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## WHITE FLUORIDE STONE FROM PEAT AREA OF LIANG ANGGANG AND GREEN FLUORIDE STONE FROM TANAH LAUT IN INCREASING RIVER FLUOR CONTENT USING CONTACT OF STONES CONTAINING FLUORIDE

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### Abstract

Fluoride content in water consumed by the people of Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province is still below the WHO recommendation and the Ministry of Health Regulation of Indonesia. This study aims to determine the differences in the ability of fluoride stones from the peat area - Liang Anggang, Banjar Regency and fluoride stones from Tanah Laut area of South Kalimantan in increasing fluoride content in river water. This type of research is an experiment with quantitative data processing techniques. The experiments were carried out in river water by means of preliminary treatment until the turbidity is less than 5 NTU. Furthermore, the processed water was recirculated into a "flour increase portable" device to manipulate the processed water with stones containing fluoride. Variations in research include 24 hours, 48 hours and 72 hours recirculation; fluorine stones types were from Liang Anggang area and from Tanah Laut. The results show that green stones from Tanah Laut area can increase fluoride content in processed river water to 0.63 mg / l. This means that the ability of this green stone is lower than that of white stone in increasing fluoride content in processed river water.

**Keywords:** *Fluoride stones; Stone contact; Increase in fluoride*

### 1. Introduction

Fluoride is a chemical substance that can be found in nature, containing 0.3 grams of fluoride in every 1 kg of the earth's crust (WHO, 2004). Fluoride can be found in various forms, such as hydrogen fluoride, sodium fluoride and many more. It can be gas, liquid, or solid, generally fluoride is colorless or white in color and dissolves in water. Fluoride can be naturally found in drinking water or because intentionally added by the company.

The fluoride content in the water we consume varies widely. Groundwater that passes through the mountains will usually mineralize naturally and will contain fluoride. The level of fluoride content depends on the stones and minerals that it passes through. After drinking or eating, almost all of the fluoride will be absorbed by our digestion, enter the bloodstream, and stored in the bones or teeth.

Living beings cannot be separated from their need for water. Water is a very vital need for human life. Therefore, the need for water must be fulfilled. Otherwise it leads to a big impact on health and social insecurity. The provision of clean water in Indonesia, especially on a large

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scale, is still concentrated in urban areas, and is managed by the city's Drinking Water Company or Perusahaan Air Minum (PAM). However, nationally, the number is still insufficient or relatively small, namely 10.77%.

Rahmawati and Said (2017) report that white stones originating from the Liang Anggang area of Banjar Regency can increase fluoride in processed river water from Mekar Sari river, Tatah Makmur District, Banjar Regency, South Kalimantan. River water from the study area has a fluorine content of 0.08 mg / l which is still classified as not meeting the requirements of WHO (2004). In this study, the fluoride stone grains used were 1-2 cm in size, had the ability to decay fluorine into water for a maximum of 3 days.

Rahmawati and Said's research (2017) used white stone media from the Liang Anggang area as a contact medium to increase the fluoride content in processed water. The contact mechanism was carried out by gravity with the flow system from top to bottom repeatedly or recirculation. The recirculation was carried out for different times, namely 6 hours; 12 hours; 24 hours; 48 hours and 72 hours.

The research continued with the same method by making modifications to the FIP (Fluor Increase Portable) equipment used in previous studies. Modifications were made to the addition of stone types as contact media (white stones and green stones), reduction of observation time (5 observations to 3 observations).

To be able to apply fluoride enrichment technology in the Tatah Makmur river water, it is necessary to carry out further trials on other types of fluorine stone. This is due to the white stone containing fluoride from Liang Anggang area which has a low fluorine content. The presence of fluorine in stones usually go along by the presence of other substances such as phosphate NaF, AgF, and KF which are soluble in water (Effendi, 2003).

Fluoride stone is usually used as jewelry because it has high brightness and luster. In 2016, stones with brightness and shine were found

when rubbed into decorations from the Tanah Laut area of South Kalimantan. Seeing the similarities in the characteristics of fluoride stones from Tanah Laut, and white from the Liang Anggang area of Banjar Regency, the researchers wanted to conduct an experiment by comparing the ability of the two stones to increase the fluorine content of processed river water.

## 2. Method

This research was an analytical research. The analysis was carried out to determine the differences in the ability of white stones and green stones to increase the Fluor content of processed water. The research sample was river water in Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province. Before making contact with the experimental stone, the river water was processed first to remove turbidity. The variables involved in this study include the dependent variable fluorine in Mekar Sari processed river and the independent variable the thickness of the media is divided into 30 cm, 40 cm, and 50 cm; The stone types come from Liang Anggang and from Tanah Laut. The contact time is the duration of flowing processed water through the stone media for 24 hours, 48 hours, and 72 hours. The instruments used in this study were an aquarium water pump with a pressure of 2 m for water recirculation, submersible for the stirring process of raw water and coagulants, a 1200 liter water reservoir for 5000 liters of raw water, a 2 meter water tower for placing water reservoirs, a 100 liter bucket for recirculating water and fluoride stone containers, and sample bottles for transporting samples to the laboratory.

The research materials consisted of Mekar Sari river water, alum, and fluoridated white stone Liang Anggang & Batu Tanah Laut. The data collection technique was obtained by taking samples directly from the Mekar Sari river water to check the initial fluorine content in the raw water of the Mekar Sari River. The turbidity of raw water from the Mekar Sari River was lowered first until it met the drinking water requirement of 5

NTU. Decreased turbidity using 2% alum solution. To determine the optimum alum dosage, a Jar-Test was performed.

The results of the intervention to increase Fluor content were obtained by passing processed raw water to the Fluoride Increase Portable with variations in media thickness, media size, and length of contact. The number of repetitions is 1 time. The total number of data is 30 data consisting of 27 data on the results of interventions on stone contact and processed water, 1 data for fluoride water immersion in white stone and Tanah Laut stones.

After the processed water passes through the stone layers in the *fluoride increase portable* device according to the above variations, a 50 ml sample was taken to be examined in a test laboratory, to see the increase in fluoride content in processed water. Data obtained from the results of laboratory tests are collected, processed in tables and graphs, and analyzed in descriptive form by comparing the results of reference books and scientific journals related to Fluor, as well as the efficiency of equipment engineering.

**3. Results and Discussion**

a. Green Fluoride Stone Media

Table 1 shows that Fluor in processed water is 0.08 mg / liter. Taking a look at the table of processed water fluorine levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water to the stones, it shows an increase in Fluor levels.

**Table 1.** Green Fluoride Stone and Contact Time to Fluor Concentration

Tebal / Ukuran	Waktu Kontak	6 Jam	12 Jam	24 Jam	48 Jam	72 Jam
10;1-2		0.21	0.27	0.43	0.43	0.45
		162,5%	237,5%	437,5%	437%	462%
20;1-2		0.20	0.32	0.45	0.46	0.46
		150%	300%	462,5%	475%	475%
30;1-2		0.22	0.32	0.44	0.47	0.48
		175%	300%	450%	487,5%	500%
40;1-2		0.23	0.34	0.43	0.47	0.49
		187,5%	325%	437,5%	487,5%	512,5%
50;1-2		0.27	0.28	0.36	0.63	0.62
		237,5%	250%	350%	687,5%	675%

The lowest increase in Fluor concentration was at 6 hours of contact time variation at 20 cm thickness of 1-2 cm Martadah stone. The highest increase in Fluor percentage in the 48J variety; 50 cm; granules 1-2 cm. The example of calculation is as follows:

$$\begin{aligned}
 PPF &= ((K_{ft} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,20 - 0,08) / K_{af}) \times 100 \% \\
 &= 150 \%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

The calculation shows the lowest magnitude of increase in Fluor occurs in 6 hour variation; 20 cm; 1-2 cm granules, which is 0.2 mg / l or 150%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 48 hours; 50 cm; granules 1-2 cm i.e. 0.63 mg / l (687%).

Figure 1 tells the increase in Fluor concentration occurs in all variations of the thickness of the *martadah* stone measuring 1-2 cm. In the contact time interval of treated water in Fluor-containing stone, there was a very sharp increase from 6 hours to 48 hours. When the contact time is increased to 72 hours, the Fluor-boosting process begins to slow down.

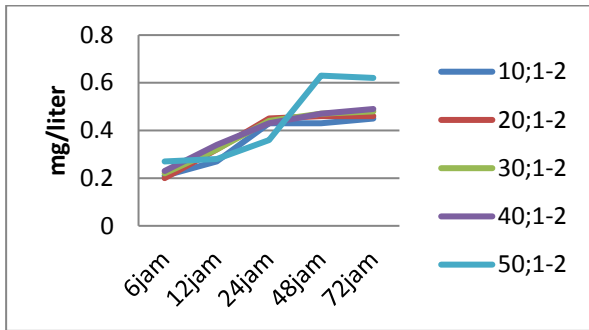


Figure 1. Batu Hijau Contact Time and Fluor Concentration

It should be assumed that the Fluor content of the stone which is soluble in treated water is starting to decrease.

b. White Fluoride Stone Media

Table 2. White Fluoride Stone and Contact Time to Fluorine Concentration

Tebal Waktu / Waktu Kontak	6 Jam	12 Jam	24 Jam	48 Jam	72 Jam
10;1-2	0.31 287,5%	0.3 275%	0.46 475%	0.58 625%	0.56 600%
20;1-2	0.27 237,5%	0.35 337,5%	0.48 500%	0.59 637,5%	0.61 662,5%
30;1-2	0.25 212,5%	0.35 337,5%	0.47 487,5%	0.61 662,5%	0.63 687,5%
40;1-2	0.32 300%	0.41 412,5%	0.46 475%	0.64 700%	0.66 725%
50;1-2	0.24 200%	0.31 287,5%	0.39 387,5%	0.66 725%	0.69 762,5%

It is known that Fluor in processed water is 0.08 mg / liter. When seen in Table 2, processed water Fluor levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water against the stones, show a significant increase. The lowest increase in Fluor concentration was at the variation of the 6-hour contact time at 50 cm thickness of 1-2 cm granular stones. The increasing percentage of fluorine increase in variation can be determined through the following calculation:

$$\begin{aligned}
 PPF &= ((K_{ft} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,24 - 0,08) / 0,08) \times 100\% \\
 &= 200\%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

Based on the calculation, it can be seen that the lowest magnitude of Fluor increase occurred in the variation of 6 hours, 50 cm; granules 1-2 cm which is equal to 200%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%).

Based on the figure 2, the increase in Fluor concentration occurs in all variations in the thickness of the stone measuring 1-2 cm. In the contact time interval of processed water in Fluor-containing stone, there is a very sharp increase from 6 hours to 48 hours.

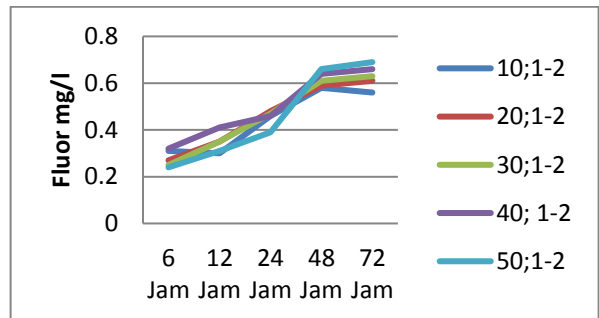


Figure 2. Batu Hijau Contact Time and Fluor Concentration

When the contact time was increased to 72 hours, the Fluor-boosting process began to slow down. It should be assumed that the Fluor content of the stones which could dissolve in processed water began to decrease.

The decrease in Fluor content in treated river water after 72 hours circulation occur in both fluoride stones. Almost all of these conditions occur in experimental studies, such as those conducted by Haris (2001) and Husaini & Haris (2011) which reduced air pollutants using a wet scrubber. At a certain time, after running the tool for a while, the effectiveness and efficiency of the equipment starts to slow down and becomes

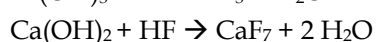
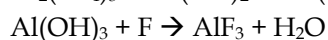
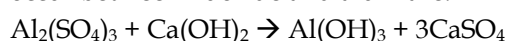
stagnant or stable. This indicates that the equipment is getting saturated. Likewise, the decay of Fluor in white and green stones measuring 1-2 cm, is thought to have started to saturate or cannot be separated from the initial bond (bonding to stone particles).

c. Difference in Ability of White Fluoride Stone and Green Fluoride Stone

The experimental results from processed river water after recirculating through white fluoride stone obtain the highest percentage of Fluor increase in processed water at a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%). Whereas in processed river water that was recirculated through green fluoride stones, the highest percentage of increase in Fluor in processed water occurs in a variation of 48 hours; 50 cm; granules 1-2 cm ie 0.63 mg / l (687%).

This shows that white fluoride stone has a better ability to increase the Fluor content in processed river water than the ability of green fluoride stone.

River water process, prior to treatment, was flowed on fluoride stones, by adding alum as a water purifier, presumably not affecting the fluoride content in river water after processing. This is based on the results of the research by Tamzil et al. (2013) that the effect of alum on the fluoride content in river water is only reduced by about 0.0005 mg / l. Meanwhile, the results of river water recirculation on fluoride stone, both green and white fluoride stones, were able to increase the Fluor content by 0.55–0.61. So that the decrease in fluoride due to the influence of alum can be overcome. The chemical formulas that occur between fluoride and alum are:



The decrease of fluoride content in processed river water after circulation for 2 to 3 days, indicates that this recirculation method can only be used for a maximum of 2 to 3 days. If this will be used for more than one time, the stone must be replaced. If this is applied to community needs, it

seems not practical. Because it will take quite a lot of time and energy. However, the addition of fluoride to increase fluoride levels in river water according to health standards is still needed. Given the habit of people using alum to purify river water, it can reduce Fluor levels in river water. So that the addition of Fluor is still recommended.

#### 4. Conclusion

To sum up, the stone abilities Green fluoride from the Tanah Laut area in terms of increasing river water Fluor levels is lower than white fluoride stone from Gambut-Liang Anggang area.

#### 5. Acknowledgement

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## 2. Method

This research was an analytical research. The analysis was carried out to determine the differences in the ability of white stones and green stones to increase the Fluor content of processed water. The research sample was river water in Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province. Before making contact with the experimental stone, the river water was processed first to remove turbidity. The variables involved in this study include the dependent variable fluorine in Mekar Sari processed river and the independent variable the thickness of the media is divided into 30 cm, 40 cm, and 50 cm; The stone types come from Liang Anggang and from Tanah Laut. The contact time is the duration of flowing processed water through the stone media for 24 hours, 48 hours, and 72 hours. The instruments used in this study were an aquarium water pump with a pressure of 2 m for water recirculation, submersible for the stirring process of raw water and coagulants, a 1200 liter water reservoir for 5000 liters of raw water, a 2 meter water tower for placing water reservoirs, a 100 liter bucket for recirculating water and fluoride stone containers, and sample bottles for transporting samples to the laboratory.

The research materials consisted of Mekar Sari river water, alum, and fluoridated white stone Liang Anggang & Batu Tanah Laut. The data collection technique was obtained by taking samples directly from the Mekar Sari river water to check the initial fluorine content in the raw water of the Mekar Sari River. The turbidity of raw water from the Mekar Sari River was lowered first until it met the drinking water requirement of 5

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NTU. Decreased turbidity using 2% alum solution. To determine the optimum alum dosage, a Jar-Test was performed.

The results of the intervention to increase Fluor content were obtained by passing processed raw water to the Fluoride Increase Portable with variations in media thickness, media size, and length of contact. The number of repetitions is 1 time. The total number of data is 30 data consisting of 27 data on the results of interventions on stone contact and processed water, 1 data for fluoride water immersion in white stone and Tanah Laut stones.

After the processed water passes through the stone layers in the *fluoride increase portable* device according to the above variations, a 50 ml sample was taken to be examined in a test laboratory, to see the increase in fluoride content in processed water. Data obtained from the results of laboratory tests are collected, processed in tables and graphs, and analyzed in descriptive form by comparing the results of reference books and scientific journals related to Fluor, as well as the efficiency of equipment engineering.

### 3. Results and Discussion

#### a. Green Fluoride Stone Media

Table 1 shows that Fluor in processed water is 0.08 mg / liter. Taking a look at the table of processed water fluorine levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water to the stones, it shows an increase in Fluor levels.

**Table 1.** Green Fluoride Stone and Contact Time to Fluor Concentration

Tebal / Ukuran	Waktu Kontak	6 Jam	12 Jam	24 Jam	48 Jam	72 Jam
10;1-2		0.21	0.27	0.43	0.43	0.45
		162,5%	237,5%	437,5%	437%	462%
20;1-2		0.20	0.32	0.45	0.46	0.46
		150%	300%	462,5%	475%	475%
30;1-2		0.22	0.32	0.44	0.47	0.48
		175%	300%	450%	487,5%	500%
40;1-2		0.23	0.34	0.43	0.47	0.49
		187,5%	325%	437,5%	487,5%	512,5%
50;1-2		0.27	0.28	0.36	0.63	0.62
		237,5%	250%	350%	687,5%	675%

The lowest increase in Fluor concentration was at 6 hours of contact time variation at 20 cm thickness of 1-2 cm Martadah stone. The highest increase in Fluor percentage in the 48 variety; 50 cm; granules 1-2 cm. The example of calculation is as follows:

$$\begin{aligned}
 PPF &= ((K_{ft} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,20 - 0,08) / K_{af}) \times 100\% \\
 &= 150\%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

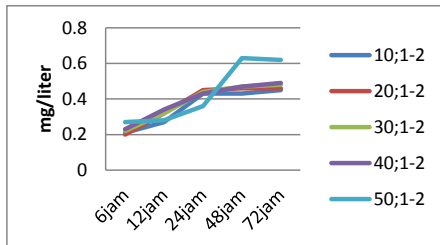
The calculation shows the lowest magnitude of increase in Fluor occurs in 6 hour variation; 20 cm; 1-2 cm granules, which is 0.2 mg / l or 150%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 48 hours; 50 cm; granules 1-2 cm i.e. 0.63 mg / l (687%).

Figure 1 tells the increase in Fluor concentration occurs in all variations of the thickness of the *martadah* stone measuring 1-2 cm. In the contact time interval of treated water in Fluor-containing stone, there was a very sharp increase from 6 hours to 48 hours. When the contact time is increased to 72 hours, the Fluor-boosting process begins to slow down.

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**Figure 1.** Batu Hijau Contact Time and Fluor Concentration

It should be assumed that the Fluor content of the stone which is soluble in treated water is starting to decrease.

b. White Fluoride Stone Media

**Table 2.** White Fluoride Stone and Contact Time to Fluorine Concentration

Tebal Waktu Kontak	6 Jam	12 Jam	24 Jam	48 Jam	72 Jam
10;1-2	0.31 287,5%	0.3 275%	0.46 475%	0.58 625%	0.56 600%
20;1-2	0.27 237,5%	0.35 337,5%	0.48 500%	0.59 637,5%	0.61 662,5%
30;1-2	0.25 212,5%	0.35 337,5%	0.47 487,5%	0.61 662,5%	0.63 687,5%
40;1-2	0.32 300%	0.41 412,5%	0.46 475%	0.64 700%	0.66 725%
50;1-2	0.24 200%	0.31 287,5%	0.39 387,5%	0.66 725%	0.69 762,5%

It is known that Fluor in processed water is 0.08 mg / liter. When seen in Table 2, processed water Fluor levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water against the stones, show a significant increase. The lowest increase in Fluor concentration was at the variation of the 6-hour contact time at 50 cm thickness of 1-2 cm granular stones. The increasing percentage of fluorine increase in variation can be determined through the following calculation:

$$PPF = ((K_{ft} - K_{af}) / K_{af}) \times 100\%$$

$$= ((0,24 - 0,08) / 0,08) \times 100 \%$$

$$= 200 \%$$

In which:

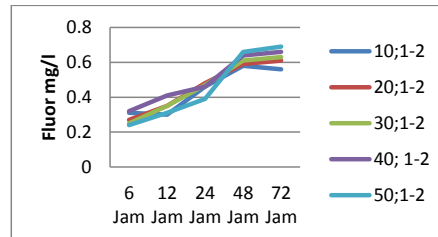
PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

Based on the calculation, it can be seen that the lowest magnitude of Fluor increase occurred in the variation of 6 hours, 50 cm; granules 1-2 cm which is equal to 200%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%).

Based on the figure 2, the increase in Fluor concentration occurs in all variations in the thickness of the stone measuring 1-2 cm. In the contact time interval of processed water in Fluor-containing stone, there is a very sharp increase from 6 hours to 48 hours.



**Figure 2.** Batu Hijau Contact Time and Fluor Concentration

When the contact time was increased to 72 hours, the Fluor-boosting process began to slow down. It should be assumed that the Fluor content of the stones which could dissolve in processed water began to decrease.

The decrease in Fluor content in treated river water after 72 hours circulation occur in both fluoride stones. Almost all of these conditions occur in experimental studies, such as those conducted by Haris (2001) and Husaini & Haris (2011) which reduced air pollutants using a wet scrubber. At a certain time, after running the tool for a while, the effectiveness and efficiency of the equipment starts to slow down and becomes

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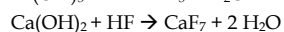
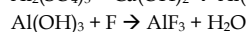
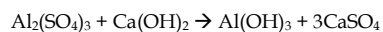
stagnant or stable. This indicates that the equipment is getting saturated. Likewise, the decay of Fluor in white and green stones measuring 1-2 cm, is thought to have started to saturate or cannot be separated from the initial bond (bonding to stone particles).

c. Difference in Ability of White Fluoride Stone and Green Fluoride Stone

The experimental results from processed river water after recirculating through white fluoride stone obtain the highest percentage of Fluor increase in processed water at a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%). Whereas in processed river water that was recirculated through green fluoride stones, the highest percentage of increase in Fluor in processed water occurs in a variation of 48 hours; 50 cm; granules 1-2 cm ie 0.63 mg / l (687%).

This shows that white fluoride stone has a better ability to increase the Fluor content in processed river water than the ability of green fluoride stone.

River water process, prior to treatment, was flowed on fluoride stones, by adding alum as a water purifier, presumably not affecting the fluoride content in river water after processing. This is based on the results of the research by Tamzil et al. (2013) that the effect of alum on the fluoride content in river water is only reduced by about 0.0005 mg / l. Meanwhile, the results of river water recirculation on fluoride stone, both green and white fluoride stones, were able to increase the Fluor content by 0.55-0.61. So that the decrease in fluoride due to the influence of alum can be overcome. The chemical formulas that occur between fluoride and alum are:



The decrease of fluoride content in processed river water after circulation for 2 to 3 days, indicates that this recirculation method can only be used for a maximum of 2 to 3 days. If this will be used for more than one time, the stone must be replaced. If this is applied to community needs, it

seems not practical. Because it will take quite a lot of time and energy. However, the addition of fluoride to increase fluoride levels in river water according to health standards is still needed. Given the habit of people using alum to purify river water, it can reduce Fluor levels in river water. So that the addition of Fluor is still recommended.

4. Conclusion

To sum up, the stone abilities Green fluoride from the Tanah Laut area in terms of increasing river water Fluor levels is lower than white fluoride stone from Gambut-Liang Anggang area.

5. Acknowledgement

We thank the following for their support, without whose help this work would never have been possible: Director of the Poltekkes Kemenkes Banjarmasin, Head of the Center for Research and Community Service of Poltekkes Kemenkes Banjarmasin, team of research experts, and Head of the Dental Hygiene Department.

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## WHITE FLUORIDE STONE FROM PEAT AREA OF LIANG ANGGANG AND GREEN FLUORIDE STONE FROM TANAH LAUT IN INCREASING RIVER FLUOR CONTENT USING CONTACT OF STONES CONTAINING FLUORIDE

Emilda Sari \*

Dental Hygiene Department ; Poktekkes Kemenkes Banjarmasin ;  
Jl. H. Mistar Cokrokusumo 1A ; Banjarbaru ; Kalimantan Selatan; Indonesia

### Abstract

Fluoride content in water consumed by the people of Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province is still below the WHO recommendation and the Ministry of Health Regulation of Indonesia. This study aims to determine the differences in the ability of fluoride stones from the peat area - Liang Anggang, Banjar Regency and fluoride stones from Tanah Laut area of South Kalimantan in increasing fluoride content in river water. This type of research is an experiment with quantitative data processing techniques. The experiments were carried out in river water by means of preliminary treatment until the turbidity is less than 5 NTU. Furthermore, the processed water was recirculated into a "flour increase portable" device to manipulate the processed water with stones containing fluoride. Variations in research include 24 hours, 48 hours and 72 hours recirculation; fluoride stones types were from Liang Anggang area and from Tanah Laut. The results show that green stones from Tanah Laut area can increase fluoride content in processed river water to 0.63 mg / l. This means that the ability of this green stone is lower than that of white stone in increasing fluoride content in processed river water.

**Keywords:** Fluoride stones; Stone contact; Increase in fluoride

### 1. Introduction

Fluoride is a chemical substance that can be found in nature, containing 0.3 grams of fluoride in every 1 kg of the earth's crust (WHO, 2004). Fluoride can be found in various forms, such as hydrogen fluoride, sodium fluoride and many more. It can be gas, liquid, or solid, generally fluoride is colorless or white in color and dissolves

in water. Fluoride can be naturally found in drinking water or because intentionally added by the company.

The fluoride content in the water we consume varies widely. Groundwater that passes through the mountains will usually mineralize naturally and will contain fluoride. The level of fluoride content depends on the stones and minerals that it passes through. After drinking or eating, almost all of the fluoride will be absorbed

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\*) Corresponding Author (Emilda Sari)  
E-mail: [meilda\\_akg\\_bjm@yahoo.co.id](mailto:meilda_akg_bjm@yahoo.co.id)



by our digestion, enter the bloodstream, and stored in the bones or teeth.

Living beings cannot be separated from their need for water. Water is a very vital need for human life. Therefore, the need for water must be fulfilled. Otherwise it leads to a big impact on health and social insecurity. The provision of clean water in Indonesia, especially on a large scale, is still concentrated in urban areas, and is managed by the city's Drinking Water Company or **Perusahaan Air Minum (PAM)**. However, nationally, the number is still insufficient or relatively small, namely 10.77%.

Rahmawati and Said (2017) report that white stones originating from the Liang Anggang area of Banjar Regency can increase fluoride in processed river water from Mekar Sari river, Tatah Makmur District, Banjar Regency, South Kalimantan. River water from the study area has a fluorine content of 0.08 mg / l which is still classified as not meeting the requirements of WHO (2004). In this study, the fluoride stone grains used were 1-2 cm in size, had the ability to decay fluorine into water for a maximum of 3 days.

Rahmawati and Said's research (2017) used white stone media from the Liang Anggang area as a contact medium to increase the fluoride content in processed water. The contact mechanism was carried out by gravity with the flow system from top to bottom repeatedly or recirculation. The recirculation was carried out for different times, namely 6 hours; 12 hours; 24 hours; 48 hours and 72 hours.

The research continued with the same method by making modifications to the FIP (Fluor Increase Portable) equipment used in previous studies. Modifications were made to the addition of stone types as contact media (white stones and green stones), reduction of observation time (5 observations to 3 observations).

To be able to apply fluoride enrichment technology in the Tatah Makmur river water, it is necessary to carry out further trials on other types of fluorine stone. This is due to the white stone containing fluoride from Liang Anggang area which has a low fluorine content. The presence of fluorine in stones usually go along by the presence of other substances such as phosphate NaF, AgF, and KF which are soluble in water (Effendi, 2003).

Fluoride stone is usually used as jewelry because it has high brightness and luster. In 2016, stones with brightness and shine were found when rubbed into decorations from the Tanah Laut area of South Kalimantan. Seeing the similarities in the characteristics of fluoride stones from Tanah Laut, and white from the Liang Anggang area of Banjar Regency, the researchers wanted to conduct an experiment by comparing the ability of the two stones to increase the fluorine content of processed river water.

## 2. Method

This research was an analytical research. The analysis was carried out to determine the differences in the ability of white stones and green stones to increase the Fluor content of processed water. The research sample was river water in Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province. Before making contact with the experimental stone, the river water was processed first to remove turbidity. The variables involved in this study include the dependent variable fluorine in Mekar Sari processed river and the independent variable the thickness of the media is divided into 30 cm, 40 cm, and 50 cm; The stone types come from Liang Anggang and from Tanah Laut. The contact time is the duration of flowing processed water through the stone media for 24 hours, 48 hours, and 72 hours. The instruments used in this study were an aquarium water pump with a pressure of 2 m for water recirculation, submersible for the stirring process of raw water and coagulants, a

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1200 liter water reservoir for 5000 liters of raw water, a 2 meter water tower for placing water reservoirs, a 100 liter bucket for recirculating water and fluoride stone containers, and sample bottles for transporting samples to the laboratory.

The research materials consisted of Mekar Sari river water, alum, and fluoridated white stone Liang Anggang & Batu Tanah Laut. The data collection technique was obtained by taking samples directly from the Mekar Sari river water to check the initial fluorine content in the raw water of the Mekar Sari River. The turbidity of raw water from the Mekar Sari River was lowered first until it met the drinking water requirement of 5 NTU. Decreased turbidity using 2% alum solution. To determine the optimum alum dosage, a Jar-Test was performed.

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After the processed water passes through the stone layers in the *fluoride increase portable* device according to the above variations, a 50 ml sample was taken to be examined in a test laboratory, to see the increase in fluoride content in processed water. Data obtained from the results of laboratory tests are collected, processed in tables and graphs, and analyzed in descriptive form by comparing the results of reference books and scientific journals related to Fluor, as well as the efficiency of equipment engineering.

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Table 1 shows that Fluor in processed water is 0.08 mg / liter. Taking a look at the table of processed water fluorine levels in all variations of the

thickness of the 1-2 cm granular stones and variations in the length of contact of water to the stones, it shows an increase in Fluor levels.

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50;1-2	0.27	0.28	0.36	0.63	0.62
	237,5%	250%	350%	687,5%	675%

The lowest increase in Fluor concentration was at 6 hours of contact time variation at 20 cm thickness of 1-2 cm Martadah stone. The highest increase in Fluor percentage in the 48J variety; 50 cm; granules 1-2 cm. The example of calculation is as follows:

$$\begin{aligned}
 \text{PPF} &= ((K_{it} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,20 - 0,08) / K_{af}) \times 100\% \\
 &= 150\%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

$K_{it}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

The calculation shows the lowest magnitude of increase in Fluor occurs in 6 hour variation; 20 cm; 1-2 cm granules, which is 0.2 mg / l or 150%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 48 hours; 50 cm; granules 1-2 cm i.e. 0.63 mg / l (687%).

Figure 1 tells the increase in Fluor concentration occurs in all variations of the thickness of the *martadah* stone measuring 1-2 cm.

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In the contact time interval of treated water in Fluor-containing stone, there was a very sharp increase from 6 hours to 48 hours. When the contact time is increased to 72 hours, the Fluor-boosting process begins to slow down.

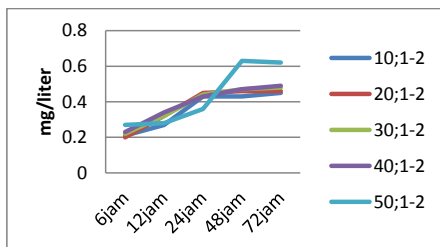


Figure 1. Batu Hijau Contact Time and Fluor Concentration

It should be assumed that the Fluor content of the stone which is soluble in treated water is starting to decrease.

b. White Fluoride Stone Media

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10;1-2	0.31 287,5%	0.3 275%	0.46 475%	0.58 625%	0.56 600%
20;1-2	0.27 237,5%	0.35 337,5%	0.48 500%	0.59 637,5%	0.61 662,5%
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It is known that Fluor in processed water is 0.08 mg / liter. When seen in Table 2, processed water Fluor levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water against the stones, show a significant increase. The lowest increase in Fluor concentration was at the variation of the 6-hour contact time at 50 cm thickness of 1-2 cm granular

stones. The increasing percentage of fluorine increase in variation can be determined through the following calculation:

$$PPF = ((K_{ft} - K_{af}) / K_{af}) \times 100\% = ((0,24 - 0,08) / 0,08) \times 100\% = 200\%$$

In which:

PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

Based on the calculation, it can be seen that the lowest magnitude of Fluor increase occurred in the variation of 6 hours, 50 cm; granules 1-2 cm which is equal to 200%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%).

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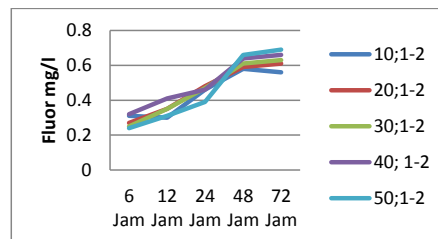


Figure 2. Batu Hijau Contact Time and Fluor Concentration

When the contact time was increased to 72 hours, the Fluor-boosting process began to slow down. It should be assumed that the Fluor content of the stones which could dissolve in processed water began to decrease.

The decrease in Fluor content in treated river water after 72 hours circulation occur in both

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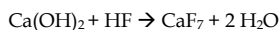
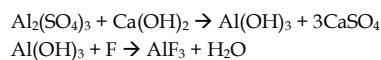
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c. Difference in Ability of White Fluoride Stone and Green Fluoride Stone

The experimental results from processed river water after recirculating through white fluoride stone obtain the highest percentage of Fluor increase in processed water at a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%). Whereas in processed river water that was recirculated through green fluoride stones, the highest percentage of increase in Fluor in processed water occurs in a variation of 48 hours; 50 cm; granules 1-2 cm ie 0.63 mg / l (687%).

This shows that white fluoride stone has a better ability to increase the Fluor content in processed river water than the ability of green fluoride stone.

River water process, prior to treatment, was flowed on fluoride stones, by adding alum as a water purifier, presumably not affecting the fluoride content in river water after processing. This is based on the results of the research by Tamzil et al. (2013) that the effect of alum on the fluoride content in river water is only reduced by about 0.0005 mg / l. Meanwhile, the results of river water recirculation on fluoride stone, both green and white fluoride stones, were able to increase the Fluor content by 0.55-0.61. So that the decrease in fluoride due to the influence of alum can be overcome. The chemical formulas that occur between fluoride and alum are:



The decrease of fluoride content in processed river water after circulation for 2 to 3 days, indicates that this recirculation method can only be used for a maximum of 2 to 3 days. If this will be used for more than one time, the stone must be replaced. If this is applied to community needs, it seems not practical. Because it will take quite a lot of time and energy. However, the addition of fluoride to increase fluoride levels in river water according to health standards is still needed. Given the habit of people using alum to purify river water, it can reduce Fluor levels in river water. So that the addition of Fluor is still recommended.

4. Conclusion

To sum up, the stone abilities Green fluoride from the Tanah Laut area in terms of increasing river water Fluor levels is lower than white fluoride stone from Gambut-Liang Anggang area.

5. Acknowledgement

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## THE INCREASE OF RIVER FLUOR CONTENT USING WHITE AND GREEN FLUORIDE STONE

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### Abstract

Fluoride content in water consumed by the people of Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province is still below the WHO recommendation and the Ministry of Health of Indonesia. This study aims to determine the differences in the ability of fluoride stones from the peat area - Liang Anggang, Banjar Regency and fluoride stones from Tanah Laut area of South Kalimantan in increasing fluoride content in river water. This type of work is analytical research. The experiments were carried out in river water by means of preliminary treatment until the turbidity is less than 5 NTU. Furthermore, the processed water was re-circulated into a "flour increase portable" device to manipulate the processed water with stones containing fluoride. Variations in research include 24 hours, 48 hours and 72 hours recirculation; fluoride stones types were from Liang Anggang area and from Tanah Laut. The results show that green stones from Tanah Laut area can increase fluoride content in processed river water to 0.63 mg / l. This means that the ability of this green stone is lower than that of white stone in increasing fluoride content in processed river water.

**Keywords:** *Fluoride stones; Stone contact; Increase in fluoride*

### 1. Introduction

Fluoride is a chemical substance that can be found in nature, containing 0.3 grams of fluoride in every 1 kg of the earth's crust (World Health Organization (WHO, 2004; García & Borgnino, 2015). Fluoride can be found in various forms, such as hydrogen fluoride, sodium fluoride and many more. It can be gas, liquid, or solid. Generally fluoride is colorless or white in color and dissolves in water. Fluoride can be naturally

found in drinking water or because intentionally added by the company.

Groundwater is the primary source of water. Such water is important component for life and environment. Groundwater that passes through the mountains will usually mineralize naturally and will contain fluoride. Fluoride content in the water we consume varies widely according to the geological characteristics at water source. (Maadid et al, 2017; Aggeborn & Mattias, 2021). Thus, it is essential to examine water requirements (Popkin et al., 2011). Adequate intake for fluoride for ages greater than 6 months is 0.05

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mg/day/kg(World Health Organization (WHO), 1997).

Man cannot be separated from their need for water. Water is a very vital need for human life(Kılıç, 2020). Therefore, the need for water must be fulfilled. Otherwise it leads to a big impact on health and social insecurity(Tarrass, Benjelloun, & Tarrass, 2012). The provision of clean water in Indonesia, especially on a large scale, is still concentrated in urban areas, and is managed by the city's Drinking Water Company. However, nationally, the supply of clean water in Indonesia is 61,29%(Badan Pusat Statistik (BPS), 2018).

White stones originating from the Liang Anggang area of Banjar Regency can increase fluoride in processed river water from Mekar Sari river, Tatah Makmur District, Banjar Regency, South Kalimantan. River water from the study area has a fluorine content of 0.08 mg / l which is still classified as not meeting the requirements of WHO(World Health Organization (WHO), 2004). In this study, the fluoride stone grains used were 1-2 cm in size, had the ability to decay fluorine into water for a maximum of 3 days.

White stone media from the Liang Anggang was used as a contact medium to increase the fluoride content in processed water by (Rahmawati & Said, 2017). The contact mechanism was carried out by gravity with the flow system from top to bottom repeatedly or recirculation. The recirculation was carried out for different times, namely 6 hours; 12 hours; 24 hours; 48 hours and 72 hours.

The research continued with the same method by making modifications to the FIP (Fluor Increase Portable) equipment used in previous studies. Modifications were made to the addition of stone types as contact media (white stones and green stones), reduction of observation time (5 observations to 3 observations).

To be able to apply fluoride enrichment technology in the Tatah Makmur river water, it is necessary to carry out further trials on other types of fluorine stone. This is due to the white stone containing fluoride from Liang Anggang area which has a low fluoride content. The presence of fluoride in stones usually go along by the presence of other substances such as phosphate NaF, AgF, and KF which are soluble in water(Effendi, 2003).

Fluoride stone is usually used as jewelry because it has high brightness and luster. In 2016, stones with brightness and shine were found when rubbed into decorations from the Tanah Laut area of South Kalimantan. Seeing the similarities in the characteristics of fluoride stones from Tanah Laut, and white from the Liang Anggang area of Banjar Regency, the researchers wanted to conduct an experiment by comparing the ability of the two stones to increase the fluorine content of processed river water.

## 2. Method

This research was an observational analytical research. The analysis was carried out to determine the differences in the ability of white stones and green stones to increase the Fluor content of processed water. The research sample was river water in Mekar Sari Village, Tatah Makmur District, Banjar Regency, South Kalimantan Province. Before making contact with the experimental stone, the river water was processed first to remove turbidity. The variables involved in this study include the dependent variable fluoride in Mekar Sari processed river and the independent variable the thickness of the media is divided into 30 cm, 40 cm, and 50 cm; The stone types come from Liang Anggang and from Tanah Laut. The contact time is the duration of flowing processed water through the stone media for 24 hours, 48 hours, and 72 hours. The instruments used in this study were an aquarium water pump with a pressure of 2 m for water recirculation, submersible for the stirring process of raw water and coagulants, a 1200 liter water



reservoir for 5000 liters of raw water, a 2 meter water tower for placing water reservoirs, a 100 liter bucket for recirculating water and fluoride stone containers, and sample bottles for transporting samples to the laboratory.

The research materials consisted of Mekar Sari river water, alum, and fluoridated white stone Liang Anggang & Batu Tanah Laut. The data collection technique was obtained by taking samples directly from the Mekar Sari river water to check the initial fluorine content in the raw water of the Mekar Sari River. The turbidity of raw water from the Mekar Sari River was lowered first until it met the drinking water requirement of 5 NTU. Decreased turbidity using 2% alum solution. To determine the optimum alum dosage, a Jar-Test was performed.

The results of the intervention to increase Fluor content were obtained by passing processed raw water to the Fluoride Increase Portable with variations in media thickness, media size, and length of contact. The number of repetitions is 1 time. The total number of data is 30 data consisting of 27 data on the results of interventions on stone contact and processed

water, 1 data for fluoride water immersion in white stone and Tanah Laut stones.

After the processed water passes through the stone layers in the *fluoride increase portable* device according to the above variations, a 50 ml sample was taken to be examined in a test laboratory, to see the increase in fluoride content in processed water. Data obtained from the results of laboratory tests are collected, processed in tables and graphs, and analyzed in descriptive form by comparing the results of reference books and scientific journals related to Fluor, as well as the efficiency of equipment engineering.

### 3. Results and Discussion

#### a. Green Fluoride Stone Media

Table 1 shows that Fluor in processed water is 0.08 mg / liter. Taking a look at the table of processed water fluorine levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water to the stones, it shows an increase in Fluor levels.

**Table 1.** Green Fluoride Stone and Contact Time to Fluor Concentration

Thickness / Contact Time	6 hours	12 hours	24 hours	48 hours	72 hours
10;1-2	0.21 162,5%	0.27 237,5%	0.43 437,5%	0.43 437%	0.45 462%
20;1-2	<b>0.20</b> <b>150%</b>	0.32 300%	0.45 462,5%	0.46 475%	0.46 475%
30;1-2	0.22 175%	0.32 300%	0.44 450%	0.47 487,5%	0.48 500%
40; 1-2	0.23 187,5%	0.34 325%	0.43 437,5%	0.47 487,5%	0.49 512,5%
50;1-2	0.27 237,5%	0.28 250%	0.36 350%	<b>0.63</b> <b>687,5%</b>	0.62 675%

The lowest increase in Fluor concentration was at 6 hours of contact time variation at 20 cm thickness of 1-2 cm Martadah stone. The highest increase in Fluor percentage in the 48 hours; 50 cm; granules 1-2 cm. The calculation is as follows:

$$\begin{aligned}
 \text{PPF} &= ((K_{ft} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,20 - 0,08) / K_{af}) \times 100 \% \\
 &= 150 \%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

K<sub>ft</sub> = The current Fluor concentration at a

variation

$K_{af}$  = Initial concentration of Fluor in processed water

The calculation shows the lowest magnitude of increase in Fluor occurs in 6 hour variation; 20 cm; 1-2 cm granules, which is 0.2 mg / l or 150%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 48 hours; 50 cm; granules 1-2 cm i.e. 0.63 mg / l (687%).

Figure 1 tells the increase in Fluor concentration occurs in all variations of the thickness of the *martadah* stone measuring 1-2 cm. In the contact time interval of treated water in Fluor-containing stone, there was a very sharp increase from 6 hours to 48 hours. When the contact time is increased to 72 hours, the Fluor-boosting process begins to slow down.

It should be assumed that the Fluor content of the stone which is soluble in treated water is starting to decrease.

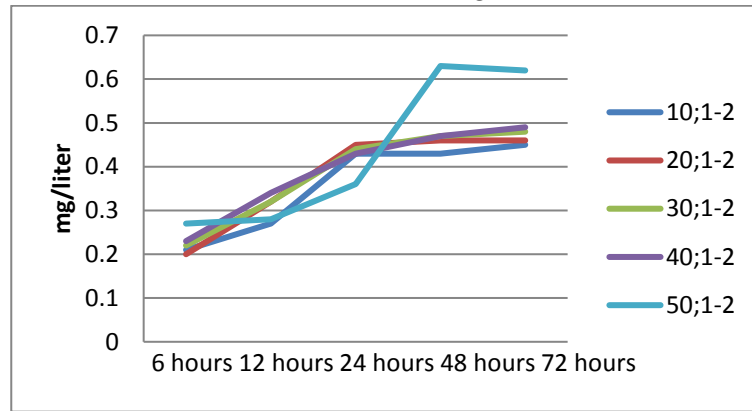


Figure 1. Green Stone Contact Time and Fluor Concentration

b. White Fluoride Stone Media

It is known that Fluor in processed water is 0.08 mg / liter. Table 2 presents the processed

water Fluor levels in all variations of the thickness of the 1-2 cm granular stones and variations in the length of contact of water against the stones, show a significant increase

Table 2. White Fluoride Stone and Contact Time to Fluoride Concentration

Thickness / Contact Time	6 Jam	12 Jam	24 Jam	48 Jam	72 Jam
10;1-2	0.31 287,5%	0.3 275%	0.46 475%	0.58 625%	0.56 600%
20;1-2	0.27 237,5%	0.35 337,5%	0.48 500%	0.59 637,5%	0.61 662,5%
30;1-2	0.25 212,5%	0.35 337,5%	0.47 487,5%	0.61 662,5%	0.63 687,5%
40; 1-2	0.32 300%	0.41 412,5%	0.46 475%	0.64 700%	0.66 725%
50;1-2	<b>0.24</b> <b>200%</b>	0.31 287,5%	0.39 387,5%	0.66 725%	<b>0.69</b> <b>762,5 %</b>

The lowest increase in Fluor concentration was at the variation of the 6-hour contact time at 50 cm thickness of 1-2 cm granular stones. The increasing percentage of fluorine increase in variation can be determined through the following calculation:

$$\begin{aligned}
 \text{PPF} &= ((K_{ft} - K_{af}) / K_{af}) \times 100\% \\
 &= ((0,24 - 0,08) / 0,08) \times 100 \% \\
 &= 200 \%
 \end{aligned}$$

In which:

PPF = Percentage of Fluor Increase

$K_{ft}$  = The current Fluor concentration at a variation

$K_{af}$  = Initial concentration of Fluor in processed water

Based on the calculation, it can be seen that the lowest magnitude of Fluor increase occurred in the variation of 6 hours, 50 cm; granules 1-2 cm which is equal to 200%. With the same calculation, the highest percentage increase in Fluor in processed water occurred in a variation of 72 hours; 50 cm; 1-2 cm granules i.e. 0.69 mg / l (762.5%).

Based on the figure 2, the increase in Fluor concentration occurs in all variations in the thickness of the stone measuring 1-2 cm. In the contact time interval of processed water in Fluor-containing stone, there is a very sharp increase from 6 hours to 48 hours.

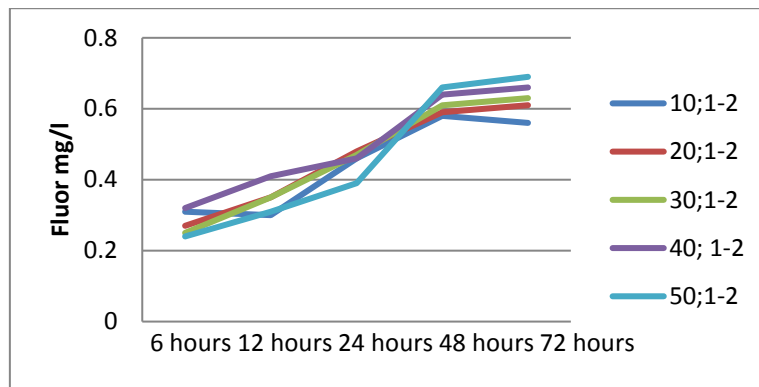


Figure 2. White Stone Contact Time and Fluor Concentration

When the contact time was increased to 72 hours, the Fluor-boosting process began to slow down. It should be assumed that the Fluor content of the stones which could dissolve in processed water began to decrease.

The decrease in Fluor content in treated river water after 72 hours circulation occur in both fluoride stones. Almost all of these conditions occur in experimental studies, such as those conducted by (Haris, 2011) and (Husaini & Haris, 2016) which reduced air pollutants using a wet scrubber. At a certain time, after running the tool for a while, the effectiveness and efficiency of the equipment starts to slow down and becomes stagnant or stable. This indicates that the equipment is getting saturated. Likewise, the decay of Fluor in white and green stones measuring 1-2 cm, is thought to have started to

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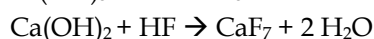
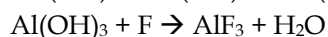
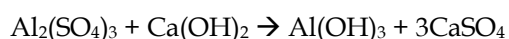
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The decrease of fluoride content in processed river water after circulation for 2 to 3 days, indicates that this recirculation method can only be used for a maximum of 2 to 3 days. If this will be used for more than one time, the stone must be replaced. If this is applied to community needs, it seems not practical. Because it will take quite a lot of time and energy. However, the addition of fluoride to increase fluoride levels in river water according to health standards is still needed. Given the habit of people using alum to purify river water, it can reduce Fluor levels in river water. So that the addition of Fluor is still recommended. This research is important to understand the environment fluor content, as it is necessary for people to fulfill their daily need. This research used white stone from peat area – Liang Anggang. The raw water was from Mekar Sari Village, South Kalimantan. The treated water is raw water whose turbidity less than 5 NTU. NTU is practical turbidity measurement in water (Hakim et al., 2019).

#### 4. Conclusion

To sum up, the stone abilities Green fluoride from the Tanah Laut area in terms of increasing river water Fluor levels is lower than white fluoride

stone from Liang Anggang area. Regarding the future work of this study, it is necessary to apply fluorine enrichment technology in the Tatah Makmur river water and to carry out further trials on other types of fluor stones. Besides, the addition of fluoride stone to a simple water purifier can be applied to purify water on a household scale and to minimize the decrease in fluor content due to purification with alum.

#### 5. Acknowledgement

We thank the following for their support, without whose help this work would never have been possible: Director of the Poltekkes Kemenkes Banjarmasin, Head of the Center for Research and Community Service of Poltekkes Kemenkes Banjarmasin, team of research experts, and Head of the Dental Hygiene Department.

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