Dry Changes – Switch to Dry Process

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Abstract

Especially thanks to the increased demand for capital goods and to the realisation of infra-structural measures in the recent years, the forecast for the coming years sees a growth rate in the cement production in Russia. In a market situation like this, it is not always easy to find the right balance between satisfying market demands and overrunning investment possibilities. Modification of kiln plants, rather than building new ones, is the more realistic way to match sales opportunities to investment limitations. The robust machinery utilised in the cement industry allows to keep older equipment in use, even within modified plants forming new process technology.

This paper examines two realistic solutions to meet the requirements for a modernisation of wet process clinker production lines, which are typical for Russia. Whether a regular dry process is to be favoured against a semi-dry process, depends on a variety of parameters and side conditions. Consequently, each and every modernisation-project is a highly specific matter, requiring individual treatment. Solutions “from the shelf” will most probably not lead to satisfying results. A stepwise approach to increased production and plant availability levels out investment and pay back.

Apart from delivering complete new plants, KHD Humboldt Wedag has a long standing tradition in delivering tailor-made engineering solutions for the more effective utilisation and the increase in efficiency of existing cement equipment. Based on the actual necessities of the cement producers, these solutions have already proven their success in numerous installations world-wide.

KHD Humboldt Wedag AG

KHD Humboldt Wedag is a world wide supplier of process know-how and machinery for the cement industry. Especially in Russia and the CIS-states, we have a strong history through our subsidiary ZAB in Dessau, the former East-Germany.

For more than 140 years KHD Humboldt Wedag has been delivering key equipment and machinery to the minerals and especially to the cement industry. For many of those machines we hold first time and key patents, as Humboldt Wedag has and outstanding record as a innovator for the cement industry.

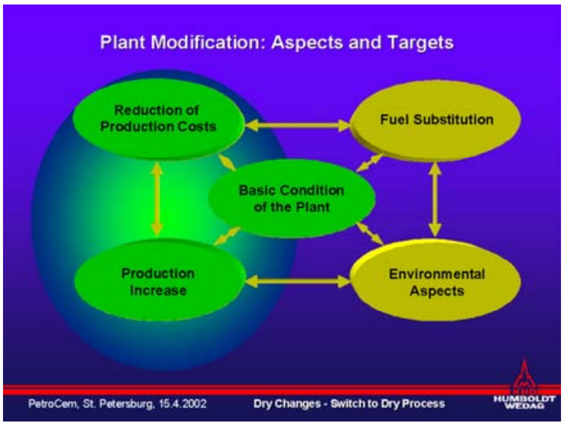
An increasingly important task for us as a proprietor of cement process know-how, is the optimization of the total production process by means of versatile and effective automation and expert systems.

Plant modification

General aspects and targets

picture 1 shows only the main aspects related to plant modernisation. Apart from the basic condition of the plant, which has always to be considered, several other aspects like fuel substitution, reduction of production costs, production increase and environmental aspects need to be taken into account. As can be easily understood, there are many interdependencies among these and possible others.

Depending on where the focus of the project should be laid, the reasonable solution will stress the relevant fields without neglecting the side-aspects in order to optimize investment costs and functionality. However, a lot of experience is required to overlook all the implications that come with bigger plant retrofits. Close cooperation between equipment supplier and cement producer are recommended even at early stages in order to achieve essential project success.

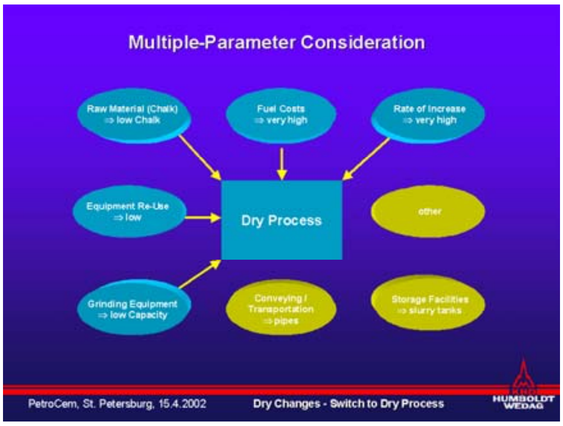


picture 1:Aspects and targets of plant modification

Situation in Russia and the CIS States

picture 2 shows the multiple parameter situation specifically for the Russian cement industry or the plants of the CIS states. The majority of the installed pyro process lines in this region of the world are wet process lines. The unavoidable high heat consumption as well as the inherent low production capacity of this process now falls back on the cement producers of Russia, that try to gear up for their future. Besides target production increase and fuel costs, especially in Russia the chalk content of the raw materials is a decisive input information. Maximum equipment re-use will be mandatory to reduce investment costs in a surrounding of yet high uncertainty in future market positioning. Kind and capacity of storage and conveying facilities will be influencing this field as well as process-type and capacity of grinding equipment. In a specific case, there will surely be even some other aspects in this multi-parameter decision. The careful evaluation reflecting the experience from supplier and client as well, will determine the type of process to be installed in the modification project.

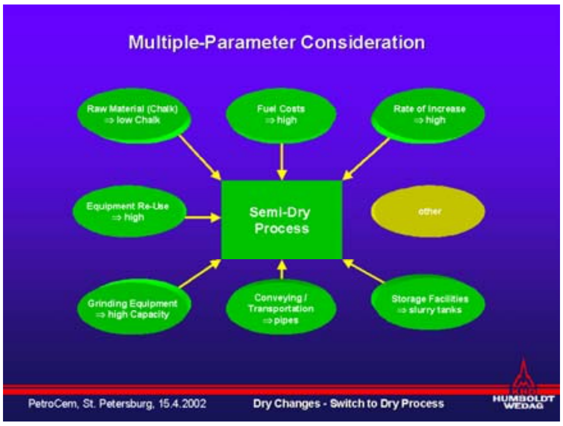
In this example, the target production increase and the fuel costs are rather high, whereas the chalk content within the raw material is relatively low. The structural condition of the plant shall be in a bad shape, so that securing functional availability outweighs the need for equipment re-use. Especially the raw material grinding facilities are of very low capacity, which will favor a new raw mill. Although the conveying equipment consists of pipes and the storage facilities are slurry tanks, the evaluation will lead in this case to a dry process plant.



picture 2: Set of parameters leading to a decision in favour of a dry process

The conversion to dry process would result basically in a shortening of the kiln, an installation of a cyclone preheater and the replacement, or the adaptation of at least the inlet part of the clinker cooler. Of course, the respective drives must be checked for suitability as well as the surrounding equipment.

picture 3 illustrates another situation. Given only slightly different preconditions regarding production increase, fuel costs and chalk content within the raw material, this case might lead to another solution. As the plant in this case, is supposed to be in a good structural condition, and the grinding capacity of the wet grinding compartment is sufficiently high, the majority of the equipment should be re-used. This way, the existing storage and conveying facilities will be incorporated into a semi-dry process.

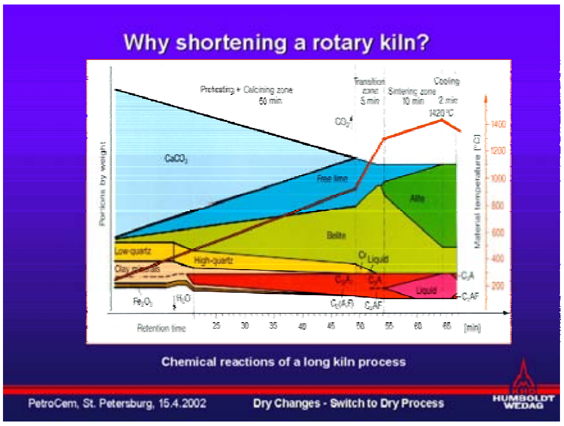


picture 3: multiple parameter situation leading to a decision in favour of a semi-dry plant

In contrast to the dry process, with the semi-dry process, a considerable amount of water enters into the pyro-system through the “kiln-feed” (see picture 6). The most economic way to pre-dry a slurry is to produce a filter cake with a disk filter press. This filter cake is then fed into the pyro-system. For that reason, after the shortening of the kiln, the preheater to be installed might only feature 3 stages. The number of stages of the preheater conforms to the water content of the filter cake. The exhaust gas from the topmost stage is then led into a hammer crusher, in which also the filter cake is inserted. After breaking up of the agglomerates in the hammer crusher, the laden gas/cake-suspension is transported upwards through the flash dryer, at the top of which a twin cyclone serves for separating the particulate matter from gas flow. The moisture content of the filter cake is now below 1 %. Finally, the down comer pipe will be connected to the ID-fan to carry away the steam loaded exhaust gas.

The length of the rotary kiln

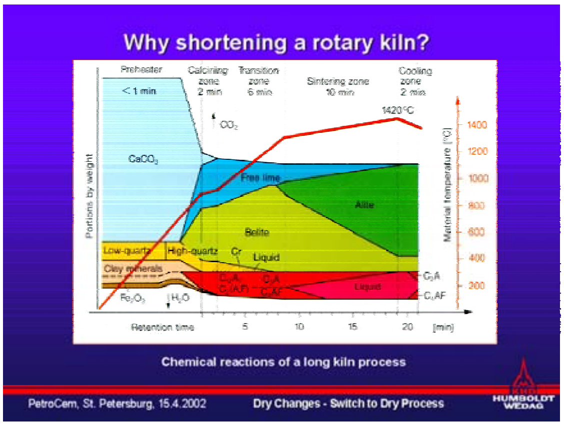
As can be seen clearly seen, shortening of the existing rotary kiln will always be part of the procedure. The following pictures (picture 4, picture 5)will illustrate, where this necessity comes from.



picture 4: chemical and physical processes of the production of cement clinker in a long rotary kiln

picture 4 shows the course of the chemical reactions of cement clinker production in a long kiln. As the temperature follows the red line in the course of time, different physical and chemical processes take place and various components and intermediate products are generated. The eye of the observer automatically falls on the big triangle in light blue representing Calcium Carbonate, which is to be converted into free lime by driving out the Carbon Dioxide. Along with drying and preheating, this is not only the visually biggest part of the process in this diagram, it actually is also the most energy consuming part of the production process. Only the technically unavoidable heat losses contribute furthermore to the energy consumption, because the sintering reactions themselves are in fact exothermic, i.e. that energy is actually set free in the sintering zone. The total retention time in a long kiln process will be at least 1 hour.

In contrast to that, picture 5 shows the precalciner process. When Humboldt Wedag invented the 2-pier kiln technology in the 1970’s, we asked for the major step in benefit, and we found out, that the drying, preheating and precalcination (driving out of the Carbon Dioxide) can better be done in a flowing gas suspension instead of a tumbling material layer in a rotary kiln. As we had invented the cyclone preheater and the PYROCLON precalciner technology some years before, we knew exactly the potential of the Humboldt preheater cyclones and the PYROCLON precalciner.



picture 5: chemical and physical processes of the production of cement clinker in a precalcination kiln

The increased efficiency of preheating and precalcining not only leads to substantial heat savings, but also to an intermediate product (“hot meal”), which is precalcined to up to 98%. This meal is ready to be sintered in the rotary kiln. As a consequence, it should be transported into the sintering zone as quickly as possible, in order to obtain a controlled kiln process and avoid unfavorable ring coatings in the kiln. For that reason, a regular length/diameter ratio of these kilns is typically around 14/1, in some cases even down to 11:1.

The reliability of this technical concept, consisting of cyclone preheater, maximum precalcination and short kiln technology, has meanwhile been proven by KHD Humboldt Wedag in more than 25 plants worldwide, as well as the superior quality of the cement clinker produced with it.

Different ways to shorten a rotary kiln

If there is sufficient place alongside the existing kiln line, the favorable solution to build a new kiln might be beside the old one. We would check the existing kiln shell and the kilns structural features for possible re-use within the new system. During operation, the new tower structure, carrying the preheater (and eventually the precalciner) will be build besides the kiln. The new cooler and the foundations for the new kiln will be build. In a relatively short downtime, the selected section of the existing kiln will be cut and erected again in its new position. Finally, the clinker transport will be extended to fit to the new position.

The advantages of this strategy are of course:

- minimum downtime
- maximum possible re-use of parts (which is, of course depending on the specific case)

If there is not sufficient space available alongside the kiln, the new kiln can also be build at the position of the old one, again keeping as many of existing parts as possible. The screening of the kiln will check shell bending and inner shell stress, as well as load capacities of the roller stations. During operation, the new tower structure, carrying the preheater (and eventually the precalciner) will be build above the kiln. In the following shut-down period, the kiln will be cut and the new cooler will be installed. The existing transport belts will preferably be re-used.

The advantages of this procedure are mainly:

- the minimum space requirements and
- the maximum possible re-use of existing parts

In some cases, when there is enough space available alongside the line, the cooler might be pre-erected and put into place at even shorter downtime periods.

The Yingde plant, China as a typical example for Russian demand

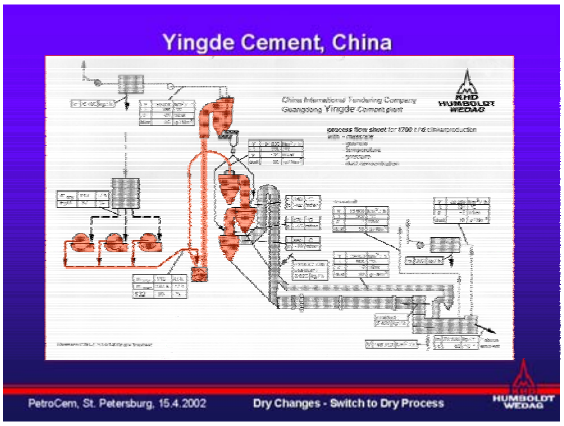
The objective for the Yingde plant was characterized:

- by an increased demand of cement
- by the operation of 2 wet kiln lines with:
- low production
- low availability and
- high energy consumption
- The raw material contained a high amount of chalk

The client chose to install a new kiln plant of semi dry technology, what enabled him to keep his existing wet grinding and pre-processing equipment.

picture 6 shows the semi-dry pyro process line of the Yingde cement plant. The major portion of the water contained in the slurry material is mechanically pressed out in a disk filter press. The product is taken as filter cakes, containing approximately 20 % water, and is fed into the pyro system over a special rotary air lock. The cakes fall into the hammer mill and are swept out of it by the air flow into the flash dryer. At the top of the tower, the cyclone separator takes out the particulate matter, which has now been dried to a water residue of approximately 1 %. A water spray system and a bypass line are installed to control the dryer operation under upset and start-up conditions. A pressure screw conveyor is used to feed the material in the consecutive 3 staged Cyclone preheater. The PYROJET® kiln burner introduces only 45 % of the total fuel demand into the kiln, the residual 55 % are fired in the precalcination burner. Hot recuperated air is taken from the PYROSTEP® cooler and routed through the tertiary air duct to the precalcination burner to serve as combustion air.

The process flow sheet in picture 6 shows typical data for the production of 1700 tons of clinker per day. The disk filters are extracting 110 t/h dry matter from the slurry. The moisture of these filter cakes that are fed into the hammer crusher/flash dryer unit is approx. 20 %. The exhaust gas from the 3 staged preheater enters into the hammer crusher with a temperature of 535 °C to provide sufficient drying capacity for the flash dryer, so that the twin separator on top of the tower can take out almost dry particulates, with a water content of below 1 %. The overall pressure loss of the preheater incl. hammercrusher, flash dryer and separator is slightly above 80 mbar. The residual equipment of the production line represents standard technology for a modern dry pyro process. The overall heat consumption of this unit is below 3560 kJ/kg cli.



picture 6: process flow-sheet of a typical semi-dry process line

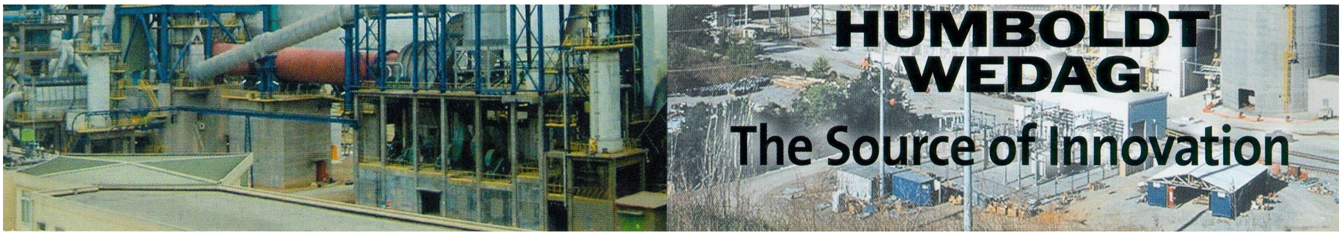
picture 7 shows the tower structure with its various pipeworks. The central piece of equipment for this process, the flash dryer itself, is the smallest of the three pipes in the center of this picture. The left pipe is the exhaust gas pipe of the 3 staged preheater, the extreme right pipe is the exhaust pipe of the separators that is routed towards the ID fan.

picture 7: tower structure of the Yingde cement plant, containing the flash dryer, the preheater and the precalciner

The performance parameters of the plant show, that the switch to semi-dry has been successful for this client, as specific consumption of heat and electrical energy have been remarkably reduced. Meanwhile, the client is installing a second identical line parallel to this first one, which will be commissioned next year.

Conclusion

On the long run, many wet kiln lines in Russia will be set out of operation. Dry process technology will be introduced into Russia and the CIS states because of their higher efficiency in production as well as in heat consumption . A lot of wet process plants will be converted to dry process instead of being build as new dry process plants. Plant modernization, however, is a complex technical procedure, that creates lots of questions and uncertainties for the cement producer. To meet the requirements of Russia's cement industry of today, highly effective plant components embedded into a sensible approach are needed. Re-use of existing equipment should be considered as well as target efficiency benefit. In fruitful cooperation with our clients KHD Humboldt Wedag has successfully completed more than 50 major plant modernizations in the last 25 years.



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