S.K.I. Schlegel & Kremer Industrieautomation GmbH

Ductile Iron through Cupola Furnace

ABSTRACT

Ductile Iron production through Cupola Furnace without Duplexing.

GD Mishra

Ductile Iron through Cupola Furnace

GD Mishra[1], steel@gdmtechnics.com
CEO, General Dynamic Multi Technical Consultancy LLP

[1]A Mechanical Engineer and MBA having 30 years of diversified experience in Product Application and implementing new Concepts and Project in India. Liquid Helium, Brewpubs, Lost Foam Castings(v-LFC) and V-Process (VPC) are few of the Products and Processes introduced in India by his efforts.

Though the cupola furnace is said to have been used from 3rd Century B.C. by the Chinese, the first cupola furnace was officially known to have been made by René-Antoine Ferchault de Réaumur around 1720 AD.

Perception & Myth

Cupola is considered polluting, and energy inefficient melting method used by small cast iron foundries. On the contrary a Modern Cupola is highly energy efficient, eco-friendly, with very high melting rate, water cooled, long campaign, versatile to produce all grades of grey and ductile irons.

Cupolas are inefficient only if they are following "old" methods and designs. The high efficiency cupola plants of today produce iron that is 15% less energy intensive than iron produced from coal-produced electricity (medium frequency). When methods for waste heat reclamation are installed (cupola flue gases), cupolas are 40-60% more energy effective than electric melting.

United States Pipe and Foundry, LLC, American Cast Iron Pipe Company & McWane Ductile. have been regularly operating Cupola Furnace to produce Ductile Iron Pipes. Nearly 2.3 million tons/year of ductile iron production is produced by cupola melting in US.

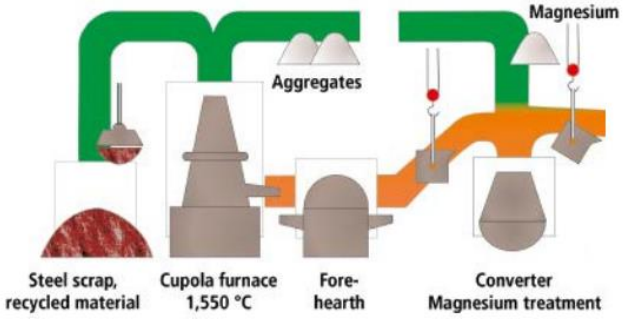
American Cast Iron Pipe Co. (ACIPCo) recently commissioned a new cupola melting system that the designer and builder reports has helped the ductile-iron foundry meet environmental regulations, increase productivity, and save production costs. Kuttner LLC North America, Port Washington, WI, says the new installation it designed is achieving federal MACT (maximum achievable control technology) standards for airborne emissions, and increasing ironmaking efficiency. The new, long campaign hot-blast water cooled cupola has a diameter 3810 mm cupola with a nominal production capacity of 100 ton/hr.

Many cupola shops continue to invest in technical improvements in furnace efficiency and heat recovery systems as part of their long-term strategy for sustainability.

A wide range of scrap input can be handled, such as dirt, high zinc, shredder contaminants, bundles, iron briquettes, high oxide content and self-reducing briquettes. In stream desulfurization for ductile or compacted graphite base iron allows for the melting of low-cost high sulphur scrap.

Cupolas are well known to have lower labor cost per unit of iron, especially for high production cupolas, say above 20-25 tons per hour. This makes it quite acceptable for Counterweights and Ductile Iron Pipe Industry.

State of the art pollution controls for cupolas have been in place in Europe for two decades, proving that properly designed air pollution control systems make cupolas viable.

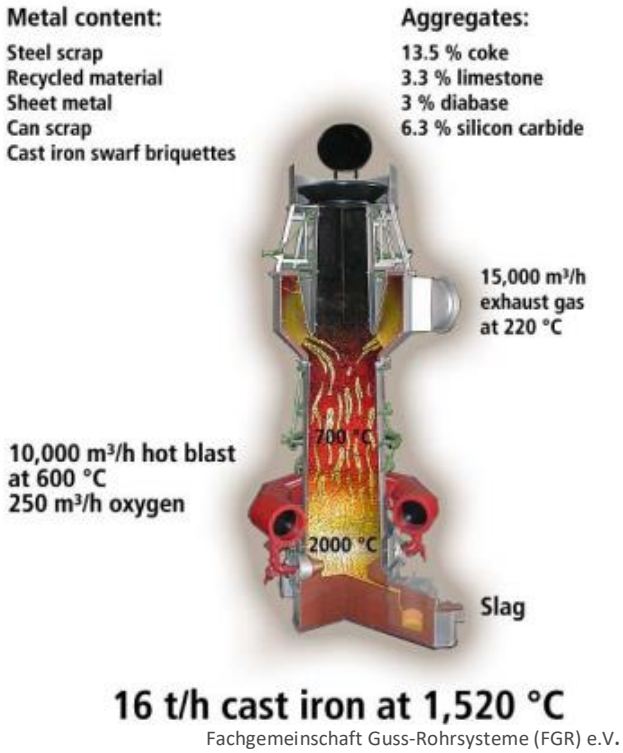


Fachgemeinschaft Guss-Rohrsysteme (FGR) e.V.

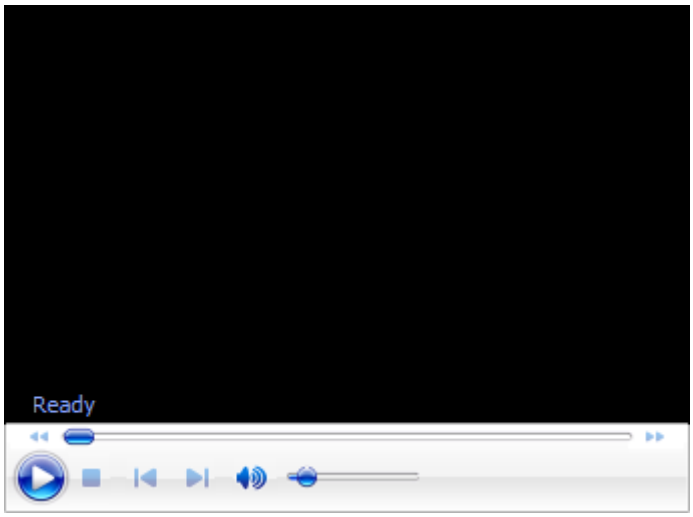
Silent Features of Modern Cupola

1. Increase the temperature of molten iron
   Under the condition of constant coke consumption, hot air at 400 to 500°C can increase the temperature of molten iron by 60 to 100°C, and the tapping temperature can reach 1500-1560°C.
2. Save coke and eliminate harmful gases
   After preheating and supplying air, the CO in the furnace gas is basically burned out, which prevents harmful gases from polluting the atmosphere.
3. Reduce the burning loss of Si and Mn elements and reduce the oxidation of molten iron.

4. Reduce melting costs
    a. Continuous production for 30 days or two shifts × 45 days
    b. As a large amount of mixed/graded scrap can be added, the cost of metal charge is reduced.
5. High degree of automation



Basic lined cupola is preferred, wherein slags of high basicity can be maintained. For example, a cupola lined with dead burned magnesite brick laid with magnesite mortar has been found to produce excellent results. Heats run in a conventional acid lined cupola produced the same effects as those attained in the basic lined cupola, but to a less degree.



The coke used in the cupola furnace always contains a small proportion of sulphur, which dissolves in the liquid iron and can have a negative effect on the mechanical properties of the iron. This means that a stage has to be added after the production of the molten iron in which the sulphur is removed. This is done by using appropriate raw materials, such as calcium carbide, to which the sulphur becomes chemically bound. The reaction products float on the iron melt as slag and can thus be separated off.

Sulphur Reduction for Ductile Iron

In the Scrap charge of 70% steel and 30% pig iron addition of Calcium Carbide to the extent of 7% of metal charge, Limestone 5% & Fluorspar 2% in each coke charge can be done and reducing coke to 6% (in place of 15-17%) which will increase the melt rate by 40%. Final melt will have about 0.03% Sulphur, 3.3 % Carbon 2.3% Silicon.

Further to reduce cost of production 30% of Coke Charge should be substituted by Rice/Paddy Briquettes. These have a calorific value of 3500 kCal/kg. The use of briquettes helps in extra Carbon pickup and Sulphur reduction by another 30%.

Hot Blast Water Cooled long-campaign Cupola will ensure tapping temperature of 1500-1560 °C. This metal would be collected in Holding Furnace and finally sample will be taken for spectrometer test. Further addition of Calcium Carbide for final adjustment of C & S if needed and then inoculation with FeSiMg to produce Ductile Iron.

References & Acknowledgments:

1. https://kids.britannica.com/scholars/article/cupola-furnace/28238
2. https://www.moderncasting.com/articles/2018/08/22/state-us-cupola-industry
3. Sam F. Carter, Jr., Ala., assignor to American Cast Iron Pipe Company, Birmingham.