

# Portland Cement Manufacturing



Portland cement plant.

## Introduction

Everyone is familiar with Portland cement. Mixed with water and aggregate, it forms the Portland cement concrete that is used in everything from sidewalks to bridges to skyscrapers. Portland cement is also used for mortar, masonry units and soil stabilization. Tremendous amounts of raw materials containing lime, silica, alumina and iron oxide and an enormous amount of energy are required to meet the demand for Portland cement. Producers are increasingly looking at IRC materials to reduce their material and energy costs as well as to cut the carbon dioxide emissions that result from cement manufacturing.

## IRC Materials in Portland Cement

Portland cement is composed of calcium silicates, calcium aluminates, calcium aluminoferrites and usually some gypsum. When water is added to the cement, the calcium minerals hydrate and form a gel. This gel is what holds the aggregate together in concrete. To make cement, the raw materials are usually dried and ground, and then the mixture is heated in a kiln to form clinker. The clinker is then mixed with gypsum and other materials and ground into the fine powder known as Portland cement. The main methods of using IRC materials in cement manufacturing are using the byproduct materials in place of traditional raw materials, or by using the byproduct materials as a cement substitute in the final product.

Both blast furnace slag and steel slag contain a number of minerals that make them good feedstock material for cement manufacturing. Steel slag in particular usually has a high lime content, similar to that of cement clinker. An added benefit of using slag is that the materials are usually dry and already calcined, meaning additional energy is not needed to convert calcium carbonate to lime. This cuts down on processing and energy costs. Foundry sands are also commonly used as feedstock to provide silica, aluminum and iron.

Pelletized and granulated blast furnace slag can also be ground and used as slag cement. Slag cement can be used by itself as a binder, or mixed with Portland cement. Mixing slag cement with Portland cement helps improve the strength and lowers the permeability of the hydrated cement. Similarly, coal fly ash can be added to cement to improve its properties. Coal fly ash is a pozzolan that reacts with free lime in hydrated cement. The pozzolanic effect improves the long term strength and durability of concrete made with coal fly ash.

## Benefits

The use of IRC materials in Portland cement production or as a cement substitute has significant environmental and performance benefits. Substituting one ton of coal fly ash or slag cement for one ton of Portland cement prevents almost one ton carbon dioxide emissions. Manufacturing slag cement uses only 15% of the energy needed to make Portland cement. The amount of natural materials required and the amount of landfill space used are both decreased, leading to cost savings. Finally, cement made with IRC materials tends to produce stronger, more durable and denser concrete.