

# UPGRADING THE U.S. COBALT STOCKPILE SUPPLY

*P.G. Bennett\*<sup>1</sup>, J.V. Atwood\*<sup>2</sup> and L.D. Redden\*<sup>3</sup>*

## INTRODUCTION

Approximately 19.2 million kg (42.3 million lb) of cobalt contained within the U.S. National Defense Stockpile is classified as grades B and C. This material cannot be used for strategic and critical applications but is adequate for less critical uses. Since the stockpile was established to meet United States needs in the event of a national emergency, it follows that if the stockpile is to be maintained, the lower quality grades B and C cobalt should be upgraded or replaced<sup>(1)</sup>.

Existing technology to upgrade lower quality cobalt includes methods for producing catalysts and cobalt compounds. This technology could produce from the stockpile cobalt an extra fine cobalt powder, which could be used in the production of cemented carbides. Chemical means can also be utilised to produce powder compacts for vacuum melted superalloys. However, high-surface-area cobalt powders oxidise easily and thus would be unsuitable for long-term stockpile storage.

Researchers at the SLRC have developed a process scheme utilising a novel Double Membrane Electrolytic Cell (DMEC) and conventional hydrometallurgical techniques to produce, from lower quality stockpile cobalt, cathodes meeting DOD specification P13-R6-grade A dated December 18, 1985<sup>(2)</sup>.

**Table 1 - Analysis from the Cobalt Stockpile Emergency Demonstration**

Element Cu/units	Stockpile Cobalt	P13-R6-A Specification	DMEC Cathodes		
			No. 1	No. 2	No. 3
Co%	97.350*	≥99.850	99.89	99.91	99.9
Ni%	.450*	.065	.045	.039	.044
Fe%	.150*	.010	.025*	.004	.004
Mn%	.110*	.001	<.0005	<.0005	<.0005
Cu%	.036*	.0044	<.001	.001	<.001
Pb ppm	3.2	5	8*	1.2	3.5
Zn%	.015*	.0034	.0011	<.001	<.001
Si%	.110*	.0054	<.005	<.005	<.005
Al%	.038*	.0054	<.005	<.005	<.005
S%	.017*	.002	<.001	<.001	<.001
C%	.089	.014	.004	.003	.003
Il ppm	290*	14	9	3	3
O%	1.40*	.020	.005	.0029	.0027
Bi ppm	<.50	1	<.5	<.5	<.5
As ppm	<1	10	<1	<5	<5
N%	.004	.0014	<.001	<.001	<.001
Sb ppm	<1	5	1	<1	<1
P%	<.005*	.0034	<.003	<.003	<.003
Sn ppm	2.70	14	<5	<5	<5
Se ppm	<1	5	1	<1	<1
Ag ppm	<.70	5	<.5	<.5	<.5
Zn + Cd%	.015*	.0044	.0012	<.001	<.001
Te ppm	<.50	5	<.5	<.5	<.5
Ti ppm	<1	5	<1	<1	<1
Hg ppm	<1	5	<1	<1	<1
Cl ppm	<50	400	<400	<100	<100
Na%	.70*	.02	<.001	<.001	<.001
Mg%	.039*	.010	<.0005	<.0005	<.0005
Ca%	.057*	.020	<.001	<.001	.001

\* Exceeds specification P13-R6 grade A, dated Dec. 8 1985

## SAMPLE

### CHARACTERISATION

Four kegs of stockpile cobalt were received at the SLRC from the Defense Logistics Agency. The sample consisted of approximately 1000 kg (2,200 lb) of rondelles (see figure 1) measuring 1.3 cm in diameter by 2.5 cm long (0.5 in diameter by 1.0 in long). An analytical composite from each keg was prepared and sent to an independent laboratory to be assayed for the

suite of elements listed in the DOD specification. Average analytical results are presented in Table 1.

### UPGRADE PROCESS

The key feature of the upgrade process is the DMEC. The DMEC, as used in this application, is essentially a novel electrorefining cell. Stockpile cobalt is electrolytically dissolved in anode baskets while high purity cobalt is deposited at the cathode. A cobalt chloride anolyte is generated



# DOUBLE MEMBRANE ELECTROLYTIC CELL

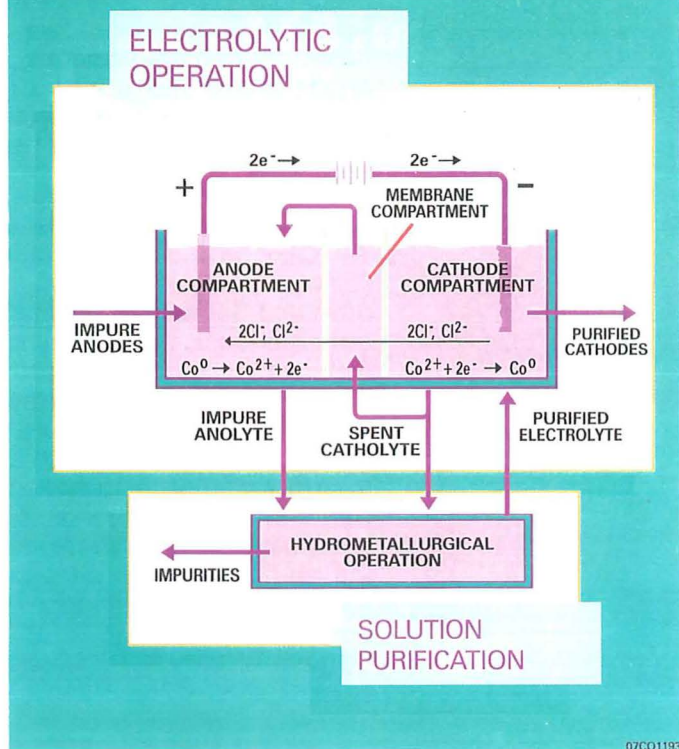


Fig. 3 - Schematic diagram of DMEC operation

acid washed carbon alleviated the iron problem. The lead contamination was thought to be associated with the graphite anode contacts used in the DMEC. An acid preleach of the graphite was conducted prior to the second and third demonstration operations.

Analysis of cathodes from the third continuous demonstration, cathodes 2 and 3, indicated that the cathodes met criteria for all 29 elements mandated by the P13-R6 grade A specification. Table 1 compares the DOD specification to the stockpile cobalt and the DMEC cathode products. Figure 4 shows several cobalt cathodes that were produced along with the impure stockpile material.

## Summary

DMEC technology coupled with conventional hydrometallurgical solution purification procedures successfully upgraded lower

quality stockpile cobalt yielding grade A cobalt cathodes. The upgraded cobalt contained >99.9% cobalt while meeting specifications for all 28 impurities.



Fig. 4 - Photograph of high purity DMEC cobalt cathodes and stockpile cobalt

## References

1. Federal Emergency Management Agency, Quality Assessment of National Defense Stockpile Cobalt Inventory (Contract EMW-C-1023). American Society for Metals, 1983, pp. 3-11.
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3. Redden L.D. and J.N. Greaves. The Technical and Economic Aspects of Producing High Purity Cobalt and Nickel from Superalloy Scrap Utilising a Double-Membrane Electrolytic Cell, Hydrometallurgy, Elsevier Science Publisher, v. 29, no. 1-3, 1992, pp. 547-565.

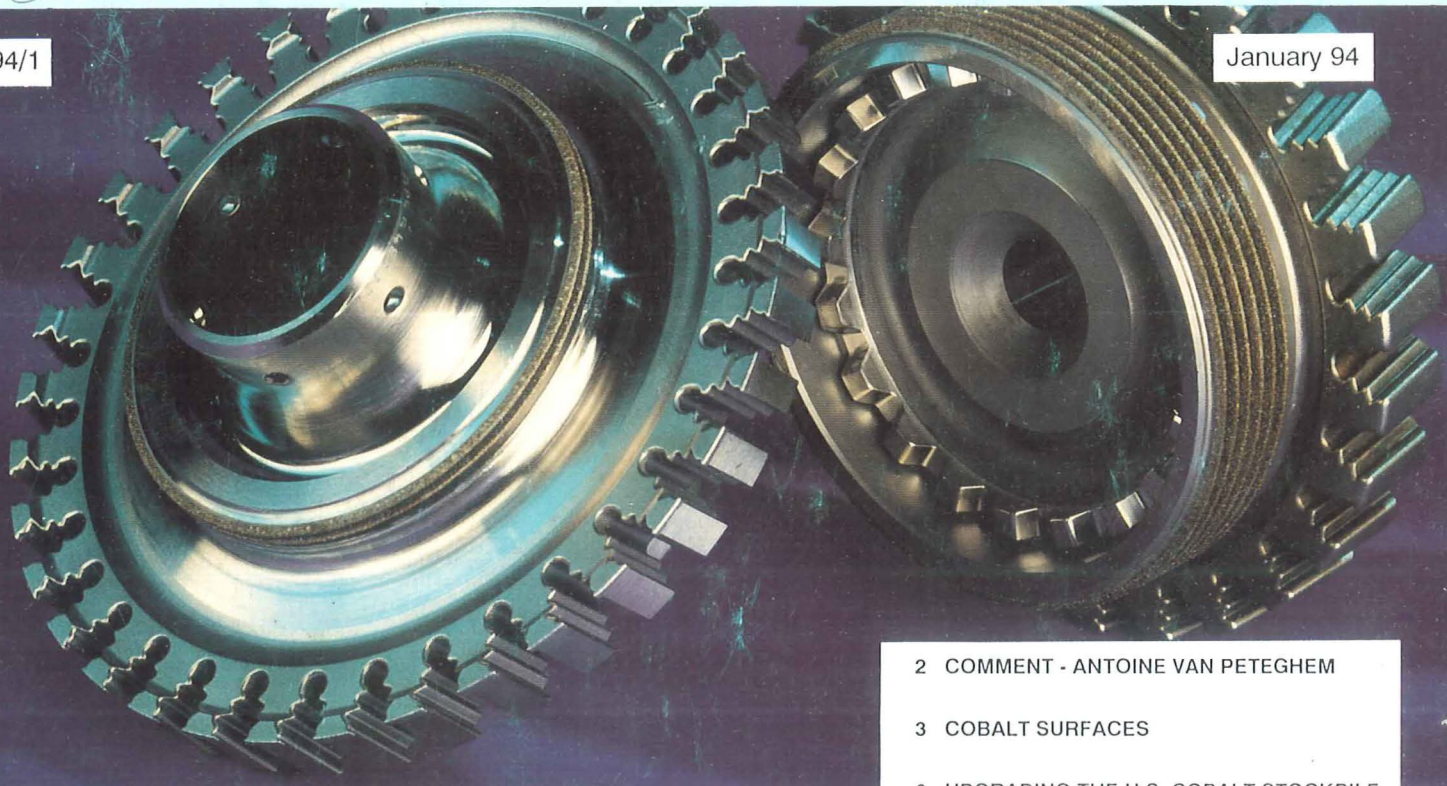
- \*1 Chemical Engineer
- \*2 Metallurgical Engineer
- \*3 Supervisory Metallurgist  
Salt Lake City Research Center,  
USBM, Salt Lake City, UT.

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