

# Effect of Cooling Water Fraction Of Salt in Low Carbon Steel Properties

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## Abstract

Low carbon steel plate is widely used in the field of construction that require high hardness and ductility . One method used to increase the hardness of the low carbon steel plate that is by quenching water plus salt . The results showed that the quenching is based on a study of 10% salt water has a hardness of 168 VHN with  $\sigma_u = 33.62$  ,  $\epsilon = 12$  % and the lowest is 15 % salt water quenching VHN 101  $\sigma_u = 30.30$  and  $\epsilon = 7.30$ % composition of the study above was 10 % salt solution in the cooling water will cause a decrease in mechanical properties .

Key Words : Quenching, Salt, Mechanical Properties

## 1. Introduction

Low carbon steel plate is widely used in the field of construction that required hardness and high ductility. In this research, through heat treatment processes include: hardening, quenching and tempering with medium air conditioning, water, water + salt ( NaCl ) 5 %, water + salt water + 10 % and 15 % salt. The chemical composition of the low-carbon sheet steel plate products of PT. Krakatau Steel is shown in the table below:

Unsur	Prosentase (%)	Unsur	Prosentase (%)
C	0,112	Ni	0,0143
Si	< 0,117	Mo	0,0065
Mn	0,443	Cu	0,0176
P	< 0,0008	Al	0,0381
S	< 0,0002	Fe	99,350
Cr	0,0085		

Low carbon steels containing less than 0.25 % carbon is therefore low carbon steel is less responsive to heat treatment.

The use of salt water cooling media with different percentages will affect the hardness of the test specimen can be seen in the graph increase in violence by using salt water cooling medium in the Figure below.

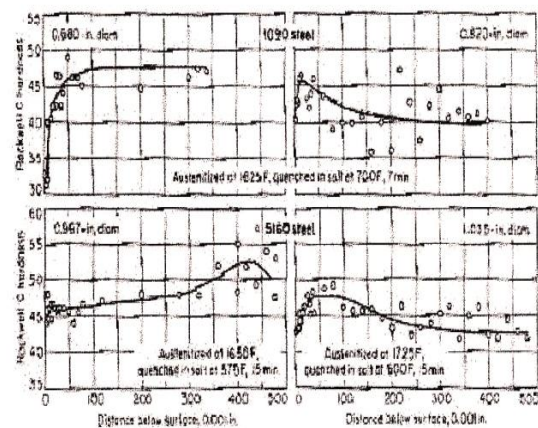


Figure 1. Relationship between the distance from the surface of the work piece surface brine solution during soaking or cooling [4]

From the results of previous studies [9] showed that the more the composition of the salt is dissolved

in water, air, increasing the hardness of the metal, as shown in Figure 2

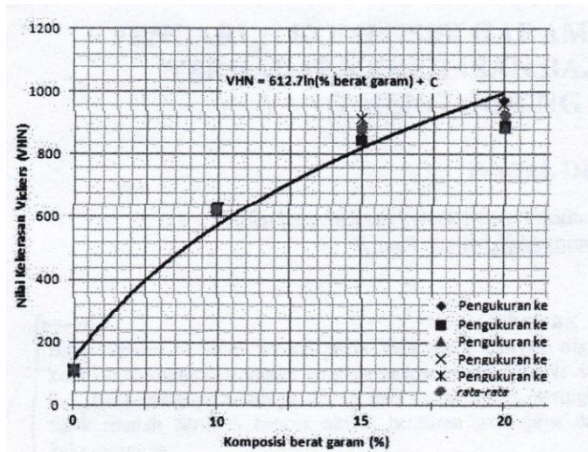


Figure 2. Curve Vickers hardness values increase in relation to the percentage weight of the composition in a solution of salt water cooling [9]

The Vickers hardness increases will approach a constant value at the higher salt composition. This is shown in Figure 3 below. .

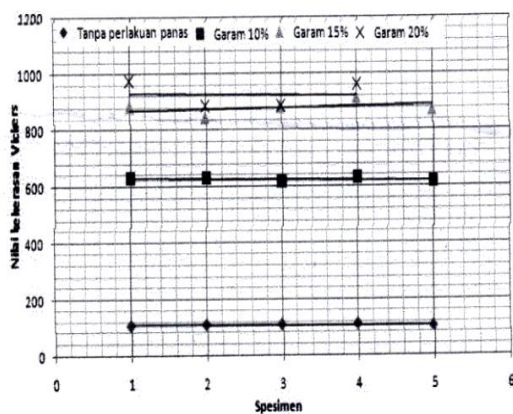


Figure 3. Comparison of the hardness using the composition of salts in water cooler [9]

## 2. Method and Procedure

Research at the laboratory of the University of Sriwijaya in Indralaya. Test specimens in the form of low-carbon steel plate thickness of 2 mm is cut to the size 200x32x2 mm and then molded into tensile test specimens are given heat treatment by heating to a temperature of 900° C and be detained for 30 minutes and then a rapid cooling following 5 to normalizing (air cooling), 5 with a cooling medium for cooling

water , cooling to 5 to 5 % salt water and cooling to 5 to 10 % salt water and five test specimens for cooling by 15 % brine .

Testing procedures that are used in this study are as follows :

1. Hardness Testing,
2. Pull Testing,
3. Micro Structure Testing.

## 3. Results and Discussion

### 3.1 The chemical composition

Grouping based on the content of carbon steel can be divided into 3 parts. Steel with a carbon content of less than 0.30% is called the low carbon steel, steel with a carbon content of 0.30% - 0.45% carbon steel was called and with a carbon content of 0.45% to 0.71% is called high carbon steel.

Laboratory test results Metals Technical Inspection Department of PT.Pupuk Sriwijaya show elements are 99.683% Iron (Fe), 0.315% element Manganese (Mn) and other elements such as C, V, Ni, Mo and others who have a relative percentage very small so that the percentage of other elements forming is poor, and from the above data we can conclude the test specimens are categorized in the group of low carbon steel. categorized in the group of low carbon steel.

### 3.2 Tensile Testing

Tests conducted to determine the tensile yield strength, tensile strength, elongation and modulus of elasticity of the low carbon steel pipes and carbon steel plate tensile test carried out at the Laboratory of Metallurgy of Sriwijaya University in Indralaya.

Table 1. The average value of  $\sigma_y$ ,  $\sigma_u$ ,  $\sigma_f$  in kgf/mm<sup>2</sup> and a large e (elongation)

	Process	$\sigma_y$ (kgf/ mm <sup>2</sup> )	$\sigma_u$ (kgf mm <sup>2</sup> )	$\sigma_f$ (kgf /mm <sup>2</sup> )	e (%)
1	First Specimen	14.38	20.14	12.47	22.90
2	Normalizing	10.77	16.50	8.25	23.90
3	Water Quenching	25.89	34.82	28.02	10.06
4	Water Quenching +Salt 5%	25.34	33.83	28.91	6.90
5	Water Quenching + Salt 10%	24.18	33.62	29.57	12.00
6	Water Quenching+ Salt 15%	22.54	30.30	23.08	7.30

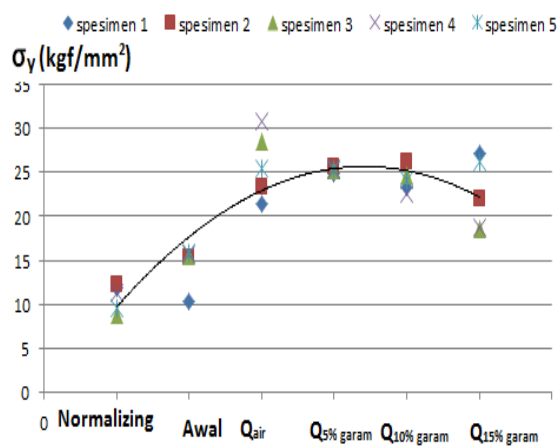


Figure 4. fracture (fracture)  $\sigma_y$  for each treatment on low carbon steel plate

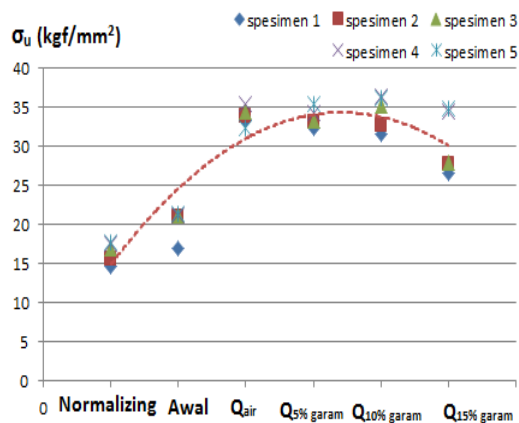


Figure 5. fracture stress (fracture)  $\sigma_y$  for each treatment on low carbon steel plate

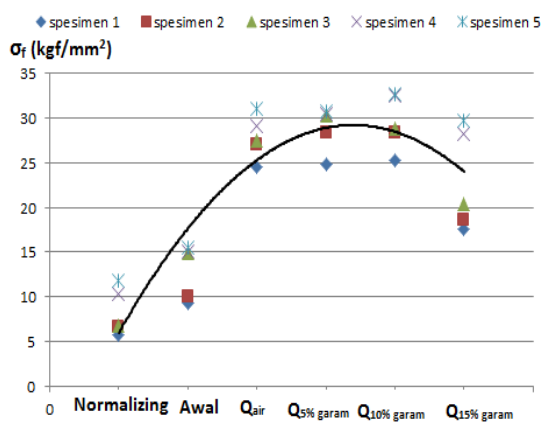


Figure 6. ultimate stress ( $\sigma_u$ ) for each treatment in low carbon steel plate

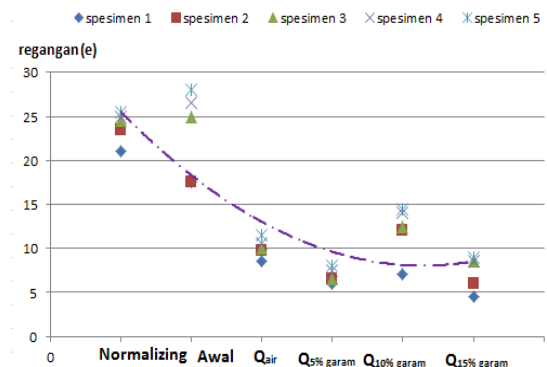


Figure 7. Extension of the graphic (elongation) for each treatment in low carbon steel plate

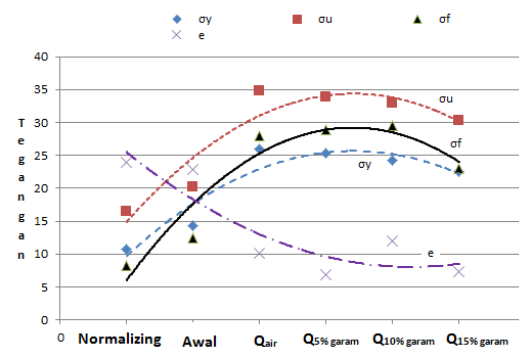


Figure 8. the graphic. stress  $\sigma_y$ ,  $\sigma_u$ ,  $\sigma_f$  and  $e$  (elongation) for each treatment in low carbon steel

### 3.3 Hardness Test (VHN)

Hardness testing aims to determine the hardness test specimen of low carbon steel plate with the test method used is the method of testing Vickers. Vickers hardness testing method using a pyramidal diamond indenter is a square where the angle between the two opposite inclined plane is  $130^\circ$ .

Table 2. Violence average low carbon steel for each treatment

Process	VHN
Normalizing	86
First Spesimen	101
Water Quenching	110
Water Quenching +Salt 5%	120
Water Quenching+Salt 10%	168
Water Quenching +Salt 15%	101

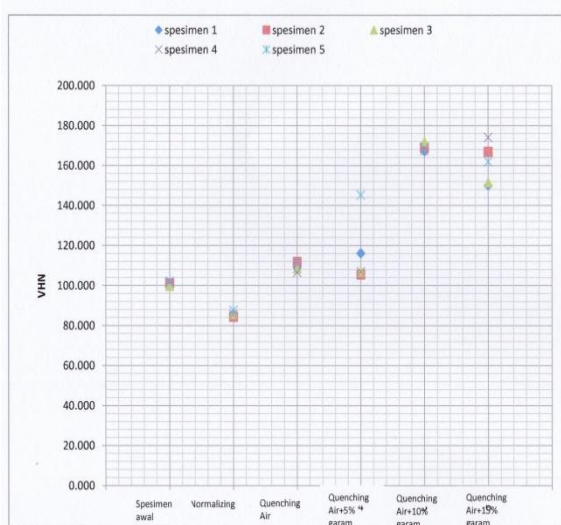


Figure 9. Graph Vickers hardness (VHN) for each treatment.

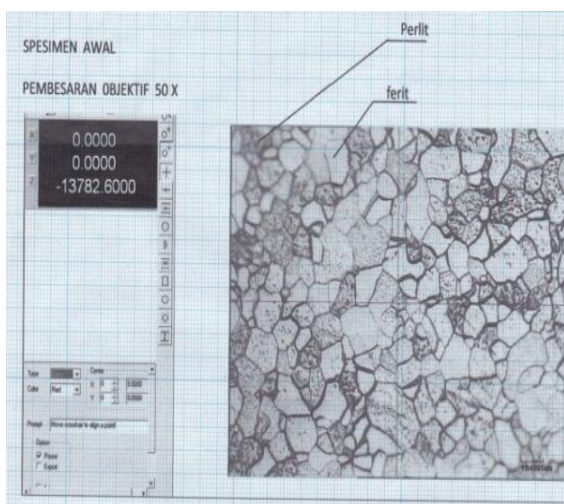


Figure 10. Test results for the microstructure of low carbon steel for the initial specimen

Table 3. grain size for each treatment

Process	Grain Size
	$\mu\text{m}$
First Spesimen	5,00
Normalizing	7,50
Water Quenching	8,18
Water Quenching +Salt 5%	7,72
Water Quenching +Salt 10%	7,96
Water Quenching+ Salt 15%	6,69

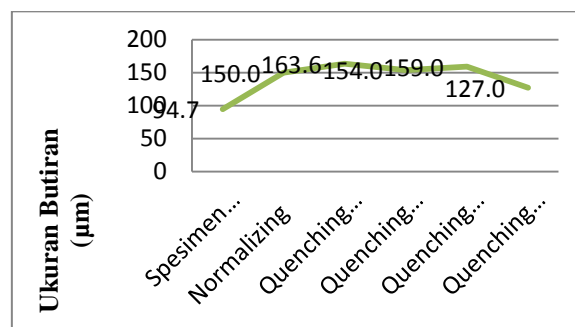


Figure 11. Graph of grain size for each treatment on a test specimen of low carbon steel plate

#### 4. Conclusion

1. The composition of the salt specimens as a cooling medium which can increase the tensile strength and hardness of materials is the percentage of 10 % salt water.
2. In the salt composition over 10 % decline in strength.

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