HGI of Coal – A Throughput Determinant of Pulverisers

Grindability index signifies the ease with which the coal can be pulverized to the desired size. Coal with higher index will be softer one to be ground and vice versa. If the coal used is of low grindability, the mill output would also reduce correspondingly. In the context of pulverization, the assessment of grindability is done using a parameter called “Hardgrove Grindability Index (HGI)” by pulverizing a small air-dried sample of appropriately sized coal in an apparatus known as “HGI apparatus” (a miniature vertical spindle ball mill) devised for this purpose following the design specified in IS: 4433 / ISO: 5074 standard. The grindability index is not an inherent property of coal such as moisture, ash, or heating value. It is simply a representation of the relative grindability of the given test coal when compared with the selected “standard coal”.

The Hardgrove Grindability Index, is an empirical measure of the work required to grind a given mass of coal based on the generation of (-)200 mesh from an air-dried coal sample in a small ball & race mill which runs at 60 rpm. A high HGI value indicates that less work is required to grind a given mass of coal and that indicates that the nature of coal is soft. The HGI measuring apparatus is widely used by thermal power stations/ laboratories to assess the mill performance wrt. its capacity/ throughput vis-à-vis the grindability of the raw coal fed.

The Hardgrove method was devised to measure the quantity of test coal, after pulverizing, that will pass a sieve of 200 mesh. A 50 gm of sample of air-dried coal, sized to (-)16 to (+)30 mesh is placed on the mortar of the test machine along with a few one (1)” diameter steel balls. After a weighted upper race has been placed on the ball and coal charge and when the machine is turned 50 revolutions, the sample is removed and screened. The quantity of pulverized coal passing the 200 mesh (74μ) sieve determines the Hardgrove Grindability Index (HGI) presented by the formula in the sample as, $HGI = 13 + 6.93\ M$, where M is the mass in grams of that portion of the coal sample passing through 200 mesh sieve after grinding. In practice, M is obtained by deducting from 50 gm the mass of the ground sample retained on 75-micron sieve.

HGI of Indian coal of Bituminous type normally varies between 45 to 60. Lignite has high grindability index. Low volatile coal, except anthracite have higher HGI. Normally, mill rated capacity, expressed in Tons per Hour (TPH), is with reference to a specific grindability index. Rated capacity of coal mill of Raymond type is generally expressed for 55 HGI and 70% passing through 200 mesh (Pulverized Fuel) PF fineness. Some designers use 50 HGI as the reference value for designating standard capacity of the coal mill of Ball & Race type. Many power generators have started specifying PF fineness as 750% passing through 200 mesh for design.

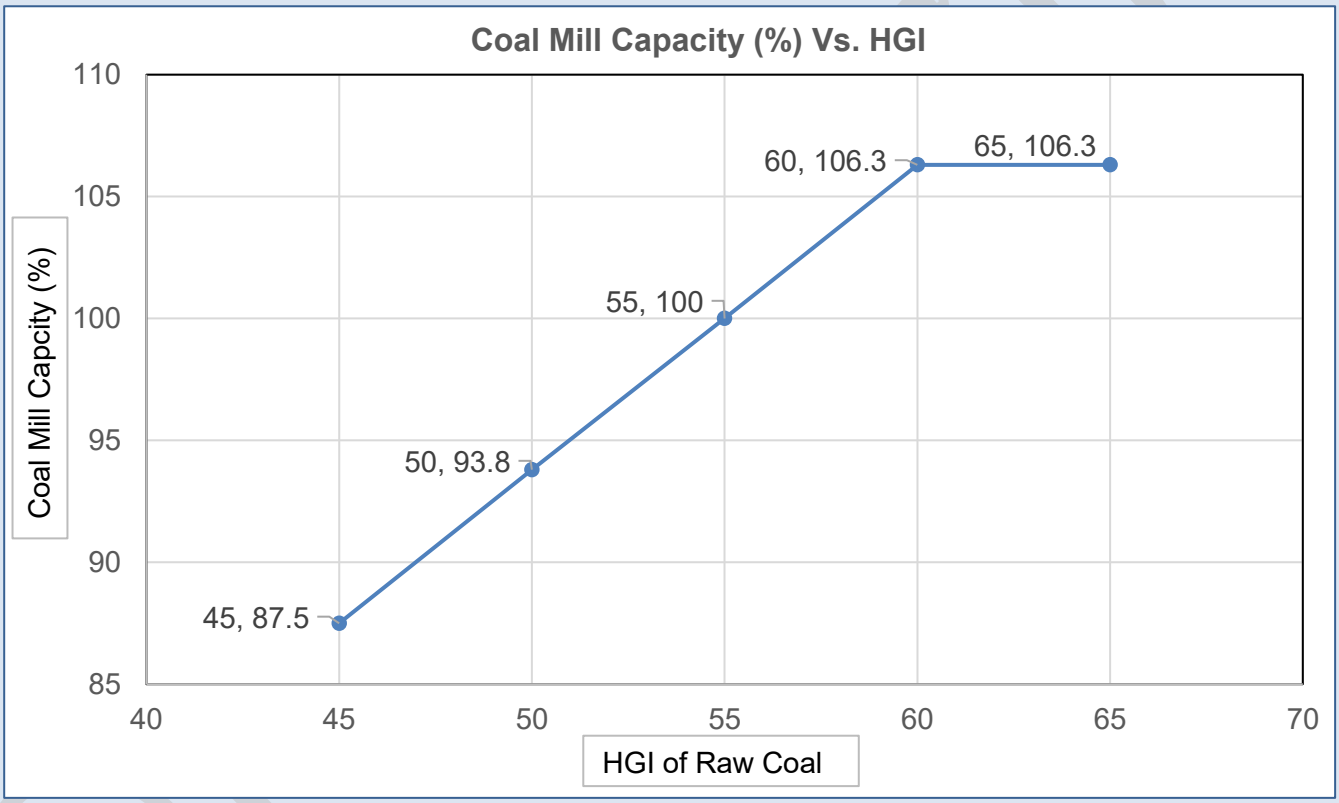
The Coal Mill designers generally consider the relationship between the Mill Capacity wrt. variation in the raw coal HGI & Total Moisture (TM) as a basic guideline for the Mill sizing & selection with slight customization based on other criteria based on their past experiences & specific contract conditions; such as, Boiler requirement, Coal quality/ Size, different PF Fineness requirement, Classification type (Static/ Rotary), Mill Outlet Temperature, Ash, Volatile Matter, Moisture content in Pulverized Fuel/ Coal etc. However, there may not be a definitive correction curve to establish the variation in mill capacity vis-à-vis one or more such parameters outside the recommended normal distribution range, and designer’s verdict is final.

The impact of HGI is largely considered as more significant than that of the Total Moisture (TM) of coal on the Mill Capacity. Accordingly, HGI range of 45 - 60 is recommended for considering the variation in the coal mill capacity/ throughput. The capacity variation must be in congruence with the requirement of the quantity of the hot primary air and/ or its temperature to maintain the required temperature and product moisture at the mill outlet. Basically, the designer has to

consider both 'mechanical' as well as 'thermal' boundary conditions for arriving at a contractual capacity/ throughput for a coal mill in the project satisfying various conditions at the same time.

HGI values vary depending upon the source of Coal. As the mineral matter or moisture level increases in coal, the index seems to be less reliable. Any coal with higher HGI and relatively low quartz content signifies that the grindability aspect of this coal is very good. It can be safely reported that the HGI value improves (increase in the absolute value) after the removal of silica and hard mineral matter like stones associated with the reduction in α-quartz content (%) in coal. The removal of hard mineral matter has beneficial effect on the HGI parameter.

A purely hypothetical graphical representation of relationship between the coal mill capacity variation vis-à-vis the HGI of the raw coal is illustrated below. Considering 55 HGI as design capacity (100%), the mill capacity reduces with the reduction in HGI value. The capacity reduction follows linearly initially and it may get steeper for very low HGI values. However, the Coal Mill capacity increases with increase in HGI value but remains constant beyond 60 HGI in wake of limiting effect of thermal as well as mechanical aspects of the design.



To have an historical perspective on the development of coal pulverizing equipment on industrial scale, it is important to note that first time in 1890, pulverized coal firing was used for cement Industry by E. H. Hurry and H. J. Seaman of Atlas Portland Cement Company for firing cement kilns. The early coal mills were built with maximum capacity of 6 TPH for 55 grindability index coal when grinding to a PF fineness for 65% through 200 mesh (75 microns size). For over a duration of more than 100 years, the pulverizing machines have witnessed wide technological advancement especially in their throughput, grinding media, power transmission mechanism, classification methodology and mechanism to impart pulverizing force on coal, and we can comfortably say that one of the most significant engineering achievements of the twentieth century is the commercial perfection of methods of firing coal in pulverized form.

Sources: Various, as learnt in my professional journey. This is for educational purpose only and not a contractual document.