

# Mössbauer Spectroscopic Study of Chemical Effect of Ascorbic Acid on Corrosion Product of Mild Steel

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**Abstract:** A systematic study of the influence of ascorbic acid on the corrosion product of mild steel has been carried out using Mössbauer spectroscopy (MS). It is observed that practically ascorbic acid has very little chemical impact on the corrosion product of mild steel, like  $\beta$ ,  $\alpha$ ,  $\gamma$  FeOOH and ferrihydrite. While in corroding media it drastically affects the chemical process of corrosion.

**Keywords:** Mössbauer, Ascorbic Acid, Corrosion, Mild Steel.

## 1. Introduction

Chemical transformation of the surface of metal and alloys are of immense techno-economic importance. Nigam et al<sup>[1]</sup> reported that ascorbic acid behaves as a corrosion inhibitor when it is present in the corrosive media (concentration > 0.05M).

The efficacy of some of the reducing agents in inhibition of corrosion of mild steel is reported by Iovchev<sup>[2],[3]</sup>, Iovchev et al<sup>[4]</sup>. Recently Natalya et al<sup>[6]</sup> reported corrosion inhibition of carbon steel in acidic environment and Adriana et al<sup>[7]</sup> have reported corrosion inhibition of carbon steel in hydrochloric acid solution.

In present work a systematic study of the influence of ascorbic acid solution on corrosion product of mild steel corroded in different corrosive media.

1. Brackish water (pH=8.45). This water contained Cl<sup>-</sup> 22.60, SO<sub>4</sub><sup>2-</sup> 11.85, NO<sub>3</sub><sup>-</sup> 4.02, Na<sup>+</sup> 44.58, Ca<sup>++</sup> 1.90, Mg<sup>++</sup> 2.90, K<sup>+</sup> 0.06 mEq/l.
2. Aqueous solution of 0.1 M strength of Lithium Chloride and ammonium Nitrate.

The aim is to see whether the ascorbic acid has any influence on transformation of rust. M.S. is used because it is suitable for the identification of chemical state of iron.

## 2. Experimental

All the chemicals used were of *analytical reagent* grade. Mild steel plates of size 2.5\*2.5\*0.2 cm<sup>3</sup> were first polished mechanically and degreased by acetone and benzene prior to use.

These plates were immersed in different corrosive media for a week. The loss of water due to evaporation was compensated by addition of de ionized water twice daily. The solution was kept in stagnant condition.

After seven days sample were dried at room temperature. The rusted plates were then treated with solution of ascorbic acid of strength 0.5M and 3.0M until whole surface was thoroughly wet. Samples were dried at Room Temperature. Finally treated rust was scrapped from the surface for

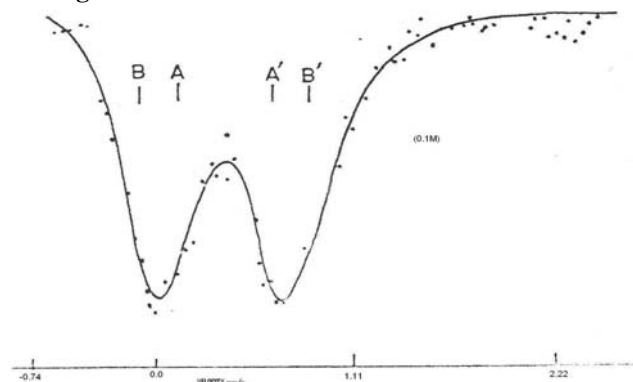
Mössbauer Spectroscopic investigations. Instrumental and Experimental setup is described in ref. [5]. Mössbauer spectra were recorded in transmission mode at Room Temperature. Isomer shift (IS) was determined with respect to centroid of standard  $\alpha$ -foil (25 $\mu$ m).

## 3. Results and Discussion

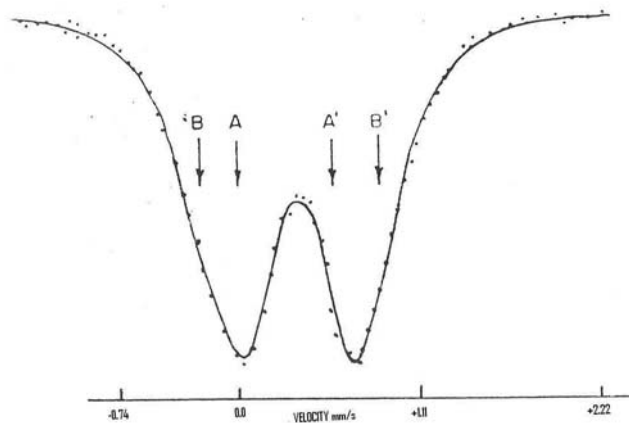
The typical Mössbauer Spectra obtained for rust of mild steel due to brackish water and electrolytes are given in fig. 1(a) and Mössbauer Parameter obtained for these spectra are given in Table 1. Mössbauer Spectra of transformed phases are shown in fig. 2 and respective Mössbauer parameters are given in Table 2.

From Table 2 it can be seen that when ascorbic acid was treated with rust, no Fe (II) species corresponding to QS=1.72mm/s and IS=1.17mm/s was observed as observed by Nigam et al<sup>1</sup>. On the other hand a weak doublet corresponding to Fe<sup>2+</sup> in high spin state was observed. It can also be seen that the transformation of rust into new phase is very small which indicates that practically ascorbic acid has very little chemical impact on rust transformation or on corrosion product like  $\beta$ ,  $\gamma$  FeOOH and ferrihydrite, while when it is used as a corrosive media it drastically affects the process of corrosion and suppress the formation of usual corrosion species like  $\beta$ ,  $\gamma$  FeOOH and ferrihydrite<sup>[1]</sup>.

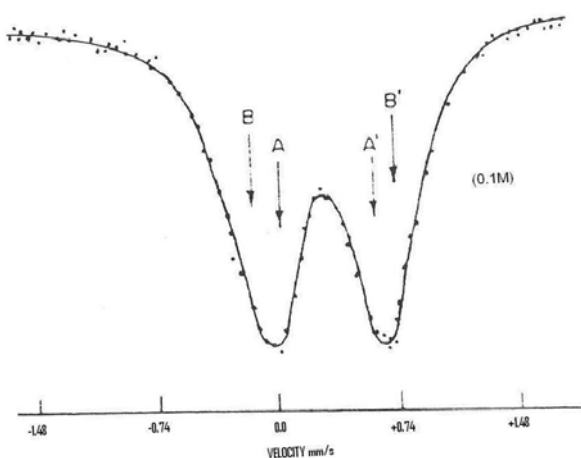
### 3.1 Figures and Tables



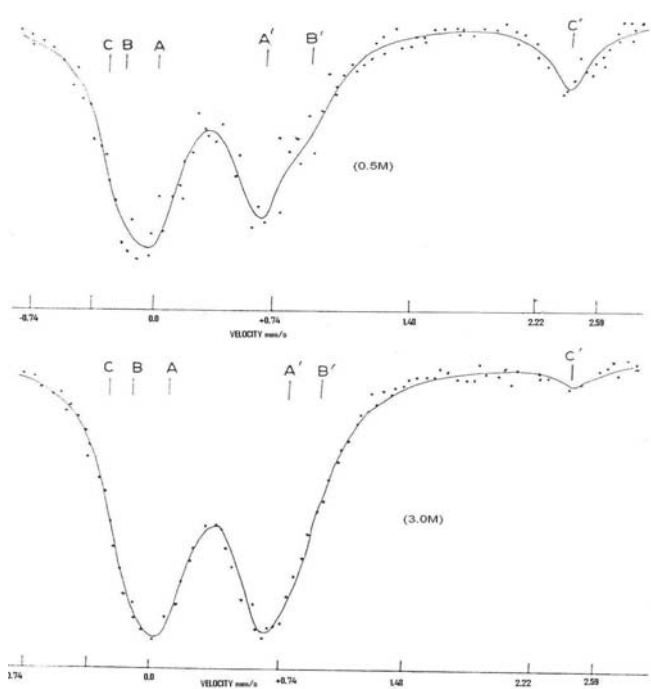
**Figure 1(a).** Spectra for rust of *Mild Steel* due to exposure in *Brackish Water* (7-Days)



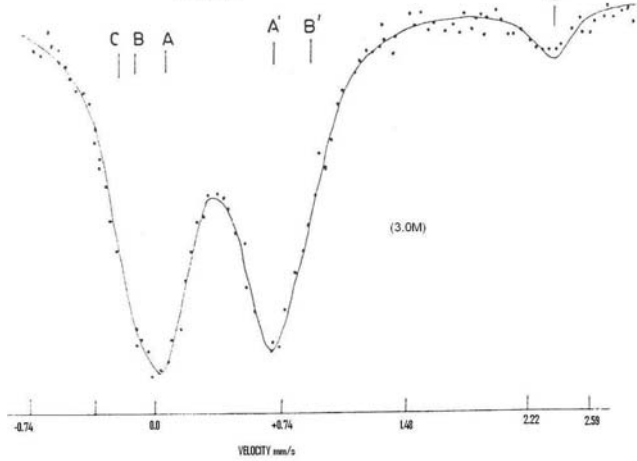
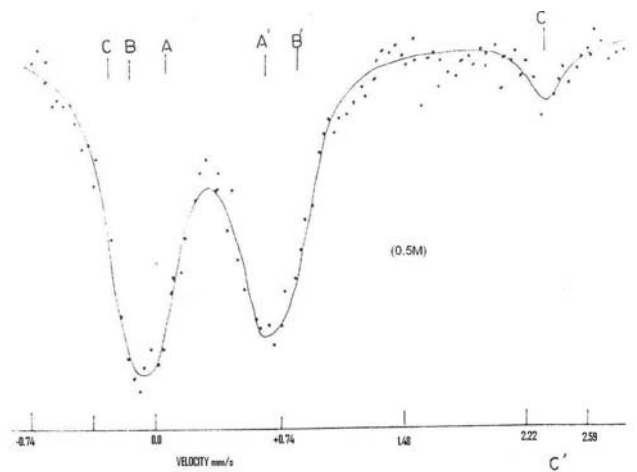
**Figure 1(b).** Spectra for rust of *Mild Steel* due to exposure in *Lithium Chloride* (7-Days)



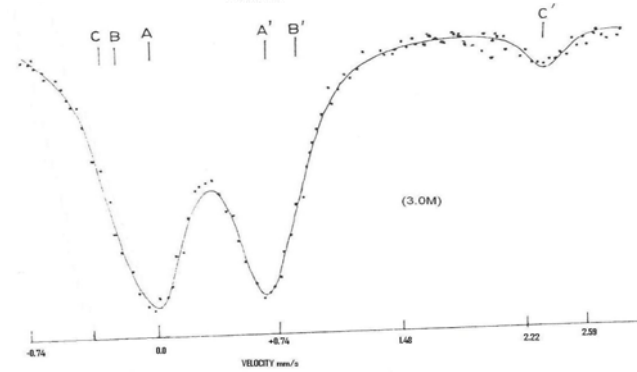
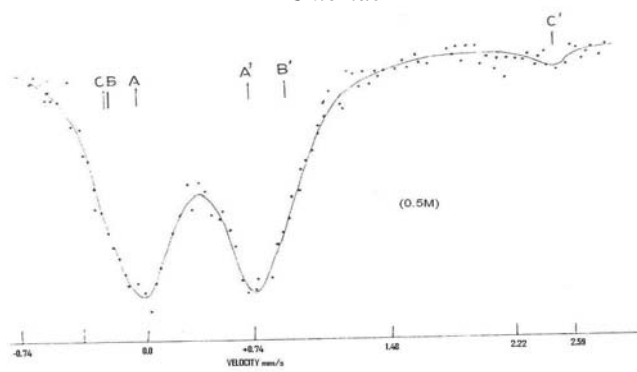
**Figure 1(c).** Spectra for rust of *Mild Steel* due to exposure in *Ammonium Nitrate* (7-Days)



**Figure 2(a).** Spectra of *Transformed Rust* (Concentration of Ascorbic Acid is indicated fig.) Corrosive Media *Brackish Water*



**Figure 2(b).** Spectra of *Transformed Rust* (Concentration of Ascorbic Acid is indicated) Corrosive Media *Lithium Chloride*



**Figure 2(b).** Spectra of *Transformed Rust* (Concentration of Ascorbic Acid is indicated) Corrosive Media *Ammonium Nitrate*

**Table 1:** Mössbauer Parameters of rust of mild steel due to different corroding mediums

Corroding Medium	Doublet	QS	IS	LW	A%	Species
		mm/sec				
Brackish Water	AA'	0.57	0.35	0.36	47	$\beta, \gamma$ FeOOH
	BB'	0.97	0.35	0.49	53	Ferrihydrite
Lithium Chloride	AA'	0.52	0.34	0.33	27	$\beta, \gamma$ FeOOH
	BB'	0.88	0.35	0.5	73	Ferrihydrite
Ammonium Nitrate	AA'	0.54	0.34	0.31	40	$\beta, \gamma$ FeOOH
	BB'	0.9	0.34	0.52	60	Ferrihydrite

**Table 2:** Mössbauer parameter of transformed phases of rust on the metal surface (in different corroding media)

Concentration of Ascorbic Acid(M)	Doublet AA'				Doublet BB'				Doublet CC'			
	QS	IS	LW	A %	QS	IS	LW	A %	QS	IS	LW	A %
	mm/sec				mm/sec				mm/sec			
<b>Brackish Water</b>												
0.5	0.63	0.32	0.41	66.0	1.09	0.38	0.30	15.0	2.70	1.1	0.3	10
3	0.56	0.36	0.42	58.0	0.96	0.36	0.41	37.0	2.66	1.11	0.3	5
<b>Lithium Chloride</b>												
0.5	0.62	0.34	0.39	60.0	1.11	0.34	0.3	10.0	2.62	1.14	0.3	13
3	0.61	0.36	0.45	65.0	1.03	0.38	0.38	25.0	2.61	1.11	0.3	10
<b>Ammonium Nitrate</b>												
0.5	0.67	0.34	0.48	85.0	1.11	0.3	0.30	10.0	2.72	1.14	0.3	5
3	0.64	0.35	0.45	75.0	1.04	0.37	0.37	15.0	2.64	1.12	0.3	10

## References

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