

# UTILIZATION OF RICE HUSK ASH AS FILLER FOR POLYAMIDE 6 AND POLYAMIDE 6.6

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## Abstract

In order to improve the dimensional stability, as well as, electrical, mechanical and thermal properties of polymers, it has been developed new filler to this purpose. The most applied filler to propitiate the features previously mentioned, are the glass and carbon fibers, the mineral filler as the calcium carbonate, the talc and the micro glass sphere. The main aim of this work is to study the rice husk ash as filler for polyamide 6 and polyamide 6.6, since it is constituted in 96% of silicon dioxide, and compare it with the talc which is the most applied mineral filler. This comparison will be made from a compound made through the refined rice husk ash and the polyamide 6 (PA 6) and polyamide 6.6 (PA 6.6) which are ones of the main engineering plastic with applications in several productive areas. The samples were injected and after their mechanical and thermal properties were measured.

## Introduction

The automotive, electric and electronic component industries, employ more and more the engineering plastics as a viable alternative for cost reduction and increasing of productivity without quality loss. Polyamide 6 and polyamide 6.6 are an engineering plastic with distinguished role on this category of polymers due to their properties<sup>1-3</sup>.

The researches have a fundamental role in new processes that aim to recycle the residues not only the industrial processes but also the ones generated in agriculture. Thus this work aims to contribute for the utilization of the rice husk ash in industrial activities, an agricultural residue that brings serious damages to the environment when discarded without the adequate control due to the great volume of this material generated in the world.

The main goal of this work is to study the rice husk ash as filler, since it is constituted about 90% of silicon dioxide and compare it with the talcum (3MgO.4SiO<sub>2</sub>.H<sub>2</sub>O) that is the most mineral filler used to verify the dimensional stability of parts injected with that composite. This comparison was made from the obtainment of composites of polyamide 6 (PA 6) and polyamide 6.6 (PA 6.6) with 30% of talc as mineral filler (MF) and with 30% of rice husk ash (RHA), injecting samples and measuring their mechanical properties of tensile strength, flexural strength and izod notched impact strength and thermal resistance of glow wire in three temperatures (750°C, 850°C and 950°C).

## Experimental

### *Obtainment of Rice Husk Ash*

The combustion of rice husk generates ashes with structural variable states (amorphous and/or crystalline) which depend on both type equipment used

for the burning, time and the temperature. The rice husk burnt in controlled conditions (maximum temperature of 1000°C), when hitting 800°C for two hours, it generates residual ash constituted of silicon dioxide in crystalline form of quartz. For temperatures in the interval from 450 to 700°C, from three to four hours, it obtains silicon dioxide in the amorphous state. When the ash is in the amorphous state it does not present risks to human health, however, when the ash contains silicon dioxide in the crystalline state this becomes less reactive and therefore it is considered harmful to the human health<sup>4-7</sup>.

Amorphous silicon dioxide is an easy grinding material and when ground, it is highly reactive. Their main properties are the low thermal conductivity and high resistance to thermal shock.

The rice husk ash used in this work was obtained from the burning of the rice husk under controlled temperature of 500°C in microwave oven for three hours being afterwards ground and sifted in grills of 325 mesh<sup>8</sup>. The residue has a black coloration due to incomplete combustion. As the main parts with PA 6 and PA 6.6 are elaborated in black color, this contamination with carbon in the rice husk ash displayed to the injected plastic parts a deep black color that benefited sensibly the visual aspect of the injected part. Formulate material with white talcum produce undesirable stains on the part surface. Formulate composites with rice husk ash do not need carbon black pigment lowering the product price.

### *Characterization of Composites*

The samples of two composites of PA 6 and PA 6.6 using as filler rice husk ash and talcum were injected and characterized determining the mechanical and thermal properties.

The analyzed mechanical properties were:

Izod notched impact strength (ASTM D 256).  
Tensile strength (ASTM D 638).  
Flexural strength ASTM D 790.

The analyzed thermal property was:  
Glow wire (NBR 6272/1980 - 750 C, 850 C and 960 C) samples with 1.66mm of thickness.

## Results

### Mechanical Properties

The values of mechanical properties presented in Table 1 represent the average of the results obtained as the number of predictable samples in compliance with the rules.

**TABLE 1.** The results of tensile strength, flexural strength and izod notched impact strength of the samples of PA 6 and PA 6.6 with filler of MF and RHA.

	PA 6 30% MF	PA 6.6 30% MF	PA 6 30% RHA	PA 6.6 30% RHA
<b>Tensile strength (MPa)</b>	57.78	67.04	63.47	65.00
<b>Flexural strength (MPa)</b>	114.00	123.00	100.96	114.00
<b>Impact strength (J/m<sup>2</sup>)</b>	33.31	34.00	30.60	32.00

### Thermal Property

In Table 2 it is presented the results of glow wire test of two types of polyamide studied with filler of MF and RHA.

**TABLE 2.** Results of glow wire test of PA 6 and PA 6.6 with filler of MF and RHA.

Composite	Glow wire		
	750°C	850°C	960°C
PA 6 30% MF	R	NR	NR
PA 6.6 30% MF	R	NR	NR
PA 6 30% RHA	R	NR	NR
PA 6.6 30% RHA	R	NR	NR

Note: R (it resists), NR (it does not resist).

## Discussion and Conclusion

The results of mechanical properties obtained when it is used 30% of mineral filler (MF) and rice husk ash (RHA) as filler for polyamide 6 and

polyamide 6.6, are similar. Regarding the thermal property (glow wire) for polyamide with 30% of RHA there was an advantage related to polyamide with 30% of MF. Polyamide 6 and 6.6 with RHA did not drip as the polyamide 6 and 6.6 with MF.

The visual aspect of the products formulated with RHA was better because they did not present stains as when talcum is used in the formulation.

With the results obtained in this work, it can be said that the rice husk ash has become an interesting alternative to be used as filler for polyamide 6 and polyamide 6.6, providing a utilization of this solid residue that today it is an environmental problem.

## References

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