Scientific Review
ISSN(e): 2412-2599, ISSN(p): 2413-8835
Vol. 5, Issue. 11, pp: 185-188, 2019
URL: https://arpgweb.com/journal/journal/10
DOI: https://doi.org/10.32861/sr.511.185.188

Academic Research Publishing Group

Original Research | Open Access

Study on the Granulation of FLY Ash from Thermal Power Station

Ganka Kolchakova
Department of Material Science and Technology, Assen Zlatarov University – Burgas, Bulgaria

Abstract

The effect of the type and amount of binding substance on the yield and strength of granules prepared from fly ash was studied. The highest yield of granules was achieved with clayish slip used as binder. The granules obtained are brittle, with compression strength 0,1MPa. The apparent density of the sintered granulates was in the range1200-1500kg/m^3 and the total porosity was 55-40%.

Keywords: Waste; Fly ash; Granulation; Properties; Compression strength.

1. Introduction

Thermal power stations (TPP) generate great amount of various types of wastes. Substantial part of them is the fly ash which is often deposited on arable land and is a major source of environment contamination [1]. It can be used for production of building materials like additives and fillers (bricks [2], ceramic articles [3, 4], concretes [5], cement, dry building mixtures, etc. [6, 7].

The main direction in the production of artificial porous fillers is connected with the wide use of industrial waste materials – mainly sols and slags from TPP [8], wastes from metallurgy [9], chemical production plants, etc. [10, 11].

The production of porous fillers from TPP sols helps solving problems with the utilization of natural resources, reduction of industrial wastes, development of no waste technologies, recultivation of arable land, etc. [12].

From the analysis of numerous scientific research works, it was found that the granulation of finely dispersed ashes generated from the coal combustion in Thermal power stations is a perspective method for utilization of this waste material [13]. The granulation methods comprise a large group of processes for formation of aggregates of spherical or cylindrical form from powders, pastes, melts and solutions of the processed materials [14]. These processes are based on different ways of treatment of the materials.

The aim of the present work is to study the possibility for granulation of fly ash generated by thermal power stations.

2. Material and Method

The fly ash used in this study originated from a coal thermal power station located in Bulgaria. The chemical composition of the ash is shown in Table 1.

Table-1. Chemical composition of fly ash (mass %)

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K2O Na2O	TiO_2	MnO	LOI	Specific surface (m^2g^{-1})	Pore Volume (cm^3g^{-1})
48.32	17.90	18.01	4.52	2.34	2.40	0.87	0.04	5.60	7.988	0.0079

The ashes from the power station have amorphous-crystalline structure (Fig.1). Its main components are SiO2, Al2O3, Fe2O3 and oxides of alkali-earth metals. The basicity modulus (Mo) of the ashes determined by the ratio between the sum of the basic oxides and the sum of the acidic ones was 0.1. This classifies the ashes used for the experiments as super acidic one.

Figure-1. Diffractogram of ash

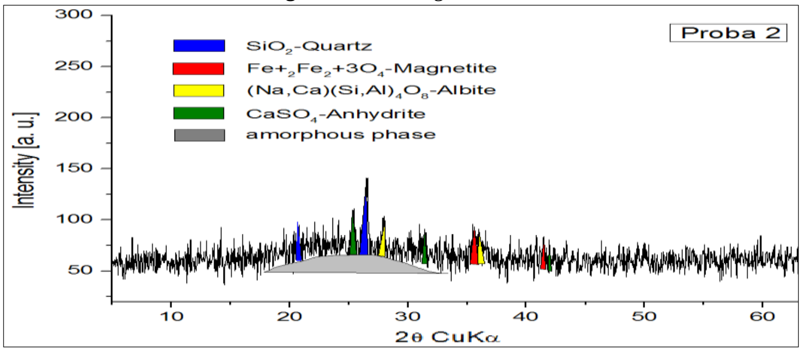


Fig.2 shows the crystalline phases of the fly ash determined by X-Ray Diffraction (XRD). The results obtained from the analysis indicated that the power station ashes are heterogeneous material containing both crystalline and amorphous phases. The crystalline phases were quartz, magnetite and albite.

The studies of ash granulation were carried out on a drum granulator. The initial ash was mixed with the calculated amount of binding substance and homogenized. The moisture content of the resultant blend was 15-20%. The blend obtained was then charged into the granulator and processed for 2-3h. The granules obtained were taken out, dried in air for one day and then the granulometric composition was determined.

3. Results and Discusion

The type and the amount of the binding substance is of special importance for the granulation process. For these experiments, 65% clayish slip and 20% aqueous solution of water soluble polymer "Laxin". The results obtained are presented in Figs. 2 and 3. The highest yield of granules was achieved with clayish slip used as binder. The granules obtained are brittle, with compression strength 0,1MPa.

Figure-2. Fraction composition of the granules depending on amount of the clayish slip

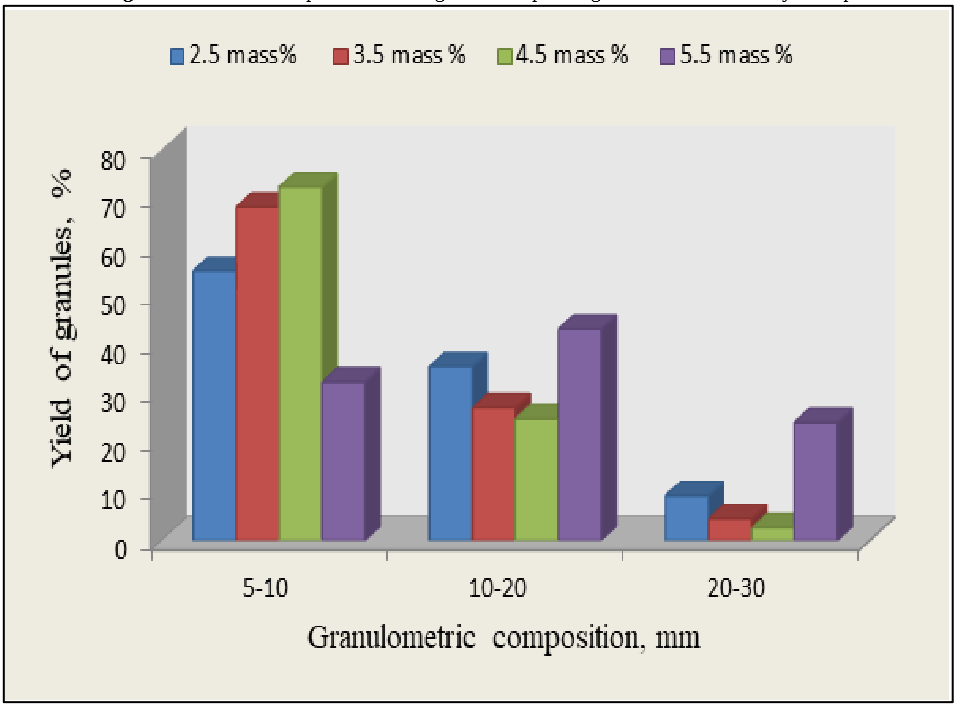
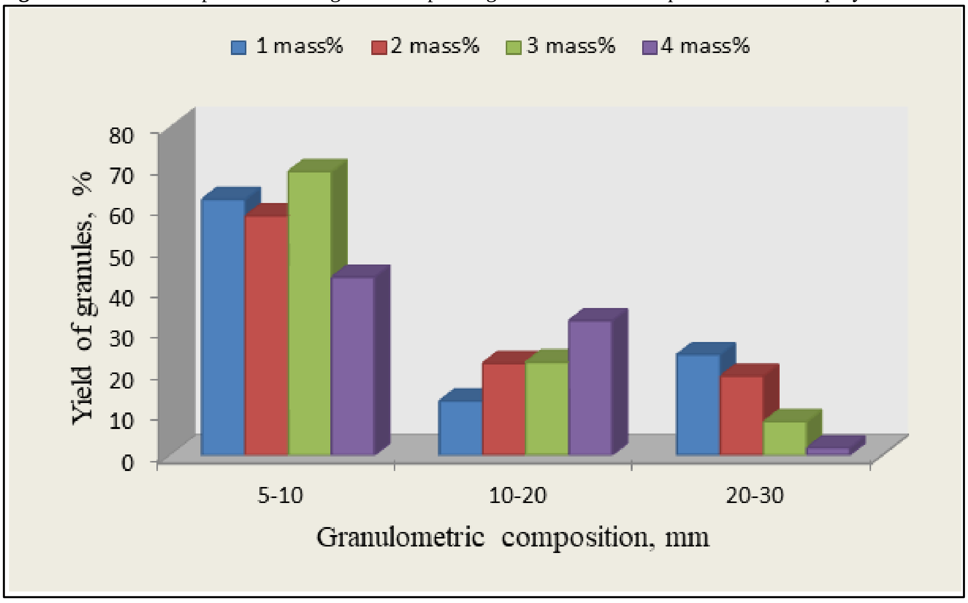


Figure-3. Fraction composition of the granules depending on amount of the aqueous solution of polymer "Laxin"



According to data in the scientific literature, the strength of the granules can be increased by increasing the drying temperature to 300ºC, as well as by introducing special hardening additives.

It is advisable to use sodium phosphates because of the structural characteristics of the phosphate ions. For the experiments, $Na_5P_3O_{10}$ was used. As binding substance, 20% solution of „Laxin" was added in amount of 1 mass %. The results obtained are shown in Table 2.

Table-2. Effect of the quantity of Na5P3O10 on the yield, by fractions

$Na_5P_3O_{10}$, mass %	Yield of granules, %	Compressive strength, MPa
-	75,5	0,11
1	89,2	0,24
2	93	0,30
3	98	0,50

It can be seen from Table 2 that the addition of Na5P3O10 increased the yield of granules of fraction 5-20mm by about 15% and granules' strength almost 4 times.

The effect of the sintering temperature on the tensile properties of the granules was also studied.

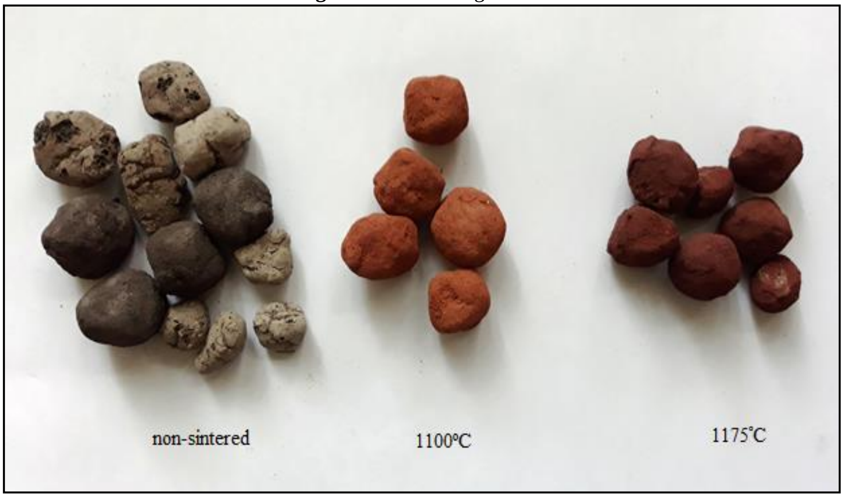
Aiming to preserve the initial shape of the granules, it is advisable to heat them in one layer. The sintering was carried out with granulate containing 4.5% clayish slip as binder.

The sintering was performed in a chamber super kanthal furnace „Naber" with programmable regulator for controlled proceeding of the process to temperatures 1100 and 1175°C and isothermal period of 15 min at 700°C. The heating rate employed was 25°C/min with isothermal period and the maximal temperature 0.5h.

Figure 3 presented a photograph of the obtained granules. The color of the non-sintered granules is grey-black. With the increase of the temperature, the granules' color changed to brick-colored to red-brown (Fig.4).

The apparent density of the sintered granulates was in the range1200-1500kg/m3 and the total porosity was 55-40%.

Figure-4. Picture of granules



To determine the compression strength, the fraction 5-20mm was used as it is the preferred one for filler in light concretes.

At 1100ºC, the compression strength was measured to be 1,1MPa, while for granules sintered at 1175ºC it was 2,2MPa which is comparable to the data on fillers used in construction.

4. Conclusions

The effect of the type and amount of binding substance on the yield and strength of granules prepared from fly ash was studied.

The highest yield of 5-20mm sized granules was observed with binder 65% clayish slip.

The use of Na5P3O10 as reinforcing additive, the yield of granules increased and their strength increased when 20% solution of „Laxin" was used as binder.

The sintering of the granules resulted in increased apparent density of the granules, decrease of porosity and substantial increase of their compression strength up to 2,2 MPa which is a good prerequisite for their use as filler in light concretes.

References

[1] Pandey, V. C. and Singh, B., 2012. "Rehabilitation of coal ash basins: Curent need to use ecological engineering." *Ecol. Eng.*, vol. 49, pp. 190-192.

[2] Cultrone, G. and Sebastian, E., 2009. "Fly ash addition in clayey materials to improve the quality of solid bricks." *Constr. Build. Mater.*, vol. 23, pp. 1178-1184.

[3] Cao, J., Dong, X., Li, L., and Dong, Y., 2014. "Recycling of waste fly ash for production of porous mullite ceramic membrane support with increased porosity." *J. Eur. Ceram. Soc.*, vol. 34, pp. 3181-3194.

[4] Qin, J., Cui, C., Cui, X. Y., Hussain, A., and M., Y. C., 2015. "Preparation and characterization of ceramsite from lime mud and coal fly ash." *Constr. Build Mater.*, vol. 95, pp. 10-17.

[5] Kockal, N. U. and Ozturan, T., 2010. "Effects of lightweight fly ash aggregate properties on the behavior of lightweight concretes." *J. Hazard Mater.*, vol. 179, pp. 954-965.

[6] Sakai, E., Miyahara, S., Ohsawa, S., Lee, S.-H., and Daimon, M., 2005. "Hydratation of fly ash cement." *Cem. Conc. Res.*, vol. 35, pp. 1135-1140.

[7] Zoorob, S. E. and Cabrera, J. G., 1997. "Design and construction of a road pavement using fly-ash in hot rolled asphalt." *Environ. Sci.*, vol. 71, pp. 149-165.

[8] Chen, H. J., Yang, M. D., Tang, C. W., and Wang, S. Y., 2012. "Producing synthetic lightweight aggregates from reservoir sediments." *Constr.Build. Mater.*, vol. 28, pp. 387-394.

[9] Gesoğlu, M., Güneyisi, E., and Öz, H., 2012. "Properties of lightweight aggregates produced with cold-bonding pelletization of fly ash and ground granulated blast furnace slag." *Mater. Struct.*, vol. 45, pp. 1535-1546.

[10] Chiou, I. J., Wang, K. S., Chen, C. H., and Lin, Y. T., 2006. "Lightweight aggregate made from sewage sludge and incinerated ash." *Waste Manage*, vol. 26, pp. 1453-1461.

[11] Corrochano, B. G., Azcárate, J. A., Rodas, M., Luque, F. J., and F., B. J., 2010. "Microstructure and mineralogy of lightweight aggregates produced from washing aggregate sludge, fly ash and used motor oil." *Cem. Concr. Compos.*, vol. 32, pp. 694-707.

[12] Parab, N., Mishra, S., and Bhonde, S. R., 2012. "Prospects of bulk utilization of fly ash in agriculture for integrated nutrient management." *Bull. Nat. Inst. Ecol.*, vol. 23, pp. 31-46.

[13] Agusta, H., Nisya, F. N., Iman, R. N., and Bilad, D. B. C., 2017. "Granulation of coal fly ash by using different types of granule agents." In *IOP Conference Series: Earth and Environmental Science.* pp. 1-8.

[14] Geetha, S. and Ramamurthy, K., 2010. "Reuse potential of low-calcium bottom ash as aggregate through pelletization." *Waste Manage*, vol. 30, pp. 1528–1535.