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UTILIZATION OF NATURAL ZEOLITE SOUTH SULAWESI AS FILTRATION MATERIALFOR REDUCING HEAVY METAL NICKEL (NI)

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ABSTRACT

The study aimed to (1) determine the characteristics of South Sulawesi natural Zeolite; (2) analyze the quality of water processing model using natural zeolite as a filtration material; and (3) determine the correlation between actual zeolite concentration and absorbency in water processing. The water of Jeneberang River was collected at three observation points. The metal contents metallic Nickel (Ni), an untreated water samples were tested before they were used.

The zeolite was activated at the temperatures 100 ° C, 200 ° C, 300 ° C and 400 ° C and characterized with XRD and SEM. Then the weight was varied to ; 20 gr, 35 gr, and 50 gr. The raw water was injected with heavy metal (Ni) 5 ppm. Then it was flowed into a model / water processing tool using zeolite as a filtration material. The length of contact time to produce clean water 1000 ml, noted.

The result of water processing was tested by Atomic Absorption Spectrophotometer (AAS). The results indicate that the effective decrease of actual concentration and absorbency was at the weight 50 grams. The value of each, is to metallic Nickel (Ni) = -0,1112. Langmuir model analysis shows that there is a high correlation with R2 = 99,2 %, moderate Freundlich models indicate that there is a fairly high correlation with R2 = 67,2 %.

Keywords: Natural ZeolitToraja South Sulawesi, Water Treatment Model, Raw Water, Heavy Metal Nickel (Ni).

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1. INTRODUCTION

According to the Government Regulation of the Republic of Indonesia Number 82 Year 2001 regarding Water Quality Management and Water Pollution Control, that the water quality management is the maintenance of the water in order to achieve the desired water quality of its designation. Water pollution control is prevention and control of water pollution and water quality restoration.

Currently, the water environment pollution result in daily purposes water consumed is no longer appropriate to its purpose. Mostly, clean water / drinking water utilized by urban communities does not meet health requirements, even water in some places are not suitable for drinking. The water, containing harmful toxic materials (heavy metals). (Rahman, 2004)

Heavy metals if it accumulates in the human body to certain amount and passed the standards allowed, can cause various health problems. Example; Heavy metals Mercury (Hg), mercury compounds are very toxic to humans. Mercury salts absorbed in the intestine and accumulate in the kidneys and liver. The mercury in drinking water should not exceed 0,002 mgr / liter.(Davis dan Cornwell, 1991 in Efendi 2003).

Binding of toxic and heavy metals contained in raw water requires expensive equipment and processing materials. But, in Dusun Sangkaropi and Dusun Kasinggiran in DesaSangkaropi, Toao and MendillaKecamatan Sa' dang Balusu in KabupatenToraja Utara and Luwu Sulawesi Selatan, zeolite mineral found, As cheap and easy to obtain natural ion exchangers. The ability of zeolites is recognized by many researchers, serving as a versatile mineral that includes; Dehydrating, as adsorbents and molecular filters, as well as ionic catalysts and exchangers (ion exchanger).

To reduce the toxic materials contained in the raw water, the adsorption and filtration methods are the alternative used in this treatment. Processed water expected to meet quality requirements, In accordance with the Regulation of the Minister of Health of the Republic of Indonesia (No.492/MenKes/Per/IV/2010).

According to the description of the background, the aims of the research are:

- What is the characteristic of South Sulawesi zeolite nature?
- What about the ability of natural zeolite South Sulawesi as raw water filtration Jeneberang River?
- How to determine the relations between actual concentrating and absorbance?

2. BIBLOGRAPHY

2.1. Water Quality Issues on River System in Indonesia

According to Sennang (1995), in 2020 Indonesian people was predicted to increase and reached ±262,409,000 people. South Sulawesi would reach ±9,800,000 people. The needs of water will increase whether the quantities, qualities, or typesof use. The fulfill of water availability for people will be more depending on quality of Stream River Area at downstream. The result from Water Resource Research Center, about reservoir water quality in Indonesia, that for 1996-2010 period, including Bili-Bili Reservoir in South Sulawesi which has high sedimentation level. The dame having water turbidity from29,00-152.000 NTU, going across the limit, 6000 NTU (Nhepelometric Turbidity Unit) (SEPLH Journal In Hamzah, 2010).

2.2. Drinking Water Supplying Requairentment

Based on Nusa &Satmoko (2008), the main problem which still been facing in drinking water supply in Indonesia

a. The level of service is low.
b. Amount of water in rainy season and dry season is flutiative.
c. The red technology for processing is less suitable with the water condition which quality is decreasing.

The water that is properly drink, has requairentments tandart, those are physis, chemical, bacteriologist requairentment,of which is one unit. If there is on parameter that cannot fulfill the requairentment, the water is not proper to drink. According to Ministry of Health (No.492/MenKes/Per/IV/2010) Republic of Indonesia.

2.3. Water Processing Theory

According to Joko (2010), there are two kinds of water processing which is commonly used for this, namely:

1. Complete processing; here, the standard water experienced complete processing namely: physical, chemical, and bacteriological processing. This processing is done for standard water of the turbid / dirty river
2. Partial Processing; standard water only experience chemistry and or bacteriological processing.

In the complete processing, there are three levels of processing, namely:

a. Physical Processing; to reduce / eliminate rough impurities, isolate mud and sand, reduce organic substances that exist in the water which will be processed. Physical processing is done without additional chemistry substance
b. Chemical Processing; to help out the next processing, for example, placing alum that cut down on existing turbidity.
c. Biology Processing; to kill/destroy bacteria especially bacterium which cause disease contained in water, for example: coliform bacteria cause stomachache. One of processing is increasing disinfectant (alum)

2.4. Filtration Theory

Filtration is a process which is used in water processing to separate pollutants (particulate) that is contained in water. In the process, water seeps and passes through the filter media so it will be accumulated on the surface of the filter and collected throughout the depth of the media in its path. Filters also have the ability to separate all the sizes of particulates including algae, viruses and soil colloids

Several types of media filter, namely:

1. Single media filter is a filtration process which requiring a single media types, usually sand or anthracite (dis solving coal).
2. Dual-media filter is a filtration process requiring two kinds of media types, usually sand and anthracite.
3. Multi-media filter is a filtration process requiring three or more kinds of media types, usually use sand, anthracite and granite.

2.5. Zeolite Theory

According to Agung, et al (2007) zeolite was first discovered by Swede mineral expert in 1756, named AF Cronstedt. Naming zeolite came from the Greek, meaning "scum stone", agree with its nature, it will effervesce when it is heated at temperatures of 100 °C - 150 °C.

The composition of natural zeolite consist of a compound of alumino silicate hydrate and alkali metal element with chemical and physical properties such as a high degree of hydration, low space density, capable of cation exchange, uniform molecular channels in hydrated crystals, catalyst and conductivity of the flow of electricity (energy services and mineral resources of South Sulawesi province, 2001).

The basic frameworks of zeolite structure consist of tetrahedral units [AIO_4] and [SiO_4] which are inter connected through O atoms (Barrer 1987).

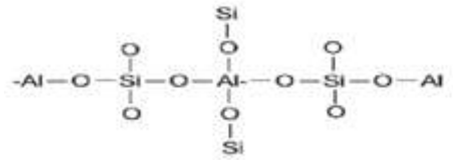


Figure 1 The main framework of the zeolite

The structure Si4+can be replaced by Al3+(Figure 1), so the general formula of zeolite composition can be expressed as follows:

$M_{x/n}[(AIO_2)_x(SiO_2)_y]mH_2O$ (Auerbach, et.al,2003) (1)

With n: the valence of cation M (alkali / alkaline), x, y = number per unit cell of tetrahedron m = number per unit cellof water molecules and M = cation alkali / soil alkaline.

2.6. The Properties of Zeolite

Zeolites have chemical properties, including:

2.6.1. Dehydration

According Barrer (1992), the natures of zeolite dehydration affect the nature of absorbtion. The uniqueness lies in the specific structure of zeolite pore. In natural zeolite, in the pores are cations or water molecules. When cations or water molecules are removed from the pores with a particular treatment, it will leave the empty zeolite pores.

2.6.2. Absorption

According to Khairinal (2000), under condition normal, void pores of zeolite crystal are filled with water molecules around the cation when heated the water will be released. The already heated zeolite can be used as gas or liquid adsorber.

2.6.3. Ion exchanger

According to Bambang, et. Al (1995), Ions in the pores is used to keep it under neutral condition. These ions can freely move so that the accurring ion exchange depends on their kind, size, and charge. Ion exchange characteristic of zeoliterelies on their cation, anion, and temperature.

2.6.4. Filter

According to Bambanget. Al (1995), zeolite can filter or separate molecules based on their polarity, size, and shape because zeolite have a large pore and void. The Smaller molecule than void and pore of zeolite can go through the pore but the big one will be trapped.

2.6.5. Zeolite Function

According to Department of Energy and Mineral Resource, South Sulawesi (2001), zeolite can be used as:

1. Agricultural use, such as fertilizer
2. Animal feed supplement
3. Ammonium ion adsorber and other poisons in soil or for remediation of formerly mined land, and as filter inwaterpurification system.

2.7. Zeolite Potency

According to South Sulawesi Department of Energy and Mineral Resource (2001), natural zeolite potency has beenfound in Sangkaropi and Kasinggiran Village, Toao and Mendilla, Sa'dangBalusu sub district, Luwu and North TorajaRegency. 122,952,000 ton zeolite has been found in 153.5 ha land with 59.27 hectares land filed using mining license.

Figure 2 (a) Zeolit of Sangkaropi (b). Zeolit of Kasinggiran

3. METHOD

This research is divided into several stages: Spectrophotometer), to determine the metal content of Nickel (Ni) in the raw water, the result can be observed in Table 1

3.1. Preparation Researches

At this stage of preparation and collection of research material, such as manufacturing of water treatment apparatus, sampling of natural zeolite in the district of North Toraja on South Sulawesi and sampling of Jeneberang river water were also prepared materials and laboratory equipment.

3.2. Implementation Research

Implementation of the research includes:

a. Test of Raw Water of Jeneberang River

- Raw water sampling of Jeneberang river is tested by means of AAS (Atomic Absorption Spectrophotometer),conducted to determine the metal content of Nickel (Ni) in the raw water, but what is also observed : pH, DO,BOD and COD.
- Place of swamp water sampling, location of water taken into the dam, amid dam and the water coming out of the dam.

b. Activation of natural zeolite

- Cleaned sample of Zeolite, then dried in the open air
- Variety of heats : 100 °C, 200 °C, 300 °C and 400 °C
- Samples of zeolites are crushed or pulverized and then sieved with a 170 mesh sieve to get the grain size of 170mesh or 3 mm.

c. The activated zeolite samples are taken sufficiently to characterize using XRD type Rigakuminifleks II and SEM(Scanning Electron Microscope) or energy Dispersive Spectrocopy (SEM-EDX) type 3 Vega Tescan. The samples were characterized to determine the content of compounds and natural zeolite pore surface of Toraja in South Sulawesi

d. Test of raw water treatment model

- Reservoir was filled by 8 liters of raw water that has been injected wih 5 ppm of heavy metal Nickel (Ni)
- Samples of zeolites that have been activated, weighed each; 20 grams, 35 grams, and 50 grams. Then put in a water treatment apparatus that is on the tube 2, 3, and 4
- Reservoir faucet is opened and drained for running into the water treatment apparatus and the contact time is calculated to produce clean water 1000ml. Same treatment for each weight variety.
- The processed water is tested by means of AAS (Atomic Absorption Spectrophotometer) type Shimadzu AA7000. The results showed that the value of concentration and the decreasing of the actual absorbance.

4. RESULTS AND DISCUSSION

4.1. Test Result of Samples in the Jeneberang River

Jeneberang river water sampling taken at three places, namely; taking incoming dams, the water in the dam and the water coming out of the dam. The water samples were tested by means of AAS (Atomic Absorption Spectro photometer), to determine the metal content of Nickel (Ni) in the raw water, the result can be observed in Table 1

Table 1 AAS Test Results Nickel (Ni) Jeneberang River

Jeneberang River Bili-bili Dam	Results AAS Ni (ppm)	DO (ppm)	DHL (Ω-1)	BOD5 (mg/L)	COD (mg/L)	pH
Water's coming in to the dam	+0,000	9,2	114,4	1,76	2,46	(5,8)
Water in dam	+0,001	10,8	103,9	1,36	2,10	(8)
Water that comes out from the dam	+0,001	9,8	128,2	1,76	3,20	(5,5)

4.2. Results Characterization of Zeolite Toraja in South Sulawesi

a. Figure of difragtogram Natural Zeolite Toraja, with the activation of heating; 100 ºC, 200 ºC, 300 ºC and 400 ºC byusing X-Ray Diffraction type RigakuMinifleks.

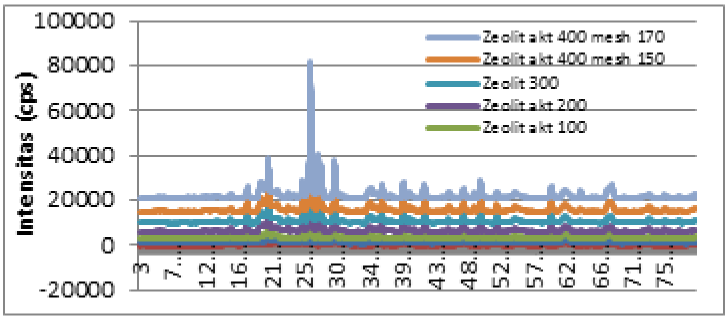


Figure 3 Difragtogram natural Zeolite of South Sulawesi

Table 2 composition of zeolites in toraja with variation of temperatur

Conten of zeolite	Temperatute			
	100°C (%)	200°C (%)	300°C (%)	400°C (%)
Quartz, syn	90			45
Potassium Chloride	3.9			
Zeolite P, (Na)				
Quartz low HP, syn		2.89		
Muscovite-2M1		71.1		
Zeolite P, (Na)		25.9		
Quartz low, syn			66.1	
Muscovite-2M1			20	14
Zeolite F (Na), Pentasodiumtecto-pdentaalumopentasilicatenonahydrate			13.9	
Albite, ordered				26
Potassium Tecto-Alumotrisilicate				9
Zeolite Nu-6(2), Silicon Dioxide				2.5
Sodalite				3.1

b. Pore surface SEM image of natural zeolite results Toraja in South Sulawesi with activation of heating 100 ºC,200 ºC, 300 ºC and 400 ºC

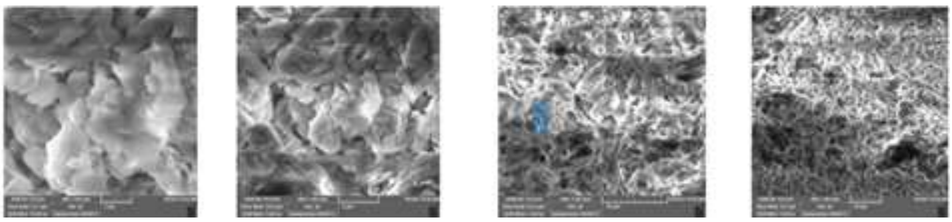


Figure 4 Scanning Electron Microscope- Energy Dispersive Spectroscopy (SEM-EDX) tipe TESCAN 3VEGAActivation ofNatural Zeolite (100 ºC, 200 ºC, 300 ºC dan 400 ºC)

4.3. Test Results Water Treatment EquipmentHeavy metals Nickel (Ni)

- Zeolite weight 20 grams

Table 3 Analysis of the water a AAS of metal Ni.

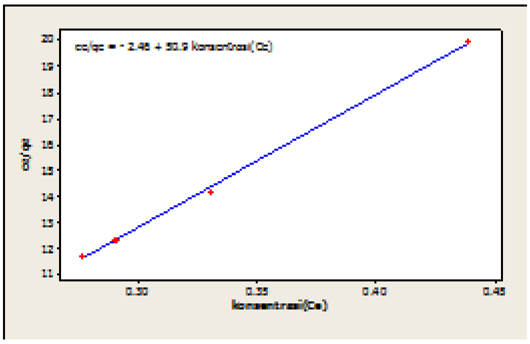
Temperature 0C	pH	Absorbance	Concentration	*Co* (ppm)	*Ce* (ppm)	*Co – Ce* (ppm)	*qe* (mg/gr)
100	5,8	0,033	0,4385	5	0,4385	4,5615	0,022
200	5,8	0,021	0,2766	5	0,2766	4,7234	0,0236
300	5,8	0,025	0,3306	5	0,3306	4,6694	0,0233
400	5,8	0,022	0,2901	5	0,2901	4,7099	0,0235

- Analysis of the test

Tabel 4 Analysis of Langmuir and Freundlich model testing

Absorbance	Concentration (Ce)	Qe(mg/gr)	log (ce)	log (qe)	ce/qe
0.033	0.4385	0.022	-0.35803	-1.65758	19.93182
0.021	0.2766	0.0236	-0.55815	-1.62709	11.72034
0.025	0.3306	0.0233	-0.4807	-1.63264	14.18884
0.022	0.2901	0.0235	-0.53745	-1.62893	12.34468

From the test results obtained regression equation model of Langmuir Ce/qe = -2,46 + 50,9 concentration (Ce), R^2= 99,8 %. Meanwhile, the Freundlich model test regression equation log (qe) = -2,01 - 0,95 log (ce), R^2= 21,4 %.



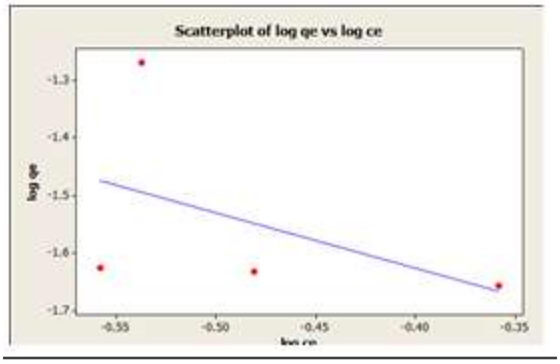


Figure 5 a) Langmuir Model b) Freundlich Model

The existence of a high correlation between Ce/qe versus Ce, and a high correlation between log qe versus log Ce, this is indicated by the value R^2= 99,8 % (Fig 5.a) and R^2= 21,4 % (Fig 5.b).

- Zeolite weight 35 grams

Table 5 Analysis of the water a AAS of metal Ni.

Temperature 0C	pH	Absorbance	Concentration	*Co* (ppm)	*Ce* (ppm)	*Co – Ce* (ppm)	*qe* (mg/gr)
100	5,8	0,019	0,2496	5	0,2496	4,7504	0,0135
200	5,8	0,015	0,1956	5	0,1956	4,8044	0,0137
300	5,8	0,022	0,2901	5	0,2901	4,7099	0,0134
400	5,8	0,019	0,24960	5	0,2496	4,7504	0,0135

- Analysis of the test

Tabel 6 Analysis of Langmuir and Freundlich model testing

absorbance	concentration(Ce)	Qe(mg/gr)	log (ce)	log (qe)	ce/qe
0.019	0.2496	0.0135	-0.60276	-1.86967	18.48889
0.015	0.1956	0.0137	-0.70863	-1.86328	14.27737
0.022	0.2901	0.0134	-0.53745	-1.8729	21.64925
0.019	0.2496	0.0135	-0.60276	-1.86967	18.48889

From the test results obtained regression equation model of Langmuir Ce/qe = -0,981 + 78,0 concentration (Ce), R^2= 100 %. Meanwhile, the Freundlich model test regression equation log (qe) = -1,86 - 0,0108 log (ce), R^2= 68,0 %.

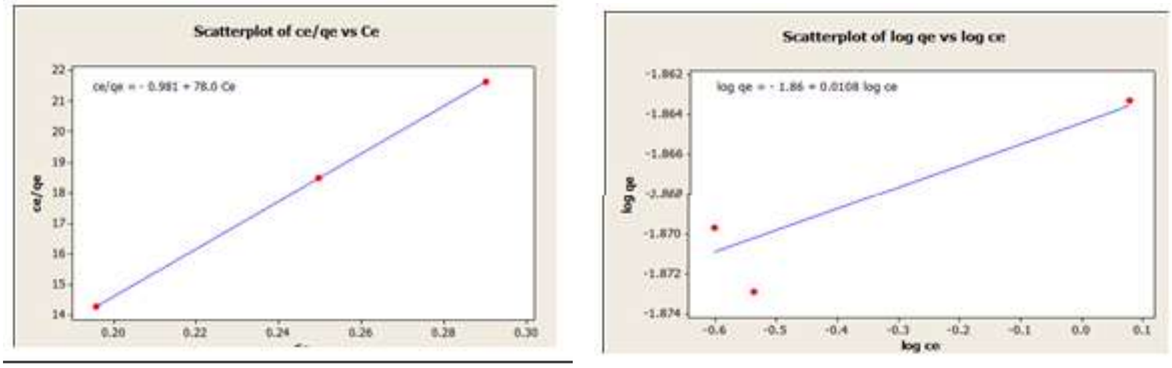


Figure 6 a) Langmuir Model b) Freundlich Model

The existence of a high correlation between Ce/qe versus Ce, and a high correlation between log qe versus log Ce, this is indicated by the value R^2= 100 % (Gambar 6.a) dan R^2= 68,0 % (Gambar 6.b).

- Zeolite weight 50 grams

Table 7 Analysis of the water a AAS of metal Ni.

Temperature0C	pH	Absorbance	Concentration	*Co* (ppm)	*Ce* (ppm)	*Co – Ce* (ppm)	*qe* (mg/gr)
100	6	0,0305	0,0687	5	0,0687	4,9313	0,0098
200	6	0,0212	-0,1115	5	-0,1115	5,1115	0,0102
300	6	0,0486	0,3977	5	0,3977	4,6023	0,0092
400	6	0,0943	1,2472	5	1,2472	3,7528	0,0075

- Analysis of the test

Tabel 8 Analysis of Langmuir and Freundlich model testing

absorbance	Concentration (Ce)	Qe (mg/gr)	log (ce)	log (qe)	ce/qe
0.0309	0.0687	0.0098	-1.16304	-2.00877	7.010204
0.0212	-0.1115	0.0102	-1.67366	-1.9914	-10.9314
0.0486	0.3977	0.0092	-0.40044	-2.03621	43.22826
0.0943	1.2472	0.0075	0.095936	-2.12494	166.2933

From the test results obtained regression equation model of Langmuirregresi Ce/qe = -1,59 + 132 concentration (Ce), R^2= 99,2 %. Meanwhile, the Freundlich model test regression equation log (qe) = -2,10 - 0,0875 log (ce), R^2= 67,2 %.

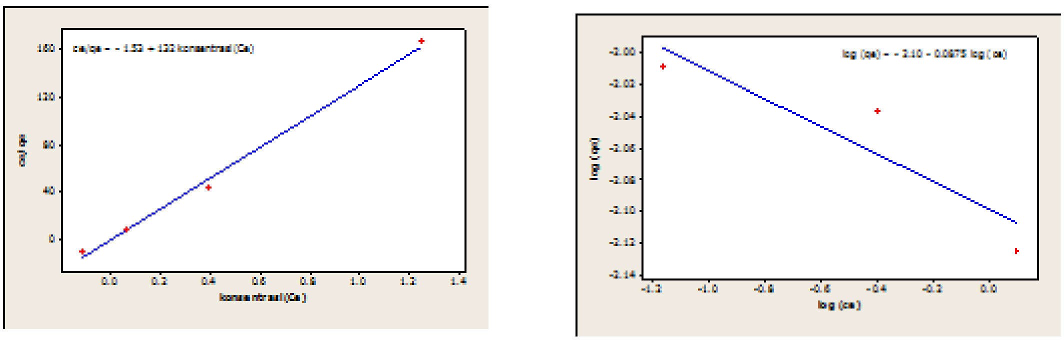


Figure 7 a) Langmuir Model b) Freundlich Model

The existence of a high correlation between Ce/qe versus Ce, and a high correlation between log qe versus log Ce, this is indicated by the value R^2= 99,2 % (Gambar 7.a) dan R^2= 67,2 % (7.b).

5. CONCLUSIONS

1. From the test results obtained by X-Ray Difraction compound content of SiO_2 (91.7%) showed a high percentage, so that the natural zeolite comes from deep-sea volcanoes have very effective metal adsorption intensity. SEM test results being seen that on heating to 300 ° C and 400 ° C open pore surface.
2. The absorbance value and the actual concentration of Ni metal, the value that is effective in zeolite weight of 50 grams is -0.111
3. Analysis of the model of Langmuir showed that there is a high correlation, with R^2 = 99.2%, while Freundlich models indicate that there is a high enough correlation with R^2 = 67.2%.

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