

Stainless Steel

L. David Roper

<http://arts.bev.net/roperldavid/>

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Introduction

High quality steel is about 96.5% iron with about 2% carbon added to it, which acts as a hardening agent. It also contains about 1.5% manganese to provide tensile strength. For this study these percentages will be considered as the necessary components of steel.

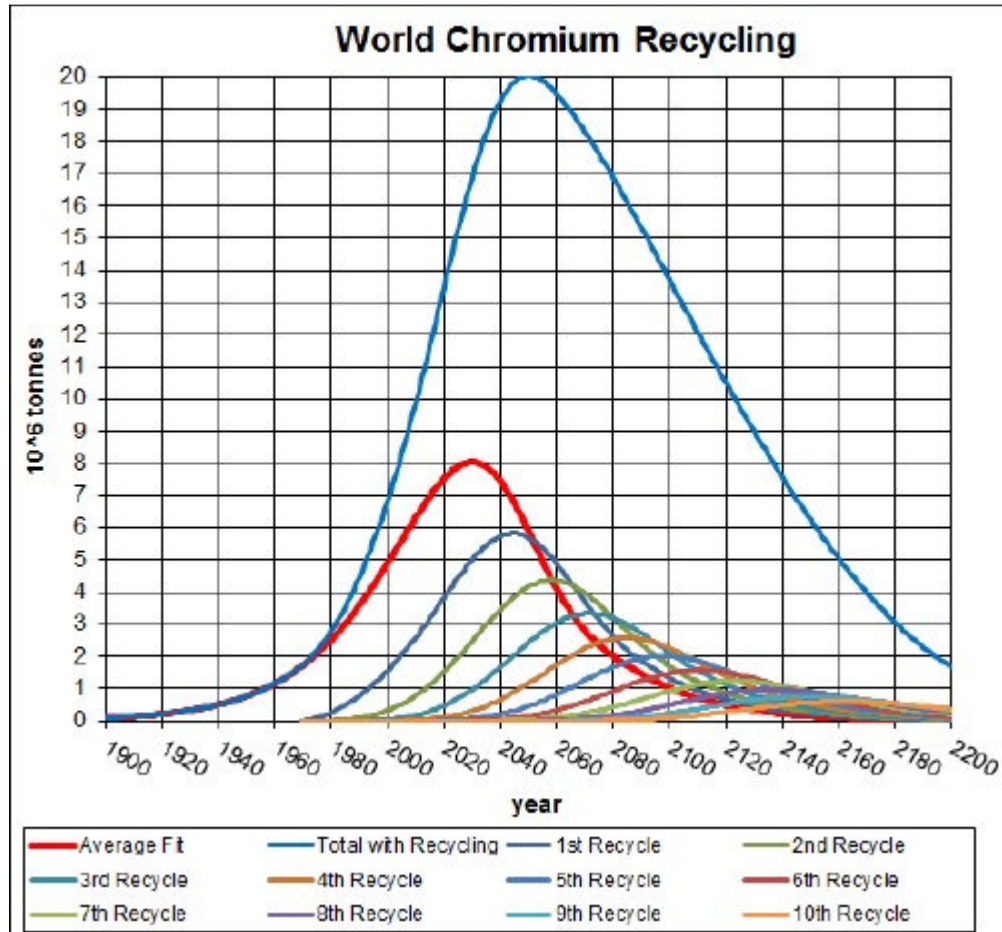
Stainless steel, invented in early twentieth century, is highly corrosion resistant. The anti-corrosion is due to ~11% by mass of chromium which forms a layer on the steel. So, for this study it is assumed that stainless steel has the following components:

1. 85.5% iron
2. 11% chromium
3. 2% carbon
4. 1.5% manganese

This study will consider the world depletion situations for iron ore, chromium and manganese and the impacts those depletions will have on the production of steel in the future. It is assumed that any limits on the availability of carbon are negligible compared to the iron-ore, chromium and manganese limits.

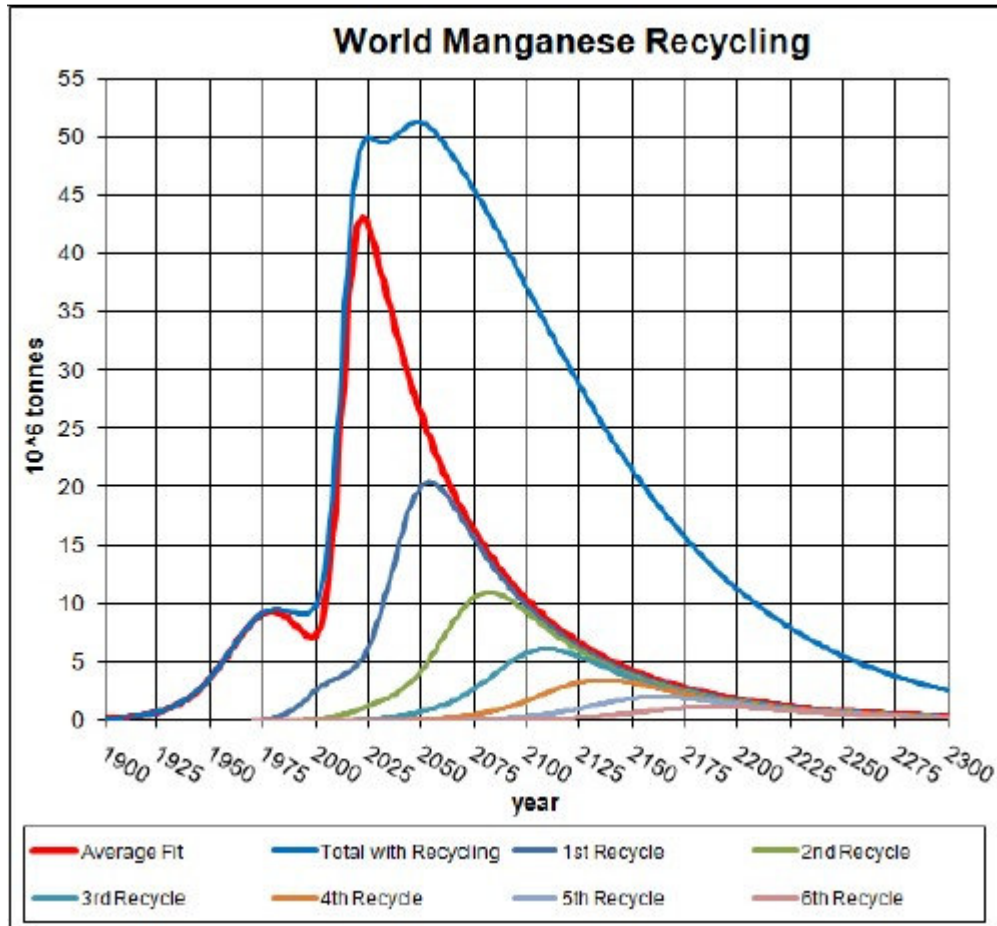
Chromium Depletion

In a previous study (<http://www.roperld.com/science/minerals/chromium.htm>) the author has dealt with chromium depletion. Making some assumptions about reserves and recycling, the following curve was obtained for chromium depletion:



Manganese Depletion

In a previous study (<http://www.roperld.com/science/minerals/manganese.htm>) the author has dealt with manganese depletion. Making some assumptions about reserves and recycling, the following curve was obtained for manganese depletion:



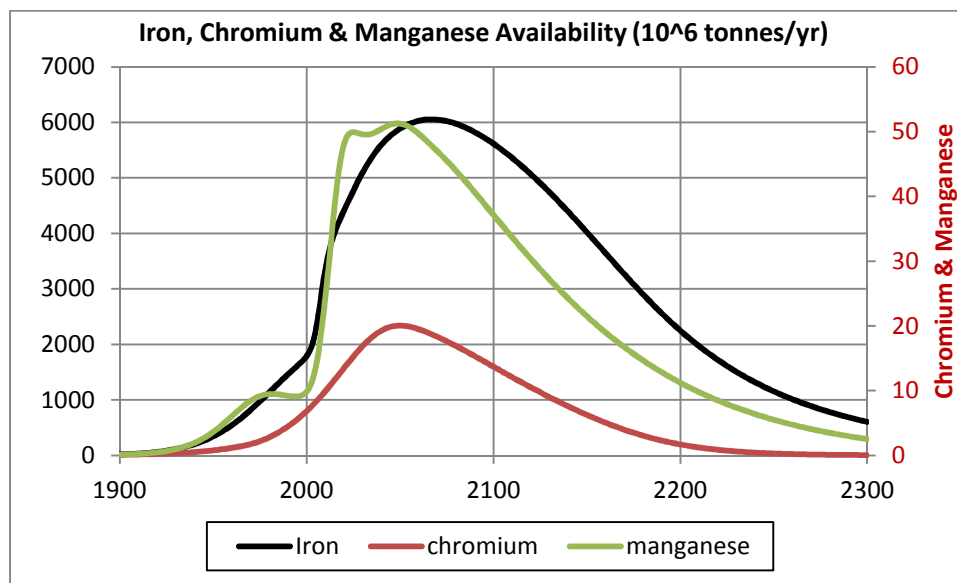
Stainless-Steel Production

For this study it is assumed that stainless steel has the following components:

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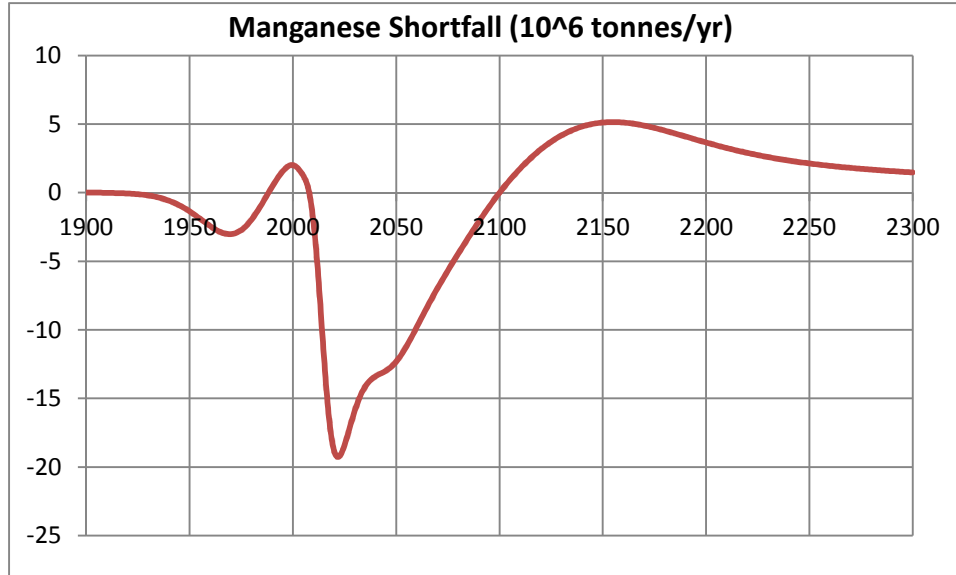
Further assume that iron ore [magnetite (Fe_3O_4) and hematite (Fe_2O_3)] is about 70% iron.

The yearly availability rates, including recycling, for iron, chromium and manganese plotted together are:



Manganese Shortfall

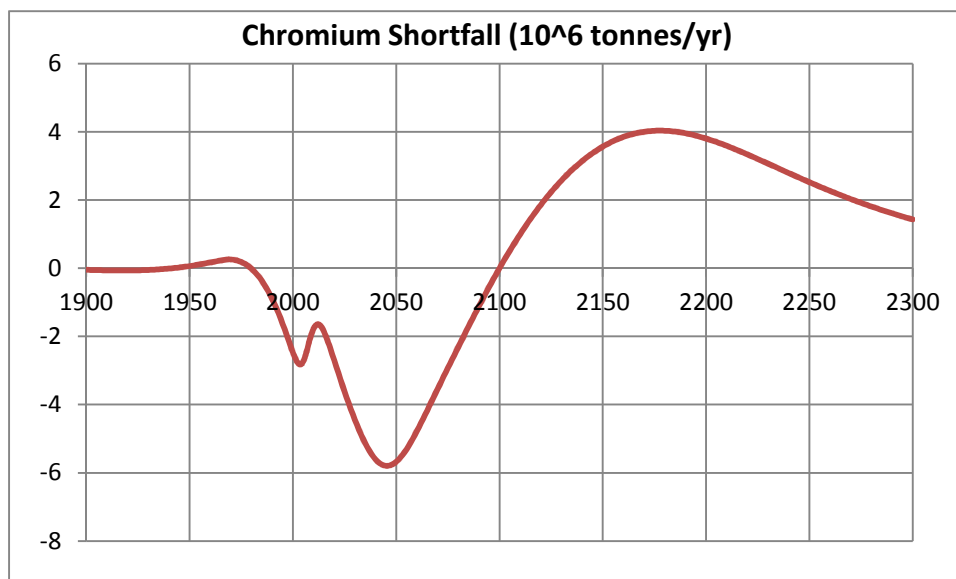
Using the stainless-steel components given above, there would be a shortfall of manganese for making stainless steel starting at year 2100 if more than 44% of the iron available were used to produce stainless steel:



This same shortfall applies to all steel production, since about the same amount of manganese is needed to make steel in general.

Chromium Shortfall

Using the stainless-steel components given above, there would be a shortfall of chromium for making stainless steel starting at year 2100 if more than 2% of the iron available were used to produce stainless steel:



So, the first bottleneck for making stainless steel will occur by a shortage of chromium, if the assumptions of this study are approximately correct.

References

- Iron (<http://en.wikipedia.org/wiki/Iron>)
- Steel (<http://en.wikipedia.org/wiki/Steel>)
- Stainless Steel (http://en.wikipedia.org/wiki/Stainless_steel)
- Chromium (<http://en.wikipedia.org/wiki/Chromium>)
- Manganese (<http://en.wikipedia.org/wiki/Manganese>)

Note that minerals are “extracted” from the Earth, not “produced”. Steel is produced from extracted iron, chromium and manganese ores.