Review on Studies of Partially Replacement Concrete Using Aluminium Dross

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Abstract – Aluminium dross is a by-product of aluminium production. At present, dross is processed in rotary kilns to recover the aluminium. The objective of present work is to utilize the aluminium dross in the natural cycle (closed loop) by using it as an engineered material and to investigate the mechanical properties of new concrete type obtained by adding aluminium dross which is an impure aluminium mixture that results from metals melting and mixing with flux. The main advantage of this type of concrete over the conventional ones is the reduction in the quantity of raw materials.

Keywords: - Aluminium Dross, Crushed Sand, Water Absorption, Compressive Strength.

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INTRODUCTION

Aluminum Dross is a by-product of Aluminum production. Today much energy is consumed to recover the Al from the dross; this is energy that could be saved if the dross could be diverted and utilized as an engineering material. There are two forms of dross – white dross and black dross. White dross is formed during the primary Al refining process, while black dross is formed during the secondary refining process, which uses relatively large amounts of Chloride salt fluxes. Subsequently, the dross is processed in rotary kilns to recover the Al, and the resultant salt cake is sent to landfills; although it is sealed to prevent from leaching, the potential for leaching exists and may harm the environment. There is much merit if the dross that is formed could be "recycled" as an engineering product for specific applications. Interestingly the main constituents of dross are Al and Al_2O_3 as well as MgO and $MgAl_2O_4$; this is ironic since there is much effort today to produce Al based composites containing second phase constituents (such as Al_2O_3). Use dross to make Al composites. We have found that dross powders are well dispersed in aluminum alloy matrix via friction stir processing; the product provides superior wear resistance with some sacrifice in strength. This certainly is a viable use of Al dross.

Use dross as a high temperature additive for de-sulphureting steel slag. The dross could be used as an additive to the slag to modify the chemistry. However, for this application, only primary dross can be considered, because we need to alleviate fluorides in the dross.

Use dross to make refractory materials such as brick, or used in concrete as filler. We have found that dross particles can be mixed well with cement. This improves stiffness, abrasion resistance, and controlling micro-cracking of the material. Work in this area became the main focus of the project.

Aluminum dross is one of the waste products obtained during aluminum refining. It consists of metal, salts oxides, and other non-metallic substances. Basically, aluminum dross is classified as either black or white while the black (dry) dross has low metal content with high amounts of oxides, salts and granular-like in form similar to sand. The white (wet) dross has extremely high metal content with small amounts of oxides and salts and form large clumps or blocks. Aluminum dross is usually produced from the melting of aluminum scrap such as used beverage containers, aluminum siding, castings and the treating of the melt with salt flux. In the course of making aluminium alloys by melting aluminium scraps in furnaces, huge quantity of dross gets generated as a bye product. The dross is a mix of aluminium & alumina. In order to recover aluminium from dross, it is processed through two routes namely hot dross processing and cold dross processing. In case of hot dross processing, the material is churned resulting in exothermic reaction leading to entrapped aluminium getting liquidities & finally getting separated. The remains after aluminium redemption are pre-dominantly alumina. Similarly in case of Cold dross processing, it is taken out for alloy making furnace. The cooled dross is pulverized. The alumina gets powdery in the process of pulverization. However aluminium remains in coarse granular form. After pulverizing, dross is sieved. As a result, powder alumina gets separated from aluminium. Generation of dross at present is of the order of 250 – 300 MT per month at various units of CMR.

LITERATURE REVIEW

2.1 F. Puertas*, M.T. Blanco-Varela, T. Vazquez

Recycling and reutilization of industrial waste and byproducts is a subject of great importance today in cement and concrete technology. Traditional industrial by-products used in cement and concrete manufacture include fly ashes, granulated blast furnace slags, and silica fume. The reactivity and efficiency of these wastes as active additions (and even as cement constituents) have been extensively studied [Dunster 2005, Naville 1994, Elinwa 2011]. Less reactive wastes are used as load (charges) in the manufacture of cement or inert aggregates in the production are a subject of great importance today in cement and concrete technology. Traditional industrial by-products used in cement and concrete manufacture include fly ashes, granulated blast furnace slags, and silica fume. The reactivity and efficiency of these wastes as active additions (and even as cement constituents) have been extensively studied [Dunster 2005, Naville 1994, Elinwa 2011]. Less reactive wastes are used as load (charges) in the manufacture of cement or inert aggregates in the production of concretes and mortars. Another application of this by-product is as an addition to the mortar as a partial substitute for the aggregates. This new mortar could be applied to make curbs, paving stones, pavements, and so forth. The goals of this work are (1) to determine the chemical interaction between this waste (PAVAL™) and the Portlander the most reactive phase of Portland cement paste) and (2) to establish the effect on physicomechanical properties when silica sand is substituted for this waste in mortar.

2.2 D.A. Pereiraa, Barroso de Aguiarb, F. Castroc, M.F. Almeidad, J.A. Labrinchae,

During the recovery of aluminum through scrap recycling, a great quantity of oxide layer forms on the surface of molten metal, which has to be removed from the melt to refine the quality of the final product. In order to promote an easier separation and to avoid the formation of additional oxidation phases, it is common to use a protective salt cover. The molten salt flux promotes the coalescence of suspended metal droplets and helps separate the clean metal from oxide contamination. The scum formed on the surface of molten metal is made of a mixture of oxides, fluxes, gases, and some free metal. Its common name is aluminum salt slag. Fluxing techniques and production practices strongly change throughout different industries giving several types of dross, normally called white and black. White dross is produced from a melting process of strongly pure scraps, having high aluminum metal content. In this case, fluxing inside the furnace is practically absent and the color of dross skimmed is gray or metallic white. Black dross is produced by secondary aluminum smelters, by using rotary furnaces to melt old casting and a low-grade aluminum scrap. Fluxes are composed of mixtures of sodium and potassium chlorides and contain small amounts of fluorides. At high molten-metal temperatures, the flux melts and becomes dark. This slag is highly salt-rich (50±70%) and is the object of our study. The Environmental Protection Agency of the US (EPA) classifies these residues as toxic and hazardous wastes [Dunster 2005].

2.3 E.M.M. Ewais a,*, N.M. Khalil b, M.S. Amin c, Y.M.Z. Ahmed a, M.A. Barakat

Since its discovery at 1908 by the French scientist Paid several research works were interested with calcium aluminate cement ‘‘refractory cement’’. Calcium aluminate cement is one of special cement characterized among others with developing about 80% of its ultimate strength after only 24 h of beginning of the hydration [Dunster 2005]. This feature enables its use as a very rapid hardening structural material in the busy locations such as factories and military places [Naville 1994]. Other applications of calcium aluminate cement include industrial flooring products (such as cast house floors), chemical resistant mortars and concretes, sewer applications, expansive grouts, floor screeds, tile adhesives, protective coatings and in building chemistry products (whereas ordinary Portland cement is combined with it to give desired setting times) [Elinwa2011, BS 881: 1992]. In addition, pure calcium aluminate technology has been used to rehabilitate dam spillways and structures affected by biogenic corrosion, such as manholes and pipes [BS 881: 1992]. However the most important feature of calcium aluminate cement is its capability to withstand high firing temperatures up to 2000 8C depending on the type of the cement and its content of impurities [BS 881: 1983]. In the field of high temperature applications, the type of cement used is determined by the required refractoriness [Dunster 2005]. Calcium aluminate cement is becoming the binder of choice for refractory formulators as the properties of monolithic refractories approach, and in some cases surpasses, the properties of refractory bricks. The flexibility a formulator has when working with calcium aluminate cement has allowed refractory castable technology to grow from simple conventional gun mixes and castables to formulations and installation systems that have significantly enhanced the refractory formulator’s offer of longer lasting lower cost refractories. Monolithic refractory technology has grown to include calcium aluminate cements in many products with enhanced properties and installation systems such as low cement, ultra-low cement, low moisture, high density, self-flowing, pumpable and formless (shotcrete) constables

Banapurmath et al. 2008 made comparative performance studies of a 4-stroke CI engine operated on dual fuel mode with producer gas and Honge oil and its methyl ester (HOME) with and without carburetor In order to meet the energy requirements they found that there has been growing interest in alternative fuels like biodiesels, methyl alcohol, ethyl alcohol, biogas, hydrogen and producer gas to provide a suitable diesel oil substitute for internal combustion engines. They use biomass energy for CI engine, solid biomass can be converted into a mixture of combustible gases, and subsequently utilized for combustion in a CI engine.

2.4 Chen Dai, Diran

Aluminum Dross is a by-product of Aluminum production. Today much energy is consumed to recover the Al from the dross; this is energy that could be saved if the dross could be diverted and utilized as an engineering material. There are two forms of dross – white dross and black dross. White dross is formed during the primary Al refining process, while black dross is formed during the secondary refining process, which uses relatively large amounts of Chloride salt fluxes. Subsequently, the dross is processed in rotary kilns to recover the Al, and the resultant salt cake is sent to landfills; although it is sealed to prevent from leaching, the potential for leaching exists and may harm the environment. There is much merit if the dross that is formed could be "recycled" as an engineering product for specific applications. Interestingly the main constituents of dross are Al and Al_2O_3 as well as MgO and $MgAl_2O_4$; this is ironic since there is much effort today to produce Al based composites containing second phase constituents (such as Al_2O_3).

3. CONCLUSION

The objective was to studies the mechanical and chemical behaviour of new concrete type obtained by adding aluminium dross. It was also aimed to studies the effect of harsh environmental conditions in the Gulf region on the durability properties of aluminium dross added concrete. Within the scope of the studies, to evaluate the properties of aluminium dross waste generated .The main tasks performed during the work can be listed as the chemical and physical tests on aluminium dross.

REFERENCES

A.M. Dunster, F. Moulinier, B. Abbott, A. Conroy, K. Adams and D. Widyatmoko, (2005). "Added value of using new industrial waste Streams as secondary aggregates in both concrete and asphalt", DTI/WRAP Aggregates research Programme STBF 13/15C, The Waste and Resources Action Programme.

A.M. Naville, (1994). "Properties of Concrete" Third Edition, Longman Scientific and Technical, Longman group UK LTD. England,

A.U. Elinwa and E. Mbadike, (2011). "The use of aluminium waste for concrete production", Journal of Asian Architecture and Building Engineering, Vol. 10, No 1, pp. 217-220.

British Standards Institute, "Testing Concrete—Methods of Testing Hardened Concrete for Other than Strength," BS 1881-5:1970, London, 36 pp.

BS 1881: Part 116: (1983). "Method for determination of Compressive strength of concrete cubes", London: British Standard Institution. 1983

BS 881: (1992). "Specification for aggregates from natural Sources for concrete", London: British standard institution, 1992.

C. Dai, (2012). "Development of aluminium dross-based material for Engineering applications", M.Sc. Thesis, Material Science and Engineering, Worcester Polytechnic Institute, January 2012. Advisor: Prof. Diran Apelian

D.A. Pereira, Barroso de Aguiar,F. Castro,M.F. Almeida and J.A. Labrincha, (2000) "Mechanical behaviour of Portland cement mortars with incorporation of Al-containing salt slags", Cement and Concrete Research, Vol. 30, pp. 1131-1138.

E.M.M. Ewais, N.M. Khalil, M.S. Amin, Y.M.Z. Ahmed and M.A. Barakat, (1999). "Utilization of aluminium sludge and aluminium slag (dross) for the manufacture of calcium aluminate cement", Ceramics International, Vol. 35, pp. 3381-3388, 2009. [10]F. Puertas, M.T. Blanco-Varela, and T. Vazquez, "Behaviour of Cement mortars containing an industrial waste from aluminium refining stability in Ca(OH)2 solutions", Cement and Concrete Research, V. 29, pp. 1673-1680.

Gwinner, D.S., (1996). "Environmental Issues in the Aluminium Reclamation Industry". In: II Seminário Internacional de Reciclagem de Alumínio, São Paulo, SP, Brazil, 8 August 1996, ABAL (Associação Brasileira do Alumínio), pp. 40–51.

Kulik, G.J and Daley, J.C., (1990). "Aluminium Dross Processing in The 90's", in 2nd Int. Symp.

Recycle. Met. Eng. Mater, TMS-AIME, Warren dale, PA, 1990, pp. 427

M. Brough, (2007). “Aluminium lightens the environmental load”, Vision the newsletter of the Foresight and Link Initiative, No4,Winter2002.URL<http://www.berr.gov.uk/files/file30193.pdf >. Access date: [11.11.2007].

M.C. Shinzato and R. Hypolito, (2005). “Solid waste from aluminium Recycling process: characterization and reuse of its economically valuable constituents”, Waste Management, Vol. 25, pp. 37-46, 2005.

O. Hollins Aluminium industry could dramatically reduce Land Filling of furnace waste. URL< http://www.ohlsti.co.uk/ohl/newsletter/ohl_wmr312.pdf >. (Accessed November 11, 2007)

Peterson, R.D and Newton, L., (2002). “Review of Aluminium Dross Processing”, Light Metals, TMS-AIME, Warren dale, PA, 2002, pp.1029

V. M. Kevorkijan, (1999). “The Quality of Aluminium Dross Particles And Cost-effective Reinforcement for Structural Aluminium-based Composites”, Composites Science and Technology, Volume 59, Issue 11, August 1999

WIKIPEDIA, (2013). “Compressive Strength”, 2013.

Zongjin Li, (2001). “Advanced Concrete Technology” First Edition, John Wiley and Son INC, Hoboken New Jersey, 2001

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