HIGH TEMPERATURE CORROSION OF METALS 
IN PURE SO₂

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The study of corrosion of metals in 
SO₂ has a great technical importance 
both for the simultaneous presence of O 
and S in many industrial processes and 
for the increase of the corrosion rate 
in these atmospheres in comparison with 
the corrosion in O₂.

In this work the relevant results in 
the study of the corrosion of various 
metals (Cr, Mn, Fe, Co, Ni, I) in 1 atm SO₂ 
at 600–1000°C are reported; the weight-
change of the samples was followed by a 
quartz-spring thermobalance, whereas the resultant corrosion layers were analyzed 
by means of X-ray diffraction, optical 
and electron scanning microscopes, and 
X-ray microanalysis.

The results show that this reaction 
leads to the production of a mixture of 
oxides and sulfides, with the exception of 
Cr for which only a small concentra-
tion of sulfur dissolved in the oxides 
has been observed. The sulfides tend to 
concentrate in the inner region of the 
scale, even if in some cases they extend 
up to the outer scale surface. In some 
cases (Co, Ni) the formation of sulfides 
takes place mainly at the scale surface 
even after some hours of reaction while 
for others (Mn, Fe) it occurs at this 
site only during the initial stages of 
the reaction but inside the scale at 
longer reaction time. In the corrosion 
of Ni and Co a continuous layer of sul-
fide free from oxide is formed directly 
and contact with the metal, presumably 
corresponding sulfide. At sufficiently 
high temperatures (above 637°C for Ni 
and 875°C for Co) the sulfide is molten 
and shows a tendency to attack preferen-
tially the metal along the grain bound-
daries. However, the nature and distrib-
ution of the phases present in the 
scale depend on the gas pressure, as well 
as on the condition of thermodynamic 
stability of the different phases, and 
on the relative rate of the different 
possible reactions in the various sys-
tems.

At last the kinetics of the reaction 
are usually irregular and only in spec-
ial cases approximate to a parabolic-type 
rate late. The reaction rate is much 
higher than that measured in pure oxy-
gen at the same temperature for Fe, Co 
and Ni, while for Cr and Mn it does not 
differ appreciably.

IMPACT TOUGHNESS OF AISI 4340 STEEL 
VERSUS NON-METALLIC INCLUSION 
DISTRIBUTION

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Studying mechanical properties of 
AISI 4340 ESR premium quality steel, 
efforts have been made to find a signi-
ificant parameter between the impact 
energy of Charpy-V specimens and the 
distribution of non-metallic inclusions 
of fracture surfaces.

Transverse Charpy-V specimens show 
arrays of very long inclusions parallel 
to the notch, due to the reduction of 
the ingot by rolling procedure.
The MnS inclusions are the main in-
clusion contents and, just due to their 
elongated shape, they seem to be the 
most critical for the propagation of 
the fracture, especially for the heat 
treatment in the region of ductile frac-
ture by microvoid coalescence.

The most sensitive parameter connect-
ed with impact energy has been found to 
be the linear distance between MnS in-
clusion on transverse Charpy-V specimens 
from bars with a gradient of very low 
sulphur content, both for ductile and 
brittle fracture.

To achieve good statistical distribu-
tion, results have been obtained analyz-
ing the SEM on-line images at a proper 
magnification.

Impact toughness in transverse di-
rection has been expressed as a linear 
function of the mean distance of elonga-
ted inclusions on the fracture surface.
The above mentioned linear relation-
ship has been checked for two different 
heat treatments.

Furthermore, the fracture profiles 
have been evaluated in order to better 
correlate the distance among inclusions 
and MnS volume fraction in both condi-
tions of heat treatment.