SIMA DRI Technical World

Issue flagged by Prof. Brhama Deo:

PCC is Post Combustion Chamber. People normally use the term ABC (after Burning Chamber)

Plants use the waste from bag filter dust from discharge end to burn in ABC. There is no problem in doing so as the coal particles in dust have already lost (almost) their volatile matter and do not pose much additional issue of SOx and NOx for environment. However the higher size particles can get carried over to boiler Radiant Chamber water wall compartment and cause damage.

However, as also pointed out by Mr. Suresh Panda, there is an issue here to watch out. Pressure of feed end housing and reactor is managed by increasing the ID fan suction capacity. In many plants the suction capacity is not enough and because of this they are not able to suck all gases. It creates back pressure in kiln. One engineer at one plant tried to explain me a new fundamental that gas can flow from low pressure to high pressure. Well, it happens only as much as gas is sucked but the remaining gas (not sucked) causes back pressure in kiln.

ID fan damper is fully open in most cases at many plants and there is no further chance of opening more!! ID fan capacity is less (not designed to take higher load). Actually, it is worth investing in higher ID fan capacity if kiln life is to be enhanced by softening the deposits. Soft deposits form and break now and then and the zones in which this take place can be found out easily.

As mentioned above, the additional pressure (due to low ID fan capacity) causes back pressure in kiln. Increase in pressure beyond a critical point makes the deposits in the kiln hard (due to rise in temperature and also CO_2 in gas). It deposits are soft then then can be easily removed in a very short time.

Of course, the coal carried into PCC must be completely burnt. Doing this fine provided suction capacity of ID fan/motor is adequate. At no cost fine (raw) coal (say – 3 mm fraction) should be injected into ABC. Additional ash from additional coal increases deposits on walls of vessel lining. This increases the chances of explosion. At some places explosions have taken place and lives have been lost! Also, pressure increase in ABC is further enhanced due to decrease of effective volume of ABC. (increase in deposits decreases vessel volume and that further increases the pressure).

Please find some other ways of using fine coal. Environment pollution effect goes up because of higher sulphur content of exit gas. Inside kiln quite a bit of sulphur of coal is absorbed by ore/iron. But if additional fine coal is burnt in PCC/ABC then it directly goes out with gases. Let us be careful to follow environment norms otherwise some day environment people will land in the plant.

Yes, rejected fine coal is a problem to manage. Let us find ways (improved designs/systems) to inject it in the kiln itself.

For the benefit of coal fired rotary kiln industries, let us hold a design modification competition so that gas or gas + fine (-1.5 mm coal) or gas only can be injected to replace coal gradually. Cost for introducing the change should be minimum and percentage of gas that can be used should be flexible. Let us share ideas . We may will then put them up at the next conference, similar to the one organized at Joda.

If we put our minds together, then something useful may come out. We have to act fast!!
If you want to refere to some published papers on various aspects you may please look at several papers (more than seven) available at
Publication's link:
https://www.researchgate.net/profile/Brahma_Deo

One main reason of poor level of automation in coal fired rotary kilns is pressure fluctuation in coal injection pipe due to varying size and varying moisture in coal, especially in rainy season: both these strongly affect coal throw as well as flame temperature. Yes, varying coal (ash etc) and ore quality (soft or hard ore) also affect: but over a small period of time this is to a much lesser extent. Perhaps we may not completely ascribe poor quality control to poor process control only. We (in collaboration with Tata Steel Long Products at Joda) developed and successfully implemented an inexpensive online particle size and moisture determination method. It helped to improve the process control, though partially. It is definitely an important step to addressed. I believe dedication is needed to first identify and then pursue all required steps up to the end. Piecemeal approach will not give results. Just hoping that purely an AI based model (software) or even thermodynamics and kinetics-based model will do the trick is not true. Kiln is a nonlinear dynamical system. Now and then, it migrates into chaotic regions due to several reasons: viz due to uneven deposits build-up at the bottom. Sometimes the deposits break too. No model can take care of this but appropriate guidelines of change in control strategy can be developed. That will help. Process aspects have to be addressed. Process knowledge is with the operators. Such efforts take time. To my knowledge, the automation levels are very poor in steel (BOF) also. My hunch is that with gas injection the quality control will be tougher because gas, unless injected properly, may not be able to reach certain parts of the kiln. Coal gets physically distributed into the charge at the feed end. We are aware of gas channelling effects in BF too. Gas channelling effects will be much more in horizontal kiln (than in BF). Gas will always follow a shortest path of escape: that is the rule of nature. Channelling will directly influence quality fluctuation. Perhaps this may be one of the reasons that injecting COG at Meramandali from discharge end did not work. But unless we experiment, we would not know or be sure. Only those who try succeed. Using dry coal will be better but that again will cost money (to subject coal to a drying process). Through this forum perhaps everybody can opine and we can first identify all necessary steps and then proceed accordingly.

AI model with online moisture and particle size knowledge can be expected to work only in a non-chaotic zone.AI cannot simulate chaotic zone.

I request SIMA to persuade MOS to float a project on "Design modification and process modelling of coal-fired rotary kilns to permit simultaneous but flexible coal and gas injection". This is the need of the hour. Sponge iron fraternity can opine?

Dr.S C Khattoi:
The new plants design has increased the ABC volume to accommodate the Bag filter dust as they get around 1MW additional power.

To satisfy the management, Operation people try to inject all the fines in the coal injection pipe. They should cut down all -1.5mm or -2mm for disposal to others & use the + 1.5mm fractions. The usability in the kiln will improve and longer campaign life of Kiln.

Prof. Dasappa: What would be the amount of fines and unwanted coal in a typical 500 TPD plant?

Mr. G. Pothal : Actually from feed end side coal fraction to be 3-25 mm . From injection side -3mm fraction to be 30-35%. However, during tumbling activities inside the kiln additional fines are generated, depending on nature of coal and iron ore.

Mr. A Rajasekaran : There is already one R&D project on the above lines being pursued by IIT Roorkee

Prof. Viswanathan: Gas and coal can be injected only axially to a rotary kiln due to engineering constraints as the kiln is rotating. There was some talk of injecting radially which I think is not possible as we cannot connect a gas pipe to rotating structure ...in rotary kiln the gas portion provides primarily heat for the reduction and the reduction happen in the bed due to presence of carbon which provides carbon monoxide through carbon gasification reaction.

To estimate the gas that can be injected one needs to perform heat and mass balance calculations ...May be zone wise ...without that difficult to tell ...

Mr. Kesava Babu: Discharge injection will lead to high temperatures due to spontaneous combustion of gas. Reduction of coal in view of gas from discharge will lead to shortage of reductant in bed and will result in drop in grade and accretion due to carbon starvation. Gas injection in to the bed will have the following problems. 1) Under Bed injection depends on bed starting point which in turn depends on accretion at that point and kiln rpm. 2) Designing of good rotary seal to allow gas injection only into the kiln, not the other way. 3) Reversal of hot gases from kiln to gas holder is dangerous due to temperature. 4) Improper gas flow into kiln with anticipated coal reduction to the process will lead to operational problems. Design of proper rotary unidirectional valve for rotary kilns is critical for total project. This is my take on the subject.

4. Observation of Mr. B. N Das: Automation level is very low as compared to iron and steel making