PRAYON

TACKLING CHLORINE CORROSION IN PHOSPHORIC ACID PRODUCTION : PRAYON's EXPERIENCE

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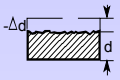
Phosphoric acid plants offer a stimulating challenge to the materials engineer

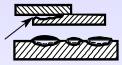
The types of materials degradation which are encountered in such plants are many and varied :

Different Types of Corrosion

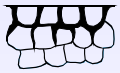


General Corrosion
Avaluable corrosion rate
g/m² ·d (mm/a)
f (medium, conc., T)

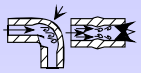
Pitting Corrosion
Local corrosion at passivable alloys
preferentially by chlorides (Br^-, J^-)
also at inclusions as MnS
f (Cl^- , v, T, pH)



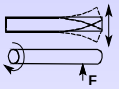
Crevice Corrosion
Local corrosion in narrow crevices, under deposits, in sealings
at passivable alloys in chloride media
f (Cl^-, T, v, O_2 , pH)



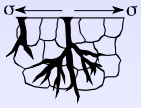
Intergranular Corrosion
Preferential attack of precipitations containing grain boundaries, e.g. stainless steels
(too high C, not stabilized)
f (medium, annealing, welding, T)



Erosion
Attack in media of high velocity, i.e. with turbulence and sharp bends
solid particles



Corrosion Fatige
Fatigue under corrosive conditions
f (frequency, σ, conc., T)



Stress Corrosion Cracking
Specific corrosion media and alloy system
high mechanical (also internal) stress
f (medium, σ, T)

Galvanic Corrosion
Galvanic series of metals:
the less noble metal dissolves
f (ΔE, λ, T)

Prayon's contribution in materials development

- 1960's : HV9 (later 904L)
  → Usines Emile Henricot in Belgium
- 1975 : Sanicro 28
  → Sandvik

Corrosion Resistance

Formation of an Oxyde Passive layer

Factors influencing corrosion

- Temperature
- Solids content and nature : Abrasion
- Impurities in the rock (trend to use lower grade rocks)

Influence of impurities on the corrosion rate

- Fluorides

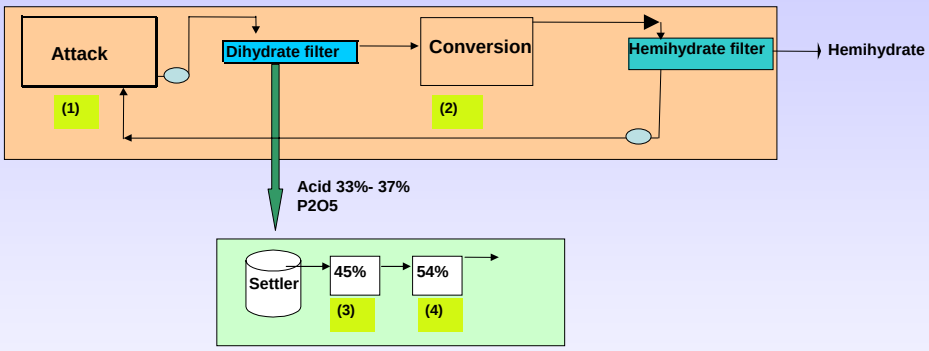
  (% SiO_2/60 + % Al_2O_3/102)/ (% F/114) > 1
- Sulfides
- Sulphuric acid
- Chlorides : locally destroy the passive layer => pitting

Acids used for laboratory Corrosion tests

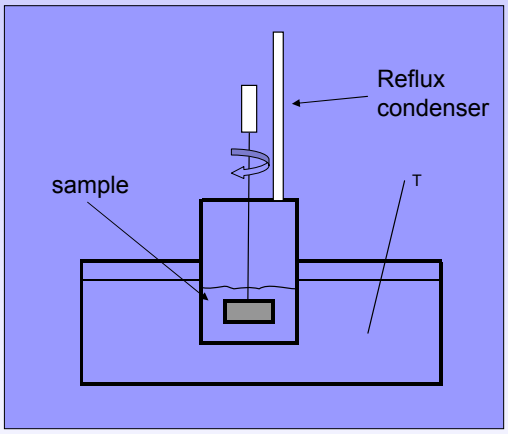
Plant acids	P_2O_5, wt.%	SO_3, wt.%	F, wt.%	$T_{testing}$, °C
1- Attack acid	33	1.6	1.8	90
2- Conversion Acid	24	9	1.6	105
3- Concentration Acid	45	2	approx. 1.4	125
4- Concentration Acid	52	2,2	approx 0.4	125

There are no sulfides, the chloride content has been varied by addition of NaCl

CENTRAL-PRAYON PROCESS

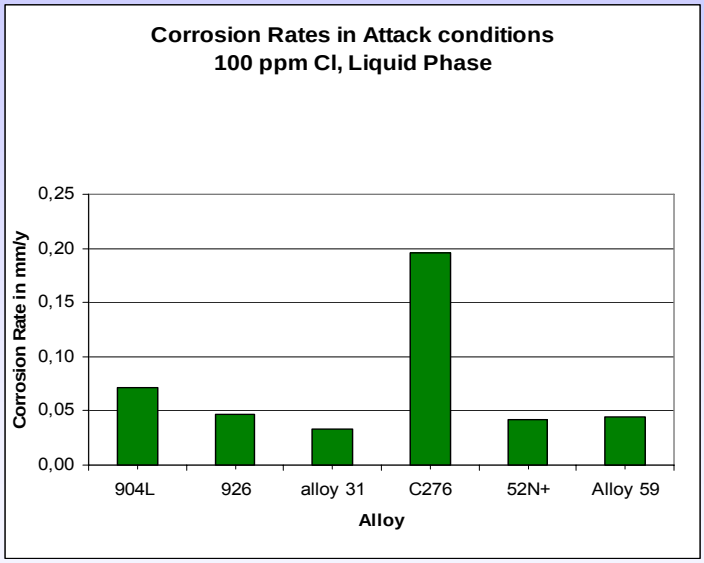


Laboratory Experimental setup

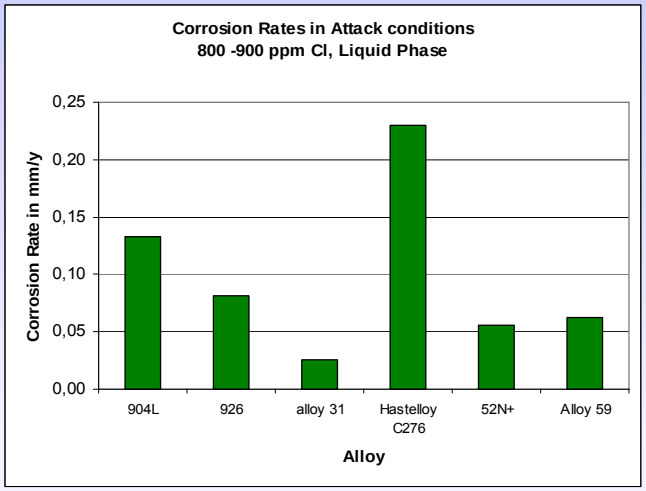


Four weeks
every week: weighing, fresh slurry

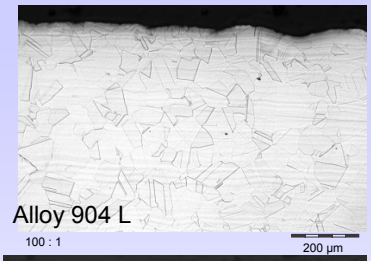
Laboratory results in Attack acid

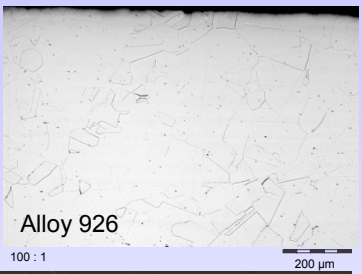


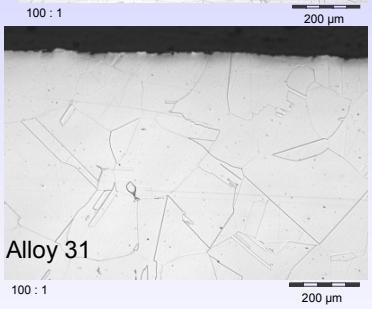
Laboratory results in Attack acid

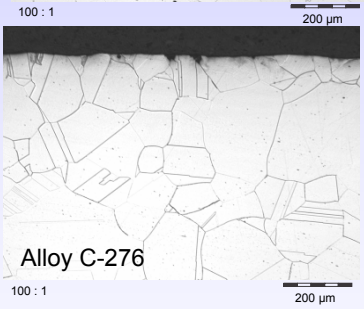


- Increase of general corrosion
- No signs of pitting observed

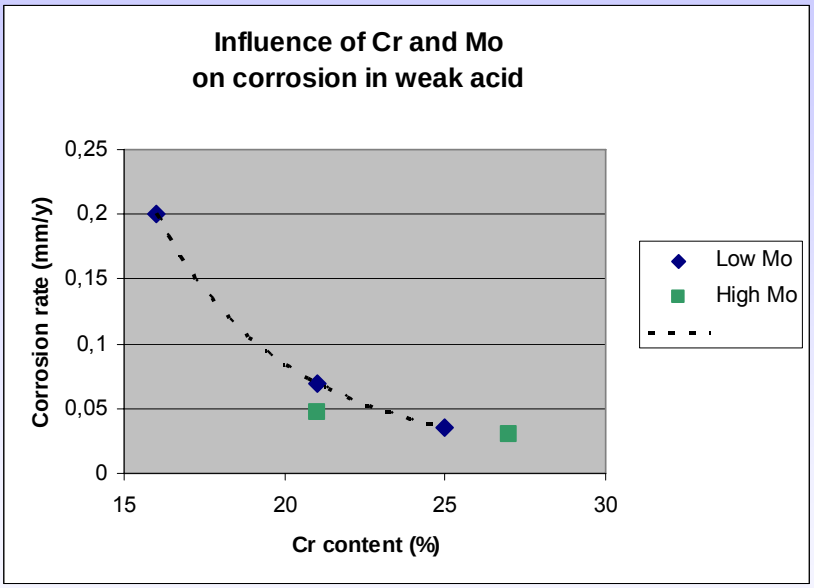

Alloy 904 L
100 : 1
200 µm


Alloy 926
100 : 1
200 µm

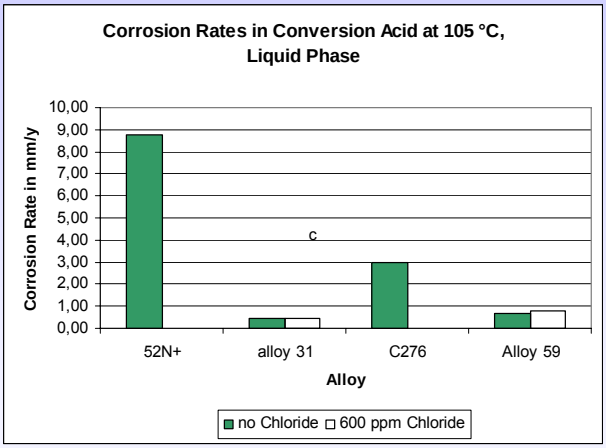

Alloy 31
100 : 1
200 µm


Alloy C-276
100 : 1
200 µm

Attack Acid


Influence of Cr and Mo
on corrosion in weak acid
Corrosion rate (mm/y)
0,25
0,2
0,15
0,1
0,05
0
15
20
25
30
Cr content (%)
Low Mo
High Mo

Laboratory results in Conversion acid



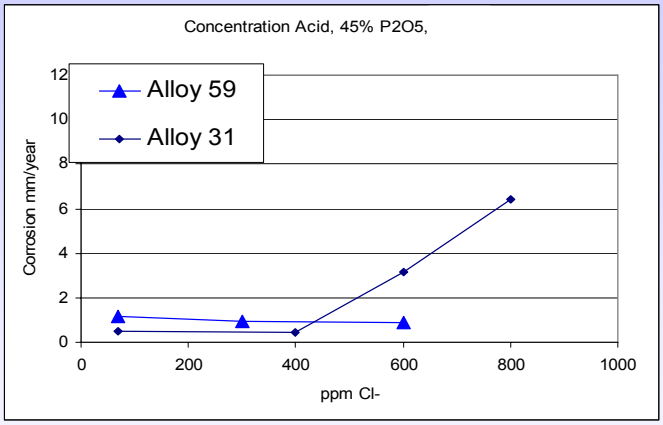
Concentration

Prayon heating elements:

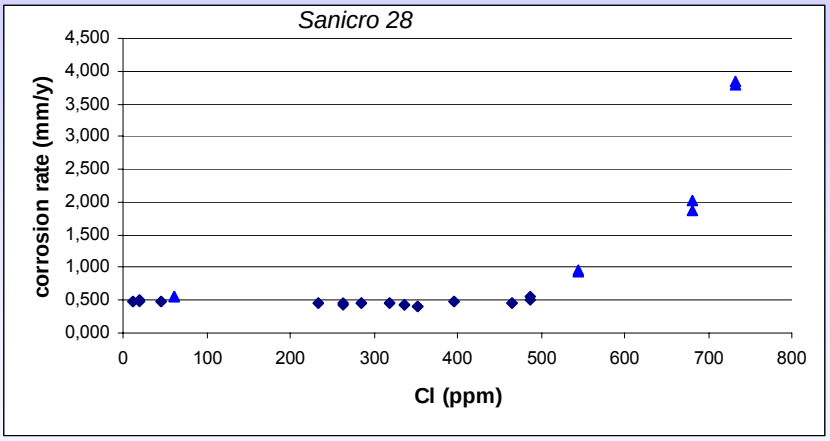
steam inside, acid outside,

open air vessel

Laboratory results in 45% P2O5 acid

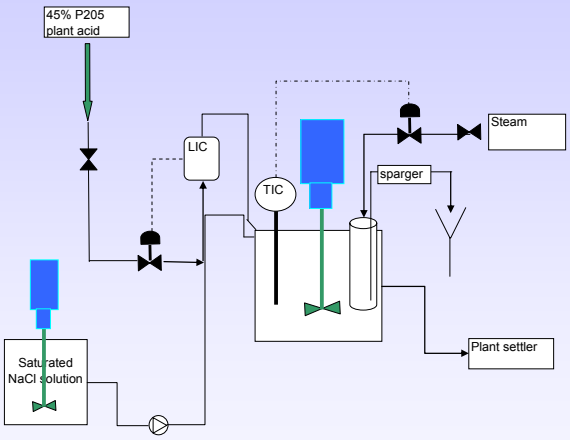


Laboratory results in 52% P2O5 acid



Pitting observed at high chlorine concentrations

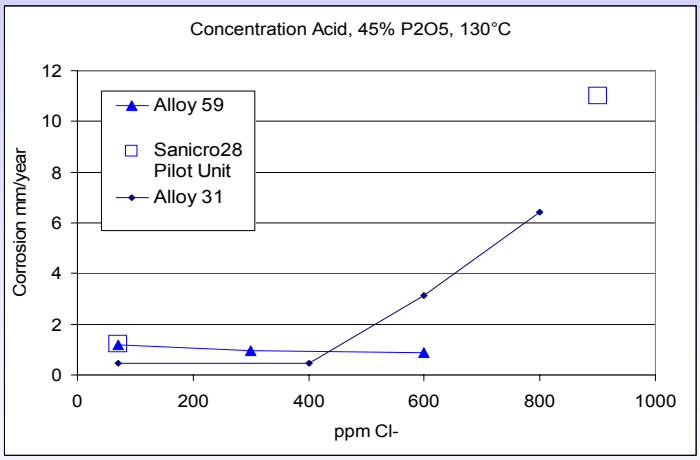
Pilot unit for heating element testing



Pilot unit

Pilot unit heating elements

Results from the pilot unit



Inside the Plant : Agitators

Z blade Agitators

Prayon Filter pans

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Conclusions and Outlook

- New materials are being developped
- Corrosion rate of alloys strongly depends upon the process conditions and the impurities content of the acid (Cl- ions studied here)
- Sometimes cheaper materials give better results than much more expensive ones.

We are running an important research program in materials:

- other impurities influence
- influence of abrasion
- electrochemical studies
- other process conditions

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