

Electrolytic Manganese - More Than Meets The Eye

Historically Electrolytic Manganese Metal (EMM) held a few basic critical and strategic uses, primarily in the alloying of Steel, Stainless Steel and Aluminum to name a few. Back in 1987 the US Gov't classified Manganese as a strategic metal and it was even considered strategic by the Dept. of Defense, (DOD) as far back as 1918. Not hard to understand when Manganese has no substitute metals in its many past steel applications and has itself (EMM) become a substitute for other more expensive metals in certain alloys thanks to new and innovative metallurgical discoveries.

Manganese, once held by the US Gov't in vast strategic reserve stockpiles are no longer in existence. They are gone, sold off. Today there are no domestic suppliers of EMM in N America and China controls 97% of the world trade in EMM. Manganese is the 4th largest traded metal worldwide, and you cannot make Steel without 10 to 20 pounds of Manganese per tonne of Steel depending on the grade and type of steel. Manganese can also replace the more costly Nickel alloy used in Stainless Steel.

Various refined forms of Manganese such as EMD (Electrolytic Manganese Dioxide) can be made from the same circuits and process as Electrolytic Manganese Metal. The USA is the largest consumer of EMD worldwide. Currently battery consumption of EMD is predicted to be the fastest growing segment of Manganese production worldwide. Chairman William Clay Ford Jr, of Ford Motor Company predicts 25% of all Fords future auto production will be electric vehicles by 2020.

As can be seen, changes are coming fast and furious in the broad spectrum of new applications for this strategic metal. With the world turning to "Green Energy" the realm of metallurgical scientists have become very interested in Electrolytic Manganese and as such have been, and are, hard at work advancing and defining new technologies and subsequent applications, many of which use EMM in the various discovery uses currently being made.

One of the first new widespread uses for EMM is used in the cathodes of Lithium-Ion batteries for Electric Vehicles (EV). EMD is used in the Anodes. This technology is already in use by GM's Chevy Volt, the Nissan Leaf and is in development by other automotive manufacturers. The

Argonne National Laboratory in conjunction with Envia Systems has developed this “High Capacity Manganese Rich Cathode” (HCMRC) battery and they claim it holds twice the charge of other Lithium-Ion type batteries currently in use, can be recharged in a few minutes and is approximately half the weight of other EV storage batteries as well as having a lower production cost than other comparable Lithium-Ion type batteries currently under development.

*Lithium Manganese Dioxide batteries (Li-Mn₂O₄) (LMD) contain 4% Lithium, 61% Manganese and 35% Oxygen by atomic weight.

The somewhat unspoken aspect of this new battery technology is the fact that every appliance, tool and EV using stored electricity will be revolutionized by this new discovery. Thinking of it in wider terms of marine and military vehicles, unmanned drones, forklifts, buses, even golf carts etc, the list seems endless. Lithiated Manganese Dioxide (LMD) batteries are already being used by Milwaukee Tools in their electric battery tools sector and this technology application is rapidly growing with many other tool companies.

LMD batteries, besides having a high power output & low production costs, also exhibit high thermal stability, and enhanced safety when compared to other Lithium-Ion batteries. The University of Illinois has recently created an advanced prototype battery using Lithiated Manganese that can be recharged in as little as two minutes.

With an estimated 30 million EV's being sold worldwide in 2011 and further estimated to rise to over 50 million by 2021 when you include the larger vehicles coming to market (according to a recent 2011 report by IDTechEx) using this technological innovation, the future for the EMM market looks bright indeed. They also state in this report that over 90% of the world's EVs are made in China, mainly for use in China.

On another front, researchers at the College of Science and Engineering at the University of Minnesota have developed an early stage Multi-ferroic Alloy that converts heat directly into electricity. This consists of a combination of Nickel, Cobalt, Manganese and Tin. In a quote from Prof. Richard James who led the research team he states, **“This research is very promising because it represents a new method for energy conversion that has never been done before.”** They also state in their report that even

though this technology is in the early stages of development it could potentially be used to capture waste heat from a vehicles exhaust that would produce electricity for charging batteries in Hybrid cars. Another possibility includes rejected heat from Industrial and Power Generation Plants. This is just one more of the many emerging new scientific discoveries being made concerning EMM.

Another example of constant change and innovation in the Manganese sector is this new technology for Wind and Solar Farms grid electrical storage recently announced this month by researchers at the DOE Pacific Northwest National Laboratory and China's Wuhan University. They have developed a large scale Sodium, Ion, Manganese Oxide battery that is more energy efficient and lower cost than Lithium due to the size and scale of batteries needed to store large grid scale electricity. This research is still early stage and ongoing.

The Days of Infinite Mineral Deposits and Low Base Metals Prices Are Over.

History will show the transition that began as we entered the 21 Century. China is showing us that transition by buying up strategic metals deposits and energy reserves around the world and other nations will follow suit as time goes on. It is time for N America to wake up to this stark reality. Its name is **“Protectionism”**

While the US is still imposing a 14% import tax on EMM and China is levying a 20% export tax, S Korea is now dropping its import tariffs on Manganese. With N America having no strategic reserves of EMM, nor any domestic mines of same and China controlling the market by 97 to 98% worldwide, combined with the fact that 2010 world production of Manganese Ore stood at 47 M Tonnes it seems that the time is ripe for a new player in the N American domestic EMM production field. We must achieve domestic production in order to remain globally competitive in the Green Energy sector as well as in the many other widespread aspects of EMM usage, especially to regain competitiveness in the vast steel industry in which the US was the leader in world production for over 100 years.

China's stranglehold and dominance of the EMM market truly represents a very serious supply threat to the rest of the world and yet there is one US

based and very large advanced stage EMM mine project in Arizona that potentially could and can change all that.

We need a long term EMM ‘domestic’ supply chain. A supply chain that is not at the mercy of a competitor nor a potential adversary.

Due to the extensive and advanced stage work currently being accomplished by American Manganese Inc, at their Artillery peak, Arizona Manganese deposit (Current NI-43-101 Resource, Indicated 6.76 Billion pounds & Inferred 8.8 Billion pounds) the USGS & Arizona Geological Survey (AZGS) are now showing substantial renewed interest in the area & project. The AZGS is now undertaking the remapping and defining of the area’s Manganese & other minerals in the Artillery area. The USGS has termed the Artillery Peak deposit as the largest low grade Manganese deposit in the US in various reports since the 1940’s.

American Manganese, subsequent to previous work by US Bureau of Mines, commissioned by the US Gov’t in WW 2 to exploit America’s lower grade Manganese resources is now leading the way in becoming the next and only Electrolytic Manganese Metal producer in the US. This prior research led to the creation of an operating plant at Three Kids, Nevada. Concurrent with this, the Bureau of mines created a process for producing EMM. This process for EMM manufacture is used today in China and S Africa. A variation of this Electrolytic process has now been updated and revamped thru new technology and design for American Manganese Inc by their subcontractor, Kemetco Research Inc, and has already been placed under US Patent application.

With extremely high electrical costs in China and S Africa as well as depleting domestic supplies of Manganese in China, both countries are producing EMM at or about \$1.30 cost p/lb. The current EMM price as of 06/11 was \$1.54 FOB Rotterdam, \$1.80 FOB US E Coast (including the 14% import duty).

The “Preliminary Economic Assessment” (PEA) 2009 study completed for American Manganese has a NI-43-101 estimated cost per pound of production @ \$0.44.

With this updated, robust & energy efficient process having been developed by Kemetco & American Manganese, mining EMM is now entering the

realm of “Green Mining Technology” with greater than 90% extraction rates thru low electrical and minimal water usage. The mining process also ends up with benign toxicity in tailings, which can be replaced immediately into reclamation areas. A continuous bench scale test pilot facility is currently being built for further testing of up to 20 Tonnes of Artillery Peak Manganese Oxide Ore by Kemetco laboratories at present, to further prove this patent pending, conceptual process which is expected to be completed in August 2011. Wardrop (a Tetra Tech Co) is currently engaged in preparing the Artillery project Pre-Feasibility Study.

It would appear that for all intents and purposes, the US is on the threshold of having a potential world class, domestic supply with a low cost, minimal impact & much needed EMM mine some time in 2014. This at a time in history when EMM finds new large scale demands in green energy, electronics, specialty steels and aluminum alloys, and a world ever growing and expanding, not to mention one with much neglected old and out-dated infrastructure needing replacement and upgrading.

The worlds need for critical metals is infinite, but the resources are not. Remember the words ‘China’ & ‘Domestic Protectionism’ you will hear them a lot in the years ahead.

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