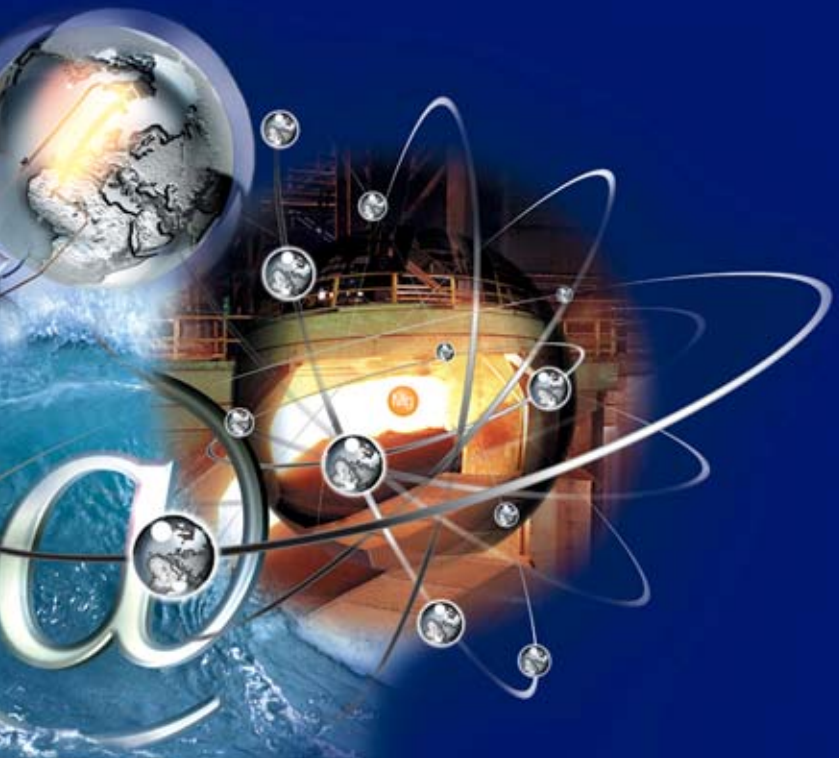
Magnesium Elektron

SERVICE & INNOVATION IN MAGNESIUM

Mining and Generation of Magnesium Alloys



Kenneth J. Clark
Magnesium Elektron

Wednesday, October 22nd, 2008
IAMFTWG
Atlantic City, NJ

AGENDA

- Magnesium!
- Extractive Metallurgy
- Alloy Development History
- Wrought Plate Manufacturing
- Machining Magnesium

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Magnesium

Magnesium is the eighth most abundant element by mass of the earth.

It’s a fact that magnesium is a necessary element for all living organisms, both plants and animals.

The green material in plants, chlorophyll contains magnesium.

Human beings also need magnesium.

The U.S. National Academy of Sciences has estimated that a nation-wide initiative to add calcium and magnesium to soft water might reduce the annual cardiovascular death rate by 150,000 in the United States.

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Magnesium

Magnesium is not found in a pure form because it bonds with other elements. It's necessary to apply a process to retrieve a usable amount of Mg.

The majority of magnesium product produced today is obtained from the processing of naturally occurring minerals such as magnesite (magnesium carbonate), magnesium chloride rich brine, and seawater.

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Magnesium Sources

A cubic mile of seawater is estimated to contain six million tons of magnesium

There are more than 300 million cubic miles of seawater

sea water

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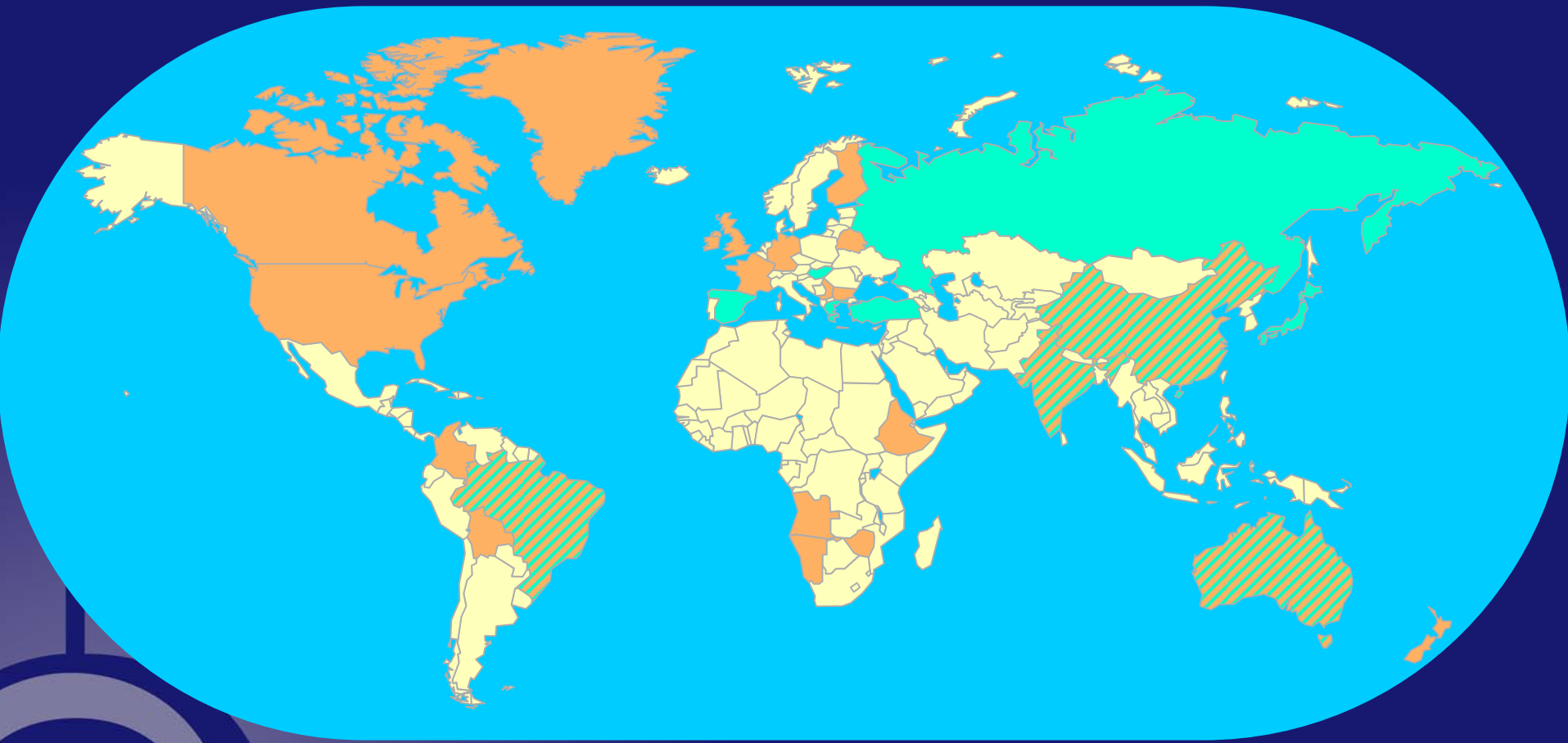
SERVICE & INNOVATION IN MAGNESIUM

Magnesium Sources



magnesite ores

dolomite ores

sea water

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SERVICE & INNOVATION IN MAGNESIUM

Sea Water Electrolytic Extraction Process

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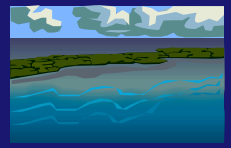

Sea Water

Dolomite Rock

Kilns

Precipitation to
Magnesium Hydrate

Filters

$Mg(OH)_2$

Purifier

Neutralizers

HCL from
Organic
Chlorination

Drier
Dehydration
From 35% to 73%
$MgCl_2$

Hydrochloric
Acid Furnace

+

–

Electrolytic
Magnesium Cells

Chlorine

Liquefaction

Liquid
Chlorine

Refining, Alloying
& Casting

Magnesium
Ingots

The Electrolytic Extraction Process

Brine Concentration Ponds

Purification Plant

Electrolytic Magnesium

Transportation to the Cast House

Ingot Casting Line

The Thermal Reduction Process

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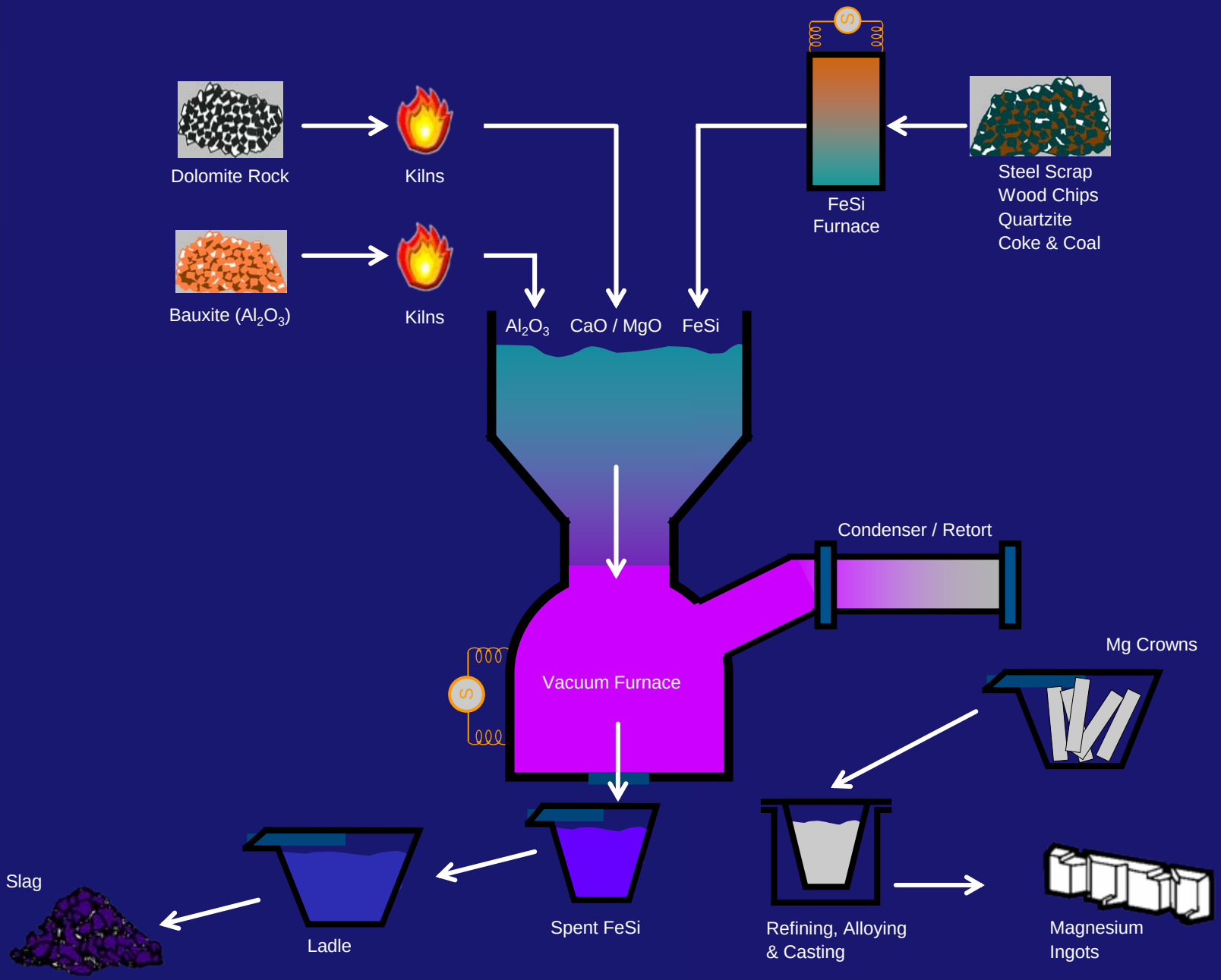
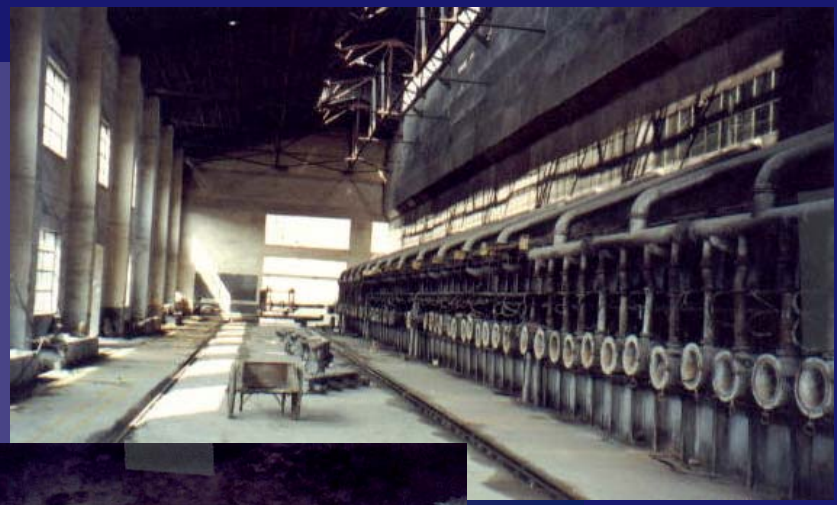
SERVICE & INNOVATION IN MAGNESIUM

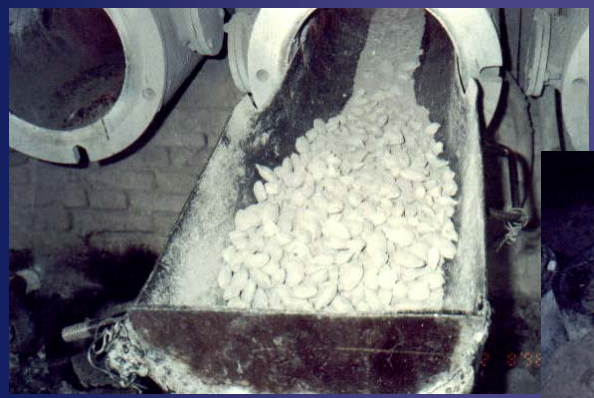


The Thermal Reduction Process

Dolomite
Mine

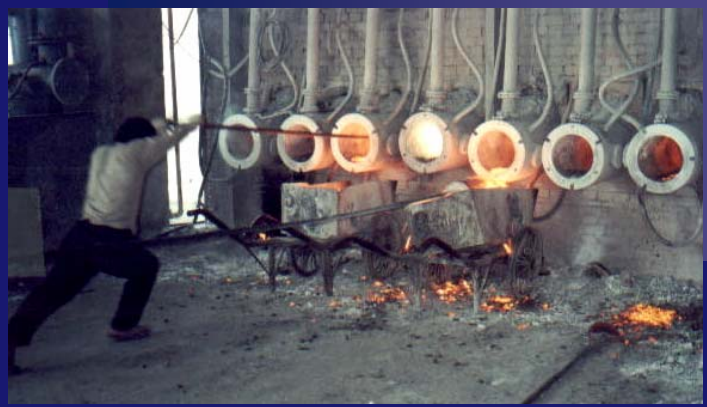
Reduction Building
With 64 Retorts





Briquettes Being
Charged into
Retorts

Magnesium Condenser
Tubes with Crowns



Unloading Slag
From Retorts

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Magnesium Alloy Development History

SAND CASTING ALLOYS

Al - Zn - Mn 1930s → mid 1980s → — AZ63A AZ81A AZ92A AZ91C AZ91E

~~Zn - Zr~~ 1940s → — ZK51A ZK61A

Zn - RE - Zr late 1940s → late 1960s → — EZ33A ZE41A

~~Zn - Th - Zr~~ early 1950s → — HZ32A ZH62A

Ag - RE - Zr early 1960s → — QE22A EQ21A

Y - RE - Zr late 1980s → — WE54A WE43B

Nd-Gd-Zr late 1990s → — Elektron 21 EV31A

Magnesium Alloy Development History

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Magnesium Alloy Development History

WROUGHT ALLOYS

Al - Zn - Mn 1930s →

M1A
AZ80A AZ61A
AZ31C AZ21A

Zn - Zr 1940s →

ZK30A
ZK60A

Zn - RE - Zr late 1940s →

EZ33A
ZE41A

~~Zn - Th - Zr~~ early 1950s →

HM21A HM21A
HK31A

Ag - RE - Zr early 1960s →

QE22A
EQ21A

Y - RE - Zr wrought early 2000s →

WE54A
WE43B

Nd-Gd-Zr early 2000s →

Elektron 21
EV31A

Elektron675 mid 2000s →

Now developing large scale production capability

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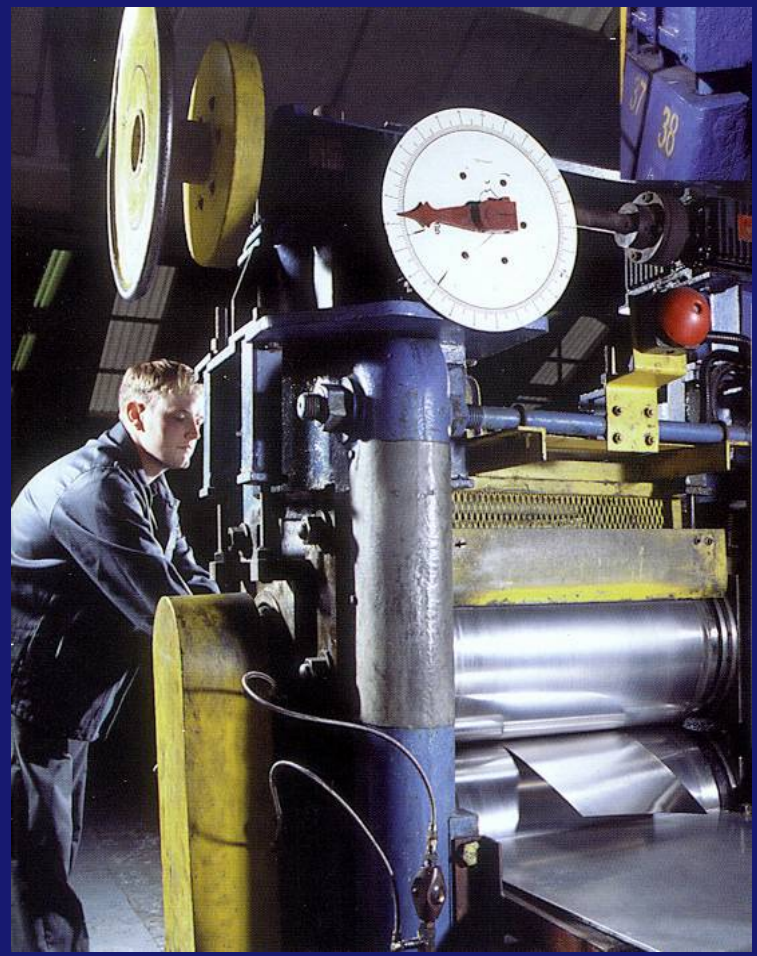
SCALE

DEVELOPMENT



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SERVICE & INNOVATION IN MAGNESIUM

MENA

Cast house

Rolling mills

½ mile

Rogan St

Merrodocia Ave

Allen St

Salvator St

© 2006 Navteq

MENA Large Scale Hot Mill

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Machining Magnesium

Tool life

With carbide tools, tool life when machining magnesium alloys is *five to ten times the life when* machining aluminum alloys. Tool life is also favorable using high speed steel.

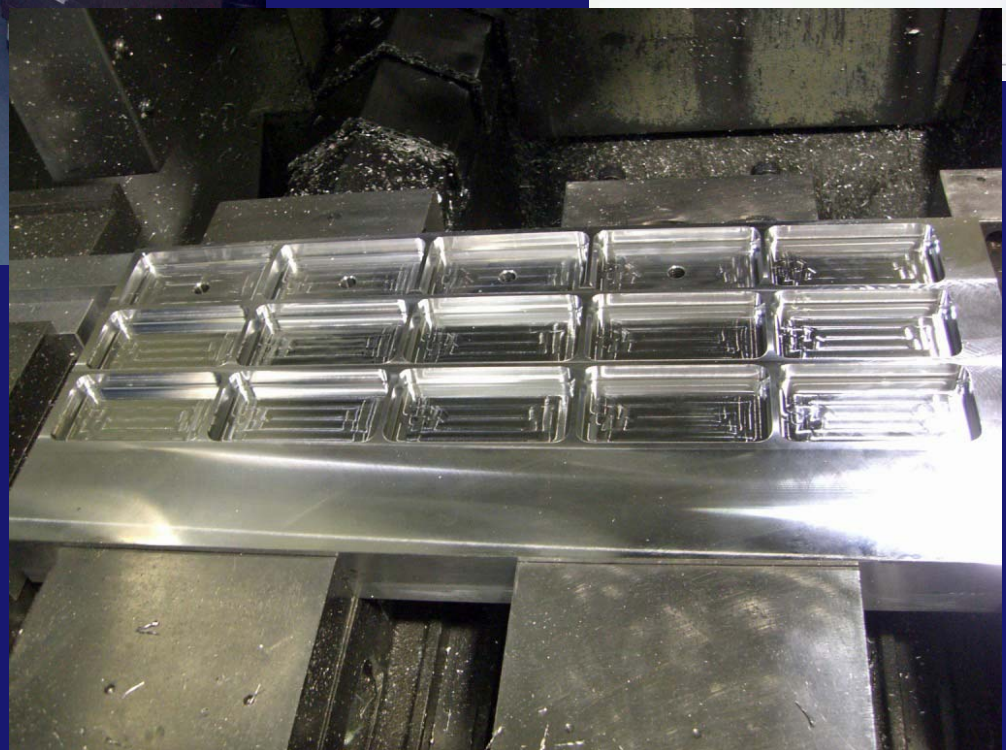
Power required

The table below gives a good indication of the relative power requirement for machining various metals:

Magnesium alloys	1.0
Aluminum alloys	1.8
Cast iron	3.5
Mild steel	6.3
Titanium alloys	7.6

Wonder Machine Services Inc.

Wonder Machine Services, Inc.



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Thank you for your kind attention!

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