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Combination of Ni-Silica Metal (Ni/SiO_2) from Rice Husk as Heat-Resistant Coating Material for Wall Paint

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ABSTRACT

Combination of Silica with Ni to become Ni/SiO2. This study aims to determine the combination of Ni/SiO2 additives to wall paint as a heat-resistant coating material. The characterization used is FTIR and XRD. The initial stage of this study involved the synthesis of nickel silica, after which it was mixed into 10 mL of paint with variations in the addition of nickel silica of 0.1; 0.2; 0.3; 0.4; and 0.5 grams. After that it was tested for heat absorption. Based on the FTIR results on silica, it shows silanol groups (Si-OH) and siloxane groups (Si-O-Si) and the XRD results show that the structure of the resulting silica is amorphous. variations in the mixture of these materials affect the specific heat of the coating. The more Ni/SiO2 that is mixed, the smaller the specific heat will be. This indicates that the coating does not absorb heat but reflects heat.

Keywords: rice husk ash, silica gel, anti-heat, paint, additives

1. INTRODUCTION

Due to the increasing average temperature of the atmosphere at the surface earth in a way significant, manyconstruction the changing building consequence height incoming temperature into the room. When it gets bigger small wide surface affected house ray the sun, then the moresmall the total possible radiation received. Displacement hot in form radiation happen between surface inside and out building so that cause acquisition heat in buildings There are two sources acquisition heat in buildings, namely from external (walls, windows, roof, and floors) and internal (occupants and equipment) of the building.[1]

Radiation sun emit ultraviolet rays (6%), light visible (48%) and infrared rays which provide effect very high heat (46%). Research results previously show that radiation sun is contributor amount hot the biggest one that came in to in building. Efforts to get thermal comfort is reduce acquisition hot. Acquisition hot can reduced with use material or material that has stand great heat, so that rate flow penetrating heat

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material the will hampered Acquisition hot can reduced with use material or material that has stand great heat, so that rate flow penetrating heat material the will hampered.[2]

Materials that can be protect construction building from hot is thermal paint. Thermal paint canapplied anywhere and can be as coating conventional used in application House stairs and commercial Literature marketing show that some thermal paints contain additive reflective, and 10 have characteristic isolation enhanced intrinsic. Reflective properties can effective If the purpose is Reduce absorption radiation sun.[3]

Draft use a layer of paint that has reflectance height on the building has Lots studied in various countries and periods 10years time There are 260 publications showing various the benefits that can be obtained obtained from method cooling in a way passive use draft painting cold for condition environment inside room and outside room a building. The paint film layer consists of from water, binder, materials additives, and pigments. Function from material added additives to in paint is for repair properties of paint, such as prevent the occurrence separator color, as substance wetting agent, as anti- fungal and anti-bacterial, desiccant, and others that improve paint ability. For increase paint ability as reflector heat, paint formulation is made with selection and addition of materials that have characteristic emission high light like silicone dioxide (SiO_2) as much as 5 – 10% is capable increase ability reflect ray sun by 20% compared to with surface concrete *(concrete)* which is not coated

A number of Study previously utilization silver as material inner paint coating form very easy particles pile up between fellow and easy oxidized so that need agent stabilizer so as not to each other piling up the usual in the form of polymer, but polymer No stand to heat and synthesis process will more complicated with more expensive costs Silver is metal transition that can do some oxidation processes and can oxidize substance others. Silver generally used because one of them its toxic nature low. Silver ion nature neutral in water, hold acid, salt and base weak Stability silver is very good to heat and light silver ions are very unique. Silver ion will bring voltage electrostatic Because has lost electron valence.[4] Particles silver own reactive nature so that own application potential that is as agent antibacterial.[5]

Indonesia is a developing country with amount resident most 4th in the world, where majority its population work in the field agriculture so that Indonesia is called as an agricultural country. One of the product main agriculture in Indonesia is rice According to the Central Statistics Agency, in 2023 rice production rice in Indonesia reached 53.51 million tons. Production paddy the biggest in Indonesia is one of them located in North Sumatra Province with results production reaching 2.46 million tons in 2023. One of the production paddy the largest in North Sumatra Province according to the Central Statistics Agency 2020 is in Deli Serdang Regency, with production reached 315.48 thousand tons. Rice husks paddy often it is said as waste in processing rice which means as material waste or material remainder from the processing process results agriculture. Utilization husk paddy the still very little, so husk paddy still become material disturbing waste.[6]

Rice husk ash paddy own content high silica that is Where composition highest in ash husk paddy is silica (SiO_2) namely around 96.3%.[7] Rice husk ash rice has great potential to be utilized as material standard for materialbased manufacturing silica. Silica oxide (SiO_2) is one of the materials that has utility in a way wide as in industry pharmaceuticals, ceramics, paints and applications specializing in the field chemistry This is due to silica own properties: porosity height, strength Mechanic high, stability thermal high, have wide surface high pore, surface stable in acidic medium, resistant to microbes.[8]

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2. Experimental

2.1. Chemicals, Equipment and Instrumentation

Tools used in study This including Glassware, Stands and Clamps, Ovens (*Memmert*, Scales analytic *(balance), Furnance (muffle furnace),* grinding tool *(mortar and pestle),* 200 mesh sieve *(shieve),* Funnel *Bunchner* and Erlenmeyer flasks, branched cups porcelain *(crucible), hot plate (thermo), Magnetic stirre*, Desiccator, Paper filter whatman, universal pH indicator 1-14,

Main ingredients used in study This is husk rice . Chemicals used is Nickel Nitrate Ni $(NO_3)_2$ *(e-merck),* acid nitrate (HNO_3) *(e- merck),* NaOH 4M *(Sodium Hydroxide) (e- merck),* Aquadest, HCl 37% (Hydrochloric Acid) *(e- merck),* Wall Paint, Paper Filter, Paper Filter *Whatman*, pH meter.

2.2. Research Procedure

2.2.1 SiO_2 extraction from Rice Husk Ash and Characterization

SiO_2 extraction from Rice Husk Ash and Characterization of Rice Husk Ash in Advance formerly crushed as much as 20 grams of 200 mesh Rice Husk Ash was weighed Then soaked in 150 mL concentrated HCl for 2 hours while stirred with using a magnetic stirrer with temperature 100˚C and speed 250 rpm then left alone for 24 hours after That filtered Then the ashes that have been filtered Then washed until neutral with distilled water and dried in the oven at 120˚C for 6 hours. Rice husk ash paddy cooled down use desiccator and weighed heavy dry. Then melted down with 125 mL of 4M NaOH and boiled while stirred until thickens After almost dry, solution entered to in a furnace at a temperature of 500°C for 30 minutes. After cold added with 200 mL of distilled water and left to stand overnight.Then filtered with paper filter whatman 42. Solution results filter This Then added with 3M HCl solution drop by drop until formed thin threads of gel while stirred with magnetic stirrer up to pH 7 (neutral) and formed sediment white. The gel that is formed washed until neutral with distilled water for remove impurities in the form of salt compound NaCl, then dried in the oven at 120˚C for 6 hours. Silica gel that has been dry weighed until constant for to obtain heavy yield, then crushed using a mortar and pestle. After ground, sieved silica gel use 200 mesh Sieve.[9]

2.2.2 Synthesis of Ni/SiO_2 Composites using the sol-gel method

Nickel nitrate colloid was obtained by dissolving 0.7 M Ni $(NO_3)_2$ precursor (Merck 99%) into distilled water, then stirred at 350 rpm for ±10 minutes. Silica sol solution and nickel nitrate colloid were mixed in a 1:1 ratio into a beaker and then stirred at room temperature at 350 rpm for ±1 hour. During the stirring process, add nitric acid (HNO_3) until the pH reaches 7 and a gel is formed. Then the gel is stored and tightly closed for 24 hours. The formed nickel silica gel was washed using distilled water at 60ºC for 3 times to remove residues in the gel. The gel was then dried in an oven at 110ºC for ±2 hours to remove water content, then ground using a mortar and pestle and filtered using a 200mesh to make a composite powder. The Ni/SiO_2 composite powder was then sintered at a temperature of 850ºC.

2.2.3 Heat Absorption Test

The heat absorption test was carried out with the following steps, first dissolving the Ni/SiO_2 compound of 0.1g, 0.2g, 0.3 g, 0.4 g and 0.5 g each dissolved into 10ml of white paint, then measuring the initial temperature of each coating material. Then provide heat to each coating material by radiation for 5 minutes. Then measure the final temperature of each coating material. Finally calculate the specific heat for each coating material.

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3. RESULTS AND DISCUSSION

3.1 silica gel synthesis

Silica gel synthesis is carried out using the sol gel method through sodium silicate precursor. The process of making silica gel from sodium silicate is carried out in four stages, namely acidification of sodium silicate, formation of hydrogel, washing and drying of hydrogel into serogel. In the first stage, the acid used to acidify sodium silicate in this study is hydrochloric acid with a concentration of 3 M. The acidification process aims to form silicic acid which is a monomer of silica gel. Gel formation occurs because oxygen atoms from silicic acid will attack silicon atoms from other free silicic acids to form silicic acid monomers. The polymerization of silicic acid will continue to form polymer balls called primary silica particles. Silanol groups from adjacent primary particles will undergo condensation to form secondary particles with a relatively larger size when compared to primary silica particles. The resulting gel is still relatively soft, called alcogel. Condensation between polymer balls continues and there is a shrinkage in the volume of alcogel after being left for 24 hours. The shrinkage of the gel volume due to the condensation reaction is followed by the elimination of the salt solution. This stage is called the synergy process. At the end of the synergy process, a relatively stiffer gel with a smaller volume will be obtained when compared to the alcogel called hydrogel. The hydrogel is washed with distilled water to remove the salts which are by-products of the silica gel formation reaction up to pH 7. The clean gel is then dried (drying) using an oven to remove the water content. The final result of this drying process is white silica powder. The silica powder obtained is then ground with a mortar and sieved using a 200mesh sieve to obtain silica with the same particle size.

Figure 1. Results of silica gel synthesis

3.2 Characterization with FTIR

Silica obtained from rice husk ash using the sol-gel method was analyzed using FTIR to determine the presence of functional groups related to silica, where the x-axis is the wave number and the y-axis is the percentage of transmittance (T). In general, functional groups in silica gel are silanol (Si-OH) and siloxane (Si-O-Si). The resulting spectrum can be seen in Figure 2. The absorption band at wave number

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952.84 indicates the presence of Si-O stretching vibration of Si-OH, while the absorption band at wave number 796.60 cm^{-1} indicates the presence of Si-O symmetric stretching vibration of the siloxane functional group Si-O-Si. The bending vibration of Si-O-Si is indicated in the absorption bands with numbers 545.85 cm^{-1} and 472.56 cm^{-1}.

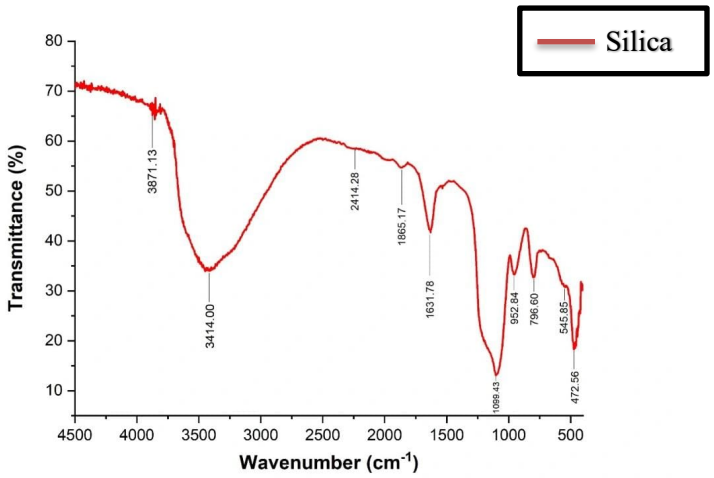

Figure 2. FTIR Characterization Spectrum of Silica

3.3 X-Ray Diffraction (XRD) Characterization

The analysis of crystallinity structure was carried out using *X-ray diffraction* (XRD). The amorphous form is characterized by a broad or sloping peak. The results of the XRD test on silica gel from rice husk ash can be seen in the following image:

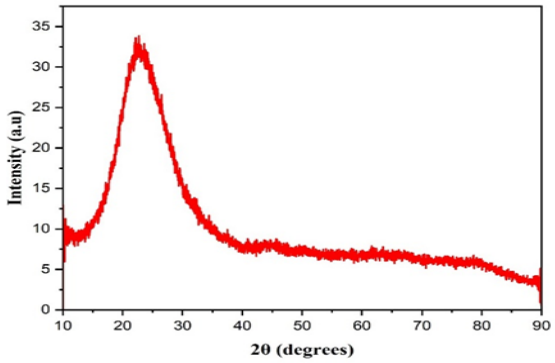

Figure 3. Difactogram of Silica Gel Characterization Results from Rice Husk Synthesis

Based on the diffractogram image and the table above, it can be seen that the silica gel synthesized from rice husk ash with a concentration of 4M NaOH shows that various peaks appear that broaden in the diffraction angle range of 2θ = 21-23˚. indicating an amorphous structure (low degree of crystallinity). So, based on the results of the diffractogram above, it can be seen that the variation in NaOH concentration does not change the structure of the resulting silica gel.

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3.4 Heat Absorption Test

Thermal conductivity is the ability of a material or substance to conduct heat. To determine the thermal conductivity of wall paint, a heat absorption test was carried out. The results of heat radiation for 5 minutes on the sample can be seen in table 3.1

Table 1. Sample radiation results data

(J)	m (kg)	T Beginning (K)	T End (T)	ΔT (K)	c (kJ/kg K)
1203,2	$0{,}1 \times 10^3$	303	305,8	2,8	4.297,1
1203,2	$0{,}2 \times 10^3$	303	305,7	2,7	2.228,2
1203,2	$0{,}3 \times 10^3$	303	305,6	2,6	1.542,6
1203,2	$0{,}4 \times 10^3$	303	305,5	2,5	1.203,2
1203,2	$0{,}5 \times 10^3$	303	305,4	2,4	1.002,7

The radiation results of 1203.2 J on each sample for five minutes produced different temperature changes. The largest temperature increase occurred in sample one, which was 2.8˚K at a Ni/SiO_2 mass of 0.1 gr, which is the smallest mass variation. Then the temperature increase decreased with increasing mass of the Ni/SiO_2 compound. The smallest temperature Increase of 2.4˚K occurred in sample 5 with a Ni/SiO_2 compound mass of 0.5 gr. This shows that the mass of Ni/SiO_2 is inversely proportional to the temperature of the sample. The greater the mass of Ni/SiO_2 mixed into the sample, the slower the temperature increase in the sample. This is because the Ni/SiO_2 compound has the character of not being able to store heat. The ability of the sample to store is indicated by the large heat capacity of the sample. The table shows that the greater the mass of Ni/SiO_2, the smaller the heat capacity of the material.

To show the relationship between Ni/SiO_2 mass and sample heat capacity mathematically, regression data analysis is required from the sample linear graph data. The graph is shown in Figure 3.4 below.

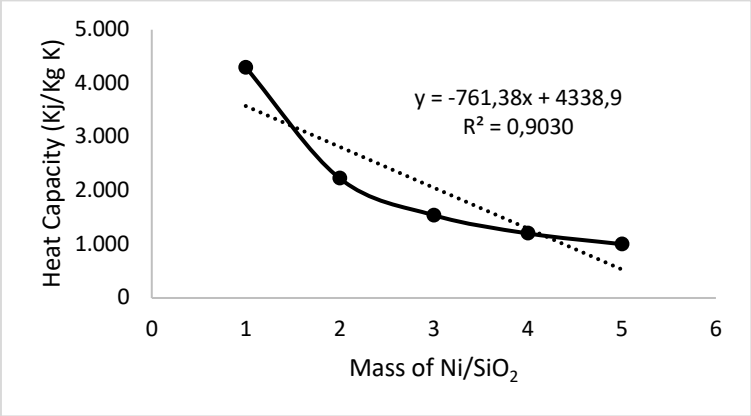

Figure 4. Graph of Heat Absorption Test Results

By using linear regression analysis, the graph equation is obtained =4338.9 + -761.38x, r = 0.95027, R^2= 0.9030. Because the calculated r is greater than the table r, there is a significant correlation between

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the mass of Ni/SiO_2 and the heat capacity of the sample. The determination coefficient R^2= 0.9030 explains that 90.3% of the heat capacity of the sample is determined by the mass of Ni/SiO_2 and the remaining 9.7% is determined by other factors.

4. CONCLUSION

Silica-based adsorbent from rice husk ash has been successfully made. The results of XRD characterization of silica gel produced by the sol-gel method from rice husk ash show that the structure is amorphous which is characterized by a wide or sloping peak. The results of FTIR characterization of silica gel from rice husk ash show that there are siloxane groups (Si-O-Si) and silanol groups (Si-OH). The results of the heat absorption test show that the greater the concentration of nickel silica, the smaller the heat capacity produced.

REFERENCES

1. Lubis, IH, & Koerniawan, MD **(2018)**. Reducing heat gains and cooling loads through roof structure configurations of a house In Medan. In *IOP Conference Series: Earth and Environmental Science* (Vol. 152, No. 1, p. 012008).
2. Hardiyanto S., Aji, MP, & Yulianto, A. **(2017)**. Coatings Heat Reflector uses TiO2 Compound *Unnes Physics Journal*, *6* (1), 70-73.
3. Simpson, A., Fitton, R., Rattigan, I.G., Marshall, A., Parr, G., & Swan, W. **(2019)**. Thermal performance of thermal paint and surface coatings in buildings in heating dominated climates. Energy and Buildings, 197, 196–213.
4. Dwandaru , WB, Putri, ZC, & Yulianti, E. **(2016)**. The Influence of Variation Concentration of Additives Solution Silver Nanoparticles Against Anti-Fungal Properties of Wall Paint as Application Nanotechnology in Wall Paint Industry *Inoteks : Journal Innovation Knowledge Knowledge , Technology , and Arts* , *20* (1), 1-18.
5. Janariah, J., Sari, JO, Sembiring, S., & Junaidi, J. **(2022)**. Preliminary Study Formation Structure Silver Silica (Ag/SiO2) Based Composite Rice Husk *Journal of Theory and Application Physics*, *10* (1), 25-30.
6. Utary, CM, Nurlaila, R., Ishak, I., Sylvia, N., & Meriatna , M. **(2023)**. The Influence time and temperature Burning of Rice Husk Ash in the extraction process silica with NaOH solvent. *Chemical Engineering Journal Storage (CEJS)* , *3* (4), 469-480.
7. Masrofah, I. **(2017)**. Study of utilization silica from husk paddy in processing waste Textiles *Journal of Engineering Media and Systems Industry*, *1*, 60-65.
8. Antovska, P., Cvetkovska M, & Goračinova , K. **(2006)**. Preparation and characterization of sol-gel processed spray dried silica xerogel microparticles as carriers of heparin sodium. *Macedonian Journal of Chemistry and Chemical Engineering*, *25* (2), 121-126.
9. Simatupang, L., & Devi, D. **(2016)**. The preparation and characterization of Sinabung volcanic ash as silicabased adsorbent. *Jurnal Pendidikan Kimia* (Vol. 8, Issue 3).

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