

## ANALYSIS OF RESIDUAL CHLORINE AND TOTAL COLIFORM ON CONSUMERS OF PERUMDAM MAJA TIRTA, MOJOKERTO CITY

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### Abstract

This study aims to determine the concentration of residual chlorine and net total Coliform distributed by Perumdam Maja Tirta Water Supply Company and received by consumers. Water samples were taken from 7 locations on the distribution network a residential area of Perumdam Maja Tirta, the first sample taken at the reservoir of the Water Treatment Plant of Perumdam Maja Tirta and six samples from consumers. The residual chlorine concentration data and Total Coliform were mapped using Surfer 16 Software, producing an iso concentration map in the form of contour lines. The results showed that the concentration of residual water chlorine received by consumers of Perumdam Maja Tirta Mojokerto City ranged from <LoQ 0.1 mg/L to 0.3 mg/L. The further away from the IPA, the concentration of residual water chlorine decreased. Total Coliform parameters ranged from <1.8 – 240/100 ml in water received by consumers of Perumdam Maja Tirta Mojokerto City. There is a need to improve the quality of water services to consumers regarding water treatment and distribution.

**Keywords:** *residual chlorine, total Coliform, distribution of clean water*

### Introduction

Perumdam Maja Tirta is a Regional Owned Enterprise (BUMD) in the form of a regional public company engaged in the water service business in Mojokerto City. Perumdam Maja Tirta has a Water Treatment Plant (IPA) located on Jalan Mayjen Sungkono, Magersari District, Mojokerto City. The Water Treatment Plant (IPA) of Perumdam Maja Tirta uses raw water from the Brantas River, producing 110 L/second production water and a distribution capacity of 70 – 80 L/second. Chlorination is a common disinfection method used in Water Treatment Plants (IPA)(Ardhana et al., 2022).

The service area of Perumdam Maja Tirta Mojokerto City covers four sub-districts and 19

sub-districts, namely Kranggan District, Magersari District, Prajurit Kulon District and Puri District. Currently, the number of customers of Perumdam Maja Tirta is 5,654 people, consisting of 980 people from Kranggan District, 3,448 people from Magersari District, and 1,193 people from Prajurit Kulon District and 33 people from Puri District. The water distribution pipe network belonging to Perumdam Maja Tirta's length reaches 235,484 m.

Total Coliform is 0 per 100 ml of sample based on the Minister of Health of the Republic of Indonesia number 492/MENKES/PER/IV/2010. The remaining chlorine, based on the Minister of Public Works and Public Housing Number 27 of 2020, is 0.3 – 0.5 mg/l in water treatment plants, based on the Minister of Health of the Republic of Indonesia Number 736/MENKES/PER/VI/2010 on Implementation of Drinking Water Quality, the remaining chlorine in the installation is 1 mg/l, while at the furthest

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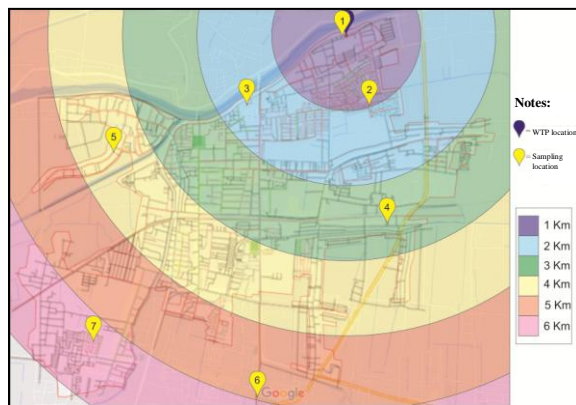
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distribution pipeline is 0.2 mg/l. Based on SNI 6774:2008, residual chlorine is 0.25 – 0.35 mg/l (Alfiah, 2020).

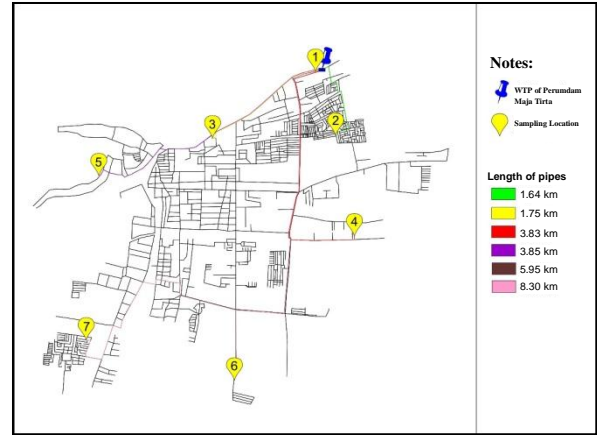
The study aimed to determine the concentration of residual chlorine and Total Coliform in clean water distributed by Perumdam Maja Tirta. The study results are expected to be input for Perumdam Maja Tirta, Mojokerto City, to improve the quality of water services to consumers, both in terms of water treatment and in the distribution of water to consumers.

**Methodology**

The research was conducted in the distribution network of Perumdam Maja Tirta, Mojokerto City. The number of samples taken from the water distribution network of Perumdam Maja Tirta is as many as 7 points, consisting of 1 sample at the reservoir of the Water Treatment Plant (IPA) of Perumdam Maja Tirta and 6 samples from consumers of the water distribution network of Perumdam Maja Tirta. The determination of this sample point is based on the radius of the distance from the Water Treatment Plant (IPA) of Perumdam Maja Tirta, namely 0 km (IPA reservoir), 1 km, 2 km, 3 km, 4 km, 5 km and 6 km. Fig 1 is a map of the research location.



**Figure 1.** Sampling point



**Figure 2.** Pipe length at each sampling location

**Table 1.** Sampling locations

Sampling Point	Coordinates	Pipe Length (Km)	Elevation (m)
1	-7.450 112.450	0	21
2	-7.459 112.453	1.64	19
3	-7.458 112.437	1.75	23
4	-7.472 112.455	3.83	20
5	-7.464 112.421	3.85	22
6	-7.493 112.440	5.90	25
7	-7.486 112.419	8.30	25

Water sampling was carried out in the morning between 06:00-09:00 am on Monday and Thursday, accompanied by officers from Perumdam Maja Tirta. Sampling followed SNI (Indonesian Standard) 06-1416-1989 on how to take water samples.

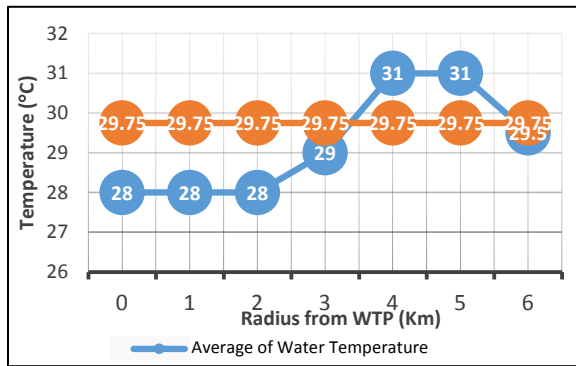


**Figure 3.** Water sampling

Furthermore, the laboratory examined the water samples for pH, temperature and Total Coliform parameters. The residual chlorine concentration data and Total Coliform were mapped with the help of Surfer Software which will produce an iso concentration map in the form of contour lines.

### Results and Discussion

The results of the measurement of temperature parameters at the sampling point show the value of the water temperature range between 27 °C – 32 °C and air temperature between 29.5 °C – 30 °C.



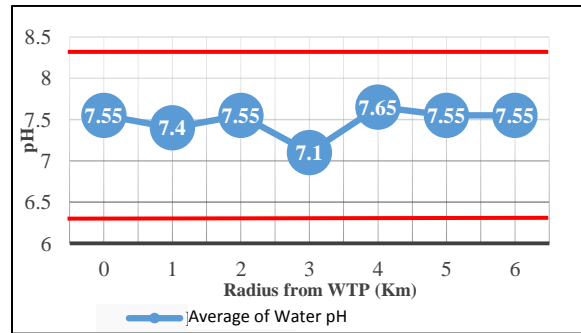
**Figure 4.** Water Temperature distributed by Perumdam Maja Tirta

Mapping temperature parameters in the service area of Perumdam Maja Tirta using Surfer 16 software is as shown in Fig . 5.



**Figure 5.** Mapping of water temperature distributed by Perumdam Maja Tirta using Surfer 16

The results of the pH test measurements in the service area of Perumdam Maja Tirta have a pH range between 7.0 – 7.7. An average pH of 7.4 spread throughout the Perumdam Maja Tirta service area.



**Figure 6.** Value of pH of water distributed by Perumdam Maja Tirta

Mapping the pH of water in the service area of Perumdam Maja Tirta using Surfer 16 software as shown in Fig. 7.

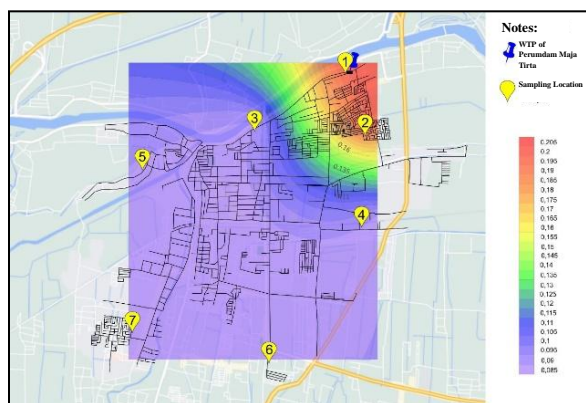


**Figure 7.** pH of water distributed by Perumdam Maja Tirta using Surfer 16

The smallest water pH value at the four sample points is located on Jl. Kedungsari RT 03 / RW 03, Kedundung, Magersari with an average pH of 7.1 depicted in blue, while the highest pH was at sample point five with an average pH of 7.65 in red.

The concentration of residual chlorine in drinking water distribution consumers of Perumdam Maja Tirta ranges between <LoQ 0.1 mg/L – 0.3 mg/L. The concentration of residual chlorine in drinking water received by consumers is lower than that required by the

Minister of Health of the Republic of Indonesia 736/Menkes/PER/VI/2010 concerning the Management of Drinking Water Quality Control, the concentration of residual chlorine is between 0.2 – 1 mg/L. The distribution of residual chlorine concentration in drinking water distributed by Perumdam Maja Tirta is described using Surfer 16 software as shown in Fig. 8.



**Figure 8.** Concentration of Residual Chlorine at Perumdam Maja Tirta Consumer interpolated by Surfer 16

The highest residual chlorine concentration at sample points 1 and 2, of 0.2 mg/L, is depicted in red, while samples 3 to 7 are depicted in blue with a residual chlorine value < LoQ 0.1 mg/L.

The further away from the Water Treatment Plant (IPA), the concentration of residual chlorine received by consumers is getting smaller (Ijlal Ramadhan & Ratni J.A.R, 2021; Sofia & Riduan, 2017). The decrease in residual chlorine is affected by the flow velocity caused by variations in the pipe diameter in the distribution pipe network (García-Ávila et al., 2021, Goyal & Patel, 2015, Hermiyanti & Wulandari, 2018)

The remaining chlorine from the Water Treatment Plant (IPA) of Perumdam Maja Tirta needs to be increased, or chlorine added at specific points in the distribution pipeline network of the Water Treatment Plant (IPA) of Perumdam Maja Tirta.

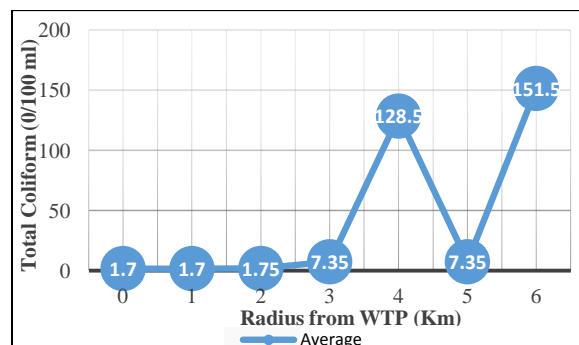
**Table 2.** Results of Distance Correlation Test Against Chlorine Residual Using SPSS

Correlations		
	Distance	Res. Chlorine
Distance Pearson Correlation	1	-.791*
Sig. (2-tailed)		.034
N	7	7
Residual Chlorine Pearson Correlation	-.791*	1
Sig. (2-tailed)	.034	
N	7	7

\*. Correlation is significant at the 0.05 level (2-tailed).

The correlation test results between distance and residual chlorine concentration in the distribution network of Perumdam Maja Tirta using SPSS have a significance value of 0.034, meaning that distance and the presence of residual chlorine are correlated with each other. The significance value of less than 0.05. The degree of relationship between the Pearson Correlation between distance and residual chlorine indicates that the result is negative. A Pearson Correlation value of -0.791 is included in the category of solid correlation. The correlation analysis test results show a correlation between distance and the concentration of residual chlorine in the distribution network of Perumdam Maja Tirta customers, Mojokerto City.

The total Coliform value of clean water is 0/100 ml, based on the Minister of Health of the Republic of Indonesia Number 492/MENKES/PER/IV/2010. The total Coliform test results for clean water distributed by Perumdam Maja Tirta range between <1.8–240/100 ml.



**Figure 9.** Total Coliform Water distributed by Perumdam Maja Tirta



The map of the average distribution of Total Coliform in the distribution network in the Perumdam Maja service area was interpolated using Surfer 16 software.



**Figure 10.** Total Coliform water distributed by Perumdam Maja Tirta using Surfer 16

The lowest total Coliform in water was at sampling locations 1 and 2, with Total Coliform  $<1.8 / 100$  ml, while the highest was at the sampling point farthest from the WTP, which was located on Jl. Suromulang Barat VII/9, Surodinawan, Prajurit Kulon with an average total Coliform content of  $151.5 / 100$  ml.

Total Coliform levels in water treatment plants are influenced by turbidity, organic substance, pH, and temperature (Amanda et al., 2017; Gunawan, 2020). The farther the location of the sample point from the IPA, the higher the Total Coliform value. This can be caused by several things, including intermittent flow, low residual chlorine, and variations in residual pressure in the piping of the drinking water distribution system. (Girmay et al., 2020; Mahdariza, 2016; Shamsaei et al., 2013)

**Table 3.** Correlation Test Results of Chlorine Residual Against Total Coliform using SPSS

		Correlations	
		Res. Chlorine	Total Coliform
Residual Chlorine	Pearson Correlation	1	-.421
	Sig. (2-tailed)		.347
	N	7	7
Total Coliform	Pearson Correlation	-.421	1
	Sig. (2-tailed)	.347	
	N	7	7

The correlation test results between residual chlorine concentration and Total Coliform in the clean water distribution network of Perumdam Maja Tirta using SPSS has a significance value of 0.347, which means that the presence of residual chlorine concentration and Total Coliform are not correlated with each other. This is because the significance value exceeds 0.05. The degree of relationship between the Pearson Correlation between residual chlorine and Total Coliform indicates that the result is negative. With a Pearson Correlation value of -0.421. The correlation analysis test results show no correlation between residual chlorine and Total Coliform in the distribution network of Perumdam MajaTirta customers, Mojokerto City.

### Conclusion

The concentration of residual chlorine in water received by consumers of Perumdam Maja Tirta Mojokerto City ranges from  $<LoQ 0.1$  mg/L to  $0.3$  mg/L, where the further away from the IPA, the concentration of residual chlorine water received by consumers decreases. Parameters of Total Coliform in water received by consumers of Perumdam Maja Tirta Mojokerto City ranged from  $<1.8 - 240/100$  ml, and the further away from IPA, the Total Coliform in water received by consumers will increase. The correlation test results between residual chlorine and Total Coliform showed no correlation based on the Pearson Correlation test using SPSS with a significance value of 0.347.

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