lugs (electro-refined) must be removed from cathodes prior to stacking bin.

5. **Gas Inclusions**

Gas inclusions in certain brands of copper cathode can cause explosions when the copper is melted and can be a serious **THREAT TO LIFE**. Explosions caused by gas expansion within the melt will progressively weaken the graphite crucible and will cause premature structural failure.

COPPER CATHODE FEEDSTOCK (cont'd)

Recommendations (cont'd)

6. **Moisture**

In all cases, greatest care and attention must be given to avoid moisture being introduced to the furnace with the cathodes. Moisture risks causing hydrogen gas porosity in the cast rod, represents an explosion hazard and can be a serious **THREAT TO LIFE**. “Bumps” and “pops” occurring as small explosions within the melt will progressively weaken the graphite crucible and will cause premature structural failure.

Surface moisture can be caused by cathodes being transported or stored in the open, or by condensation on the surface of the sheets. Cathodes should be protected in transport and stored under cover. Storage for 5-7 days in proximity to the casting machine is normally sufficient to avoid surface condensation. Operators should be alert to the possibility of finding condensation within a pack of tightly packed cathode sheets.

Internal moisture can be caused by trapped electrolyte under the surface of the copper and around the suspension lugs of full deposit cathode sheets. Brands with trapped electrolyte should not be used.

March 2005

Cu-CATH-1 Chemical Composition

Element	Symbol	Specification	ISA Brands (typical)		Typical Rautomead Rod – Customer A	Typical Rautomead Rod – Customer B
			Grade A ppm	JB ppm		
Bismuth	Bi	<2.0	<0.8	<0.2	0.24	0.04
Selenium	Se	<2.0	<0.3	<0.3	---	1.5
Tellurium	Ti	<2.0	<1.0	<0.2	0.05	<0.3
group		<3.0	<2.1	<0.6		
Arsenic	As	<5.0	0.8	0.1	0.86	<0.2
Cadmium	Cd		0.1	<0.1	0.05	<0.1
Chromium	Cr		<0.5	<0.1	0.01	<1
Manganese	Mn		0.4	<0.1	0.005	<1
Phosphorous	P		<0.3	<0.1	0.04	<2
Antimony	Sb	<4.0	<1.0	<0.1	---	<0.5
group		<15.0	<3.0	<0.5		
Lead	Pb	<5.0	2.0	<0.1	0.28	0.5
Sulphur	S	<15.0	6.9	<4.0	8.0	5.9
Cobalt	Co		<0.5	<0.1	0.01	<2
Iron	Fe	<10.0	2.0	<0.7	0.7	1.5
Nickel	Ni		1.3	<0.1	0.19	0.4
Silicon	Si		0.6		0.62	
Tin	Sn		<0.3	<0.1	0.01	0.2
Zinc	Zn		<1.5	<0.1	0.09	0.2
group		<20.0	<6.0	<1.0		
Silver	Ag	<25.0	12.0	<5.0	9.3	7.4
Oxygen	O				1.8	<2
Carbon	C				<0.4	
Aluminium	Al				0.11	
Boron	B				0.01	
Total		<65.0	<32.0	<15.0		

COPPER CATHODES 2005

Country	Brands	Producer	Capacity Tonnes	ISA Process	Type	Registered	URL	See Also	Comments
Argentina		Various Argentina			Fire refined				
Australia	ISA	Copper Refineries			Electrorefined	LME			
		Girilambone Copper			Electrowon				
		Matrix Metals			Electrowon				
	ISA	Mount Isa Mines Ltd		yes	Electrorefined	LME	http://www.mimpt.com.au		Now Owned by XSTRATA
	OLYDA	WMC (Olympic Dam Corporation) Pty Ltd			Electrorefined	LME	http://www.wmc.com/		Now owned by WMC
		WMC (Olympic Dam Corporation) Pty Ltd			Electrowon				
		Pasminco							
		Port Kembla Copper			Electrorefined				
		Straits Resources			Electrowon				
		Western Metals			Electrowon				
Austria	BRX	Montanwerke Brixlegg Aktiengesellschaft			Electrorefined	LME			
Belgium	OLEN	Umicore Copper N.V.		yes	Electrorefined	LME Comex	http://www.umicore.com		
	SME	Metallo-Chemieque International NV			Electrorefined	LME			
Brazil	Cbm	Caralba Metals SA			Electrorefined	LME			
Bulgaria		Union Miniere			Electrorefined				
Canada	FKA	Falconbridge Ltd			Electrorefined	LME Comex			
	NORANDA (produced after October 1999)	Noranda Inc.			Electrorefined	LME Comex			
	ORC	Inco Ltd			Electrorefined	LME Comex			
Chile	ABRA	Sociedad Contractual Minera El Abra			Electrorefined	LME Comex			
	AE	Corporacion Nacional del Cobre de Chile			Electrowon	LME Comex			
	AE SX EW	Corporacion Nacional del Cobre de Chile			Electrorefined	LME Comex			
	CCC	Corporacion Nacional del Cobre de Chile			Electrowon	LME Comex			
	CCC-SBL	Corporacion Nacional del Cobre de Chile			Electrorefined	LME Comex			
	cCo-SX-EW	Corporacion Nacional del Cobre de Chile			Electrowon	LME Comex			
	CDA	Compania Minera Carmen de Andacollo			Electrowon	LME			
	CHUQUI-P	Corporacion Nacional del Cobre de Chile			Electrowon	LME			
	CMCC	Compania Minera Cerro Colorado Ltda			Electrowon	LME			
	COLLAHUASI (produced after December 1998)	Compania Minera Dona Ines De Collahuasi SCM			Electrowon	LME Comex			
	ENM	Empresa Nacional de Mineria			Electrorefined	LME Comex			
	ESOX (produced after April 1999)	Minera Escondida Limitada			Electrowon	LME Comex			
	LBF	Comp. Minera Falconbridge Lomas Bayas			Electrowon	LME			
	MET	Minera El Tesoro			Electrowon	LME			
	MIC-P	Minera Michilla S.A			Electrowon	LME			
	MIC-T	Minera Michilla S.A			Electrowon	LME			
	MB	Empresa Minera de Mantos Blancos SA			Electrowon	LME			
	MV	Empresa Minera de Mantos Blancos SA			Electrowon	LME			
		Cerro Dominador			Electrowon	LME			
		Codeico - Calelones			Fire Refined				
		Codeico - El Teniente			Electrowon				
		Codeico - Radomiro Tomic			Electrowon				
		Explotadora de Minas			Electrowon				

COPPER CATHODES 2005

Country	Brands	Producer	Capacity Tonnes	ISA Process	Type	Registered	URL	See Also	Comments
China		Min. Disputada de las Condes			Electrowon				
		Min. Disputada de las Condes - Los Bron			Electrowon				
		Min. Pudahuel			Electrowon				
		Min. Pudahuel - Lo Aguirre			Electrowon				
		Compania Minera Quebrada Blanca S.A.			Electrowon	LME			
		Min. Rayrock			Electrowon				
		Sociedad Punita del Cobre			Electrowon				
	ZALDIVAR	Compania Minera Zaldivar			Electrowon				
	QING FENG	Anhui Chi Zhou Nonferrous Metal			Electrorefined	SHFE			
	TG	Anhui Tongdu Copper Stock Co. Ltd			Electrorefined	SHFE			
	IBIS	Baiyin Nonferrous Metals			Electrorefined	SHFE			
		Changsha Nonferrous Metals			Electrorefined	SHFE			
		Changzhou Orientmet			Electrorefined	SHFE			
	DA JIANG	Daye Nonferrous Metals			Electrorefined	SHFE			
		Gejiu Copper			Electrorefined	SHFE			
		Guangdong Shilu Copper			Electrorefined	SHFE			
	ZHUJIANG	Guangzhou Zhujiang Copper Co			Electrorefined	SHFE			
	HX	Huludao Zinc Refinery			Electrorefined	SHFE			
	TIAN HENG	Jiangsu Tai Cang Copper			Electrorefined	SHFE			
	GUIYE	Jiangxi Copper Company Ltd.		150,000	no	LME SHFE		http://www.jxccc.com/english/enjtgjs/enindex.htm	
GUIYE	Jiangxi Copper Ind				LME SHFE				
JIN TUO	Jinchuan Nonferrous Metals				SHFE				
JINTUN/Jinlong	Jinlong Copper Co Ltd				LME SHFE				
JINTUN (produced after 31/8/97)	Jinlong Copper Co Ltd		100,000		LME SHFE				
	Kunming Smelter				Electrorefined				
	Local Authority - Anyang/Tongbai				Electrorefined				
JIN GUANG	Local Authority - Baotou				Fire Refined	SHFE			
	Local Authority - Chengdu				Electrorefined				
	Local Authority - Chongqing				Electrorefined				
	Local Authority - Fuchuijiang				Electrorefined				
	Local Authority - Harbin				Electrorefined				
	Local Authority - Shaowu				Fire Refined				
	Local Authority - Tieling				Electrorefined				
	Local Authority - Tonghua				Fire Refined				
	Local Authority - Urumqi				Fire Refined				
	Local Authority - Wuhan				Electrorefined				
	Local Authority - Xiaoshigou				Electrorefined				
	Local Authority - Zhejiang Aluminium				Electrorefined				
PEONY	LuoYang Copper Fabricating				Electrorefined	SHFE			
JIN YAN	Mei Zhou Jinyan Industry Group				Electrorefined	SHFE			
	Mouding Copper				Electrorefined	SHFE			
JU JING	Nanhai Shi Taipinyang				Electrorefined	SHFE			
JIN TIAN	Ningbo Jintain Copper Industry				Electrorefined	SHFE			
SHANG YE	Shanghai Xinye Copper Co				Electrorefined	SHFE			

COPPER CATHODES 2005

Country	Brands	Producer	Capacity Tonnes	ISA Process	Type	Registered	URL	See Also	Comments
	TIGER	Shanghai Da Chang Copper Co			Electrorefined	SHFE			
		Shenyang Smelter			Electrorefined				
	ZHONG DING	Shenyang Xinxi Copper			Electrorefined	SHFE			
		Shuikoushan Mining Bureau			Electrorefined				
	DA TONG	Taiyuan Copper Industrial			Electrorefined	SHFE			
	TONG GUAN	Tianjin Da Tong Copper			Electrorefined	LME SHFE			
		Tongling Nonferrous			Electrorefined				
		Various China			Electrorefined				
	JING JING PAI	Wuhu Heng Xin Copper			Electrorefined	SHFE			
	SAN JIAN PAI	Yantai Nonferrous Metals Group			Fire Refined	SHFE			
	TIE FENG	Yunnan Copper Corp Ltd	?	no	Electrorefined	LME SHFE	http://www.yunnan-copper.com/ehtml/main.htm		
	JIN XIN	Yuyao Shi San Cheng Nonferrous			Electrorefined	SHFE			
	TONG DING	Zhangjiagang Lianhe Copper			Electrorefined	SHFE			
	ZHONG TIAO SHAN	Zhongtiaoshan			Electrorefined	SHFE			
		Zhuzhou Smelter			Electrorefined				
Cyprus		Hellenic Copper			Electrowon				
Egypt		Various			Fire Refined				
Finland		OM Group			Fire Refined				
Germany	OKM	Boilden Harjalvalta Metals Oy			Electrorefined	LME			
		KM Europa Metal			Fire Refined				
		Mansfelder Kupfer			Electrorefined				
	HK	Norddeutsche Affinerie AG			Electrorefined	LME Comex			
	NA-ESN	Norddeutsche Affinerie AG			Electrorefined	LME Comex			
India	BIRLA COPPER	Hindalco Industries Limited			Electrorefined	LME			
		Hindustan Copper - Malanjhand			Electrowon				
		Hindustan Copper - Ghatsila			Electrorefined				
		Hindustan Copper - Khetri			Electrorefined				
	BIRLA COPPER	Indo Gulf Fertilisers & Chem			Electrorefined				
	STERLITE	Sterfite Industries (India) Ltd			Electrorefined				
Indonesia	GRESIK	PT Smelting	200,000	Yes	Electrorefined	LME	http://www.smelting.co.id/	Mitsubishi largest shareholde	
Iran		NICICO - Sarcheshmeh			Electrorefined				
Italy		NICICO - Sarcheshmeh			Electrowon				
		Europa Metall			Fire Refined				
		Simar			Electrorefined				
		Tramet			Fire Refined				
Japan	DOWA	Dowa Mining Co Ltd	72,000	No	Electrorefined	LME Comex	http://www.dowa.co.jp/english/index.htm		
	TAMANO	Mitsui Mining & Smelting Co Ltd			Electrorefined	LME Comex			
	HM	Nippon Mining and Metals Co Ltd	180,000	Yes	Electrorefined	LME Comex	http://www.nikko-metal.co.jp/english/index.html		
	MITSUBISHI	Mitsubishi Materials Corporation			Electrorefined	LME Comex			
	OSR	Mitsui Mining & Smelting Co Ltd			Electrorefined	LME Comex			
	SR	Onahama Smelting & Refining Co Ltd			Electrorefined	LME Comex			
	SUMIKO N / SUMIKO T	Nippon Mining and Metals Co Ltd			Electrorefined	LME Comex			
	TAMANO	Sumitomo Metal Mining Co Ltd			Electrorefined	LME Comex			
		Mitsui Mining & Smelting Co Ltd							