Reclaimed Carbon Blending Process

Introduction

Reclaimed carbon (rC), defined by REACH as a mixture of amorphous carbon and silicon dioxide recovered from processing of spent tires, is a product which results from the pyrolysis of end-of-life tire rubber. It is the solid fraction of the products of pyrolysis kilns which reduce vulcanized rubber back to simpler hydrocarbon products. rC is typically made up of a mixture of rubber char, which is the solid residue of the rubber polymer itself, along with inorganic and organic fillers/reinforcing agents which are added to the rubber prior to the curing process. These consist primarily of zinc oxide, silica, and carbon black particle.

rC has been put forth as a possible replacement for virgin carbon black (vCB) in new tire production, but adoption has been slow due to poor performance characteristics of the resulting rubber, including low reinforcement and poor fatigue life. The latter problem is typically a result of large rC particles in excess of 1 µm which are not dispersible in the rubber. While the surface area and structure characteristics of rC are typically in the range of ASTM 300-series carbon blacks, the reinforcement performance is more similar to ASTM-500 or ASTM-600 series grades. As a result, rubber formulations which use these grades are typically the target of attempts to use rC in place of vCB.

It is not uncommon for a tire producer to substitute a small fraction of rC in place of vCB in a rubber formulation in order to increase the content of sustainable material in the rubber while holding the performance costs to an acceptable level. Replacement levels between 5-15% are typical.

Cabot rC Blend concept

Cabot has developed a product, STERLING® SO-C100 circular reinforcing carbon, which consists of a 10% blend of rC in Sterling SO vCB (ASTM N550). This blend of two materials holds handling advantages for customers who wish to increase sustainable content in their rubber products without the added complexity of managing an additional particle material stream. The process by which this blend is manufactured can avoid problems present in more simple blending techniques.

By adding the rC upstream of the pelletizer, the vCB and rC are intimately mixed, and then pelleted together, such that each pellet contains approximately 90% vCB and 10%rC. This co-pelleted blend resists stratification during transportation, and ensures very good distribution of the rC in the final rubber blend, avoid “banding” in which zones of the final rubber contain higher fractions of rC than intended.

Cabot rC Blend production Process

In the Cabot rC Blend process, rC is accepted by the plant in IBCs, or in bulk form, and is fed into a loss-in-weight feeder (LIW), which is able to accurately meter and dispense the solid material. This rC particle stream is then combined with a conveying air stream by means of an eductor device, which can create suction through the venturi effect as the conveying air passes through the eductor.

Figure 1 below is a basic schematic of a typical Cabot carbon black production unit. The main unit filter (MUF, in green) separates the carbon black from the reaction gases, or tail gas. The carbon black is subsequently air-conveyed upward to the process filter (in yellow), the function of which is to separate the carbon black from the conveying air. The process filter is generally located at several floors of altitude, so that the carbon black can be conveyed through the rest of the densifying and drying stages primarily by means of gravity.

In the Cabot rC blend process, the mixture of air and rC will be added to the process either into the conveying air line between the MUF and the process filter, or as a separate line entering the process filter directly. In this way, two streams of carbon particles and air (one rC and one vCB) are intimately mixed, and separated from the conveying gas in a single step.

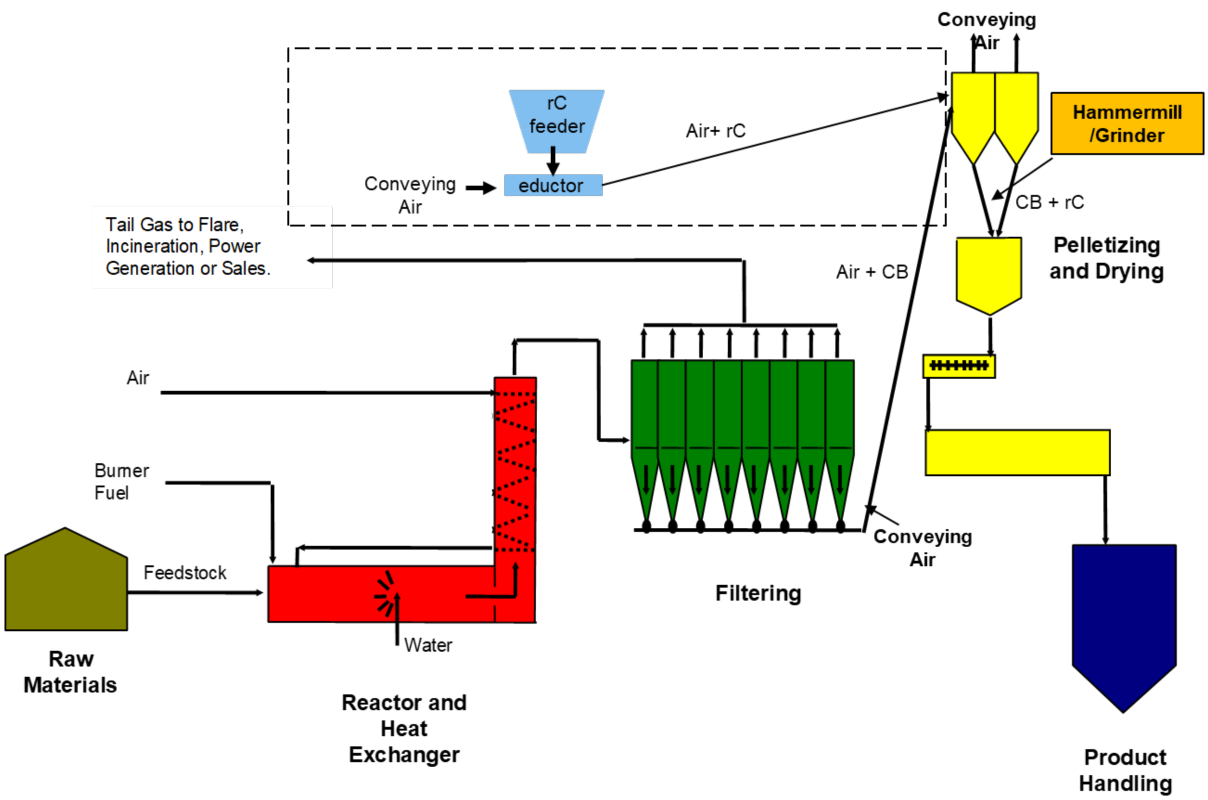

Figure 1: Schematic of Carbon Black production process with rC addition location

Additionally, the CB production process typically includes a hammermill grinder between the process filter and the agitation tank (2nd yellow unit operation). The original purpose of this equipment is to break up any larger chucks of vCB which have accumulated in upstream process. rC, like carbon black, is generally densified for transportation by means of wet pelletization. It is necessary to break these pellets up in order to achieve good distribution in the final product. The rC blend process, or co-pelletization process, takes advantage of the hammermill grinder and uses it as a means to break up the densified pellets of rC and return them to a fluffier state.

Cabot does not believe that the Hammermill grinder has sufficient energy to reduce the size of rC aggregates, but does a good job of breaking up the rC pellets in order to facilitate better blending. Figure 2 is a diagram from mill manufacturer Hosakawa detailing the particle size achievable by different types of particle mills.

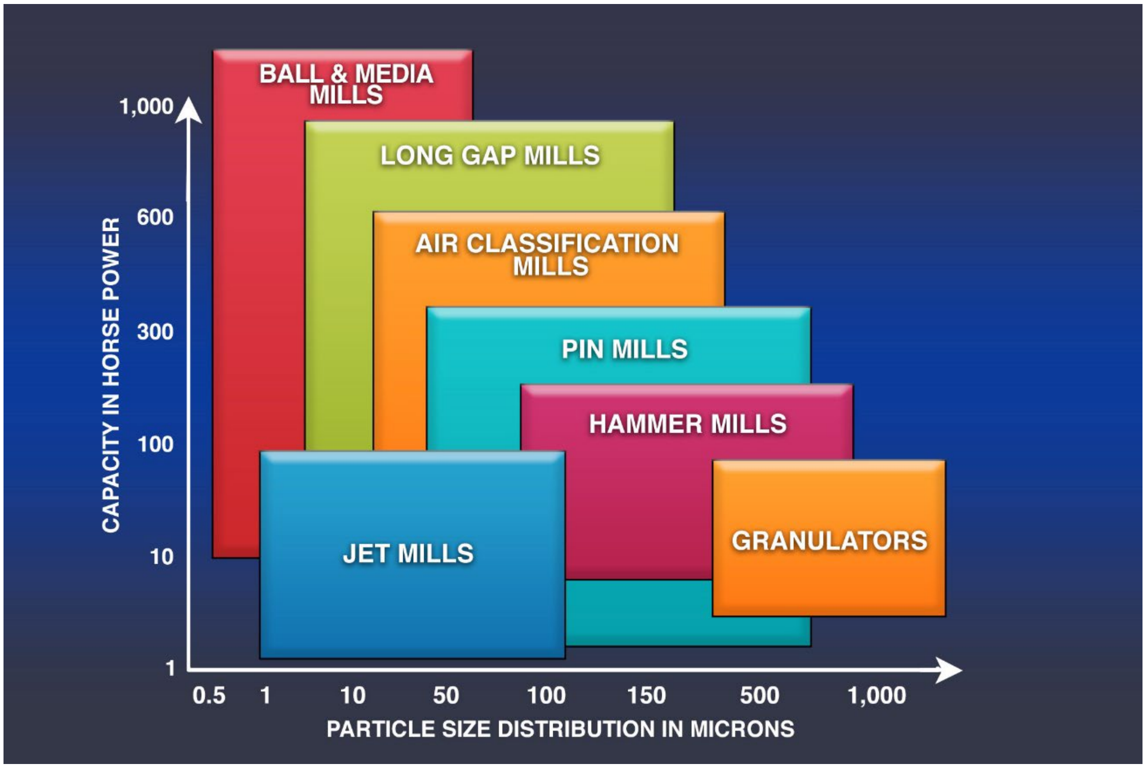

Figure 2: Particle size achievable by different types of mills designs. Source: https://www.hmicronpowder.com/applications/size-reduction/?_vsrefdom=googleads&gclid=Cj0KCQiA95aRBhCsARIsAC2xvfwbZ3Dt48q6GXcONVkQThtQVkXYBU6ubsi5a7gba-HZr33wlY3GlDUaAlSeEALw_wcB

Downstream of the process filter and hammermill, the two particle populations are indistinguishably mixed, and behave no differently than typical vCB. Thus the blended product is pelletized, dried, and packed in the normal manner of all Cabot vCB products. Thus two dissimilar particles are able to be handled by end users as a single product stream.