MultiScience - XXX. microCAD International Multidisciplinary Scientific Conference
University of Miskolc, Hungary, 21-22 April 2016, ISBN 978-963-358-113-1

EXPLOITATION PROBLEMS OF COAL PULVERIZERS

Wojciech Pospolita [4,5,6] ***Krzysztof Jesionek*** [1,2,3,5,6]
Professor[1], DSc[2], PhD[3], PhD student[4], MSc[5], Eng[6]
Wrocław University of Technology,
Poland

SUMMARY

The article presents an overview of the literature concerning issues of exploitation of coal pilverizers. Coal mills are the basic sets which correct work depends largely on the quality of the combustion process in power plants. Many years of operating experience made currently available mills characterized by high reliability and efficiency. However, increasing requirements of crunching number quality, work flexibility and security, pose new challenges for designers. Ensuring optimal operation of mills requires solution of a number of operating problems, which include wear of grinding components, ensuring the proper fragmentation of dust and fire safety. An additional difficulty is the fact, that these devices due to the nature of their work, in each case must be treated individually. This means that solution of a problem into one device, do not always take the same effect into another. Article presents the most important technologies of pulverizers in polish energy. Also describes the most important problems faced by service staff and how to prevent them.

I. INTRODUCTION

Using coal for energy purpose is a technology that is under strict requirements of environmental protection. One of the parameters, that has a very significant impact on the whole process, is the quality of fuel supplied to the combustion. By quality is meant the fuel optimal chemical composition, with a low moisture and volatiles content. However, poorly prepared coal dust coming from the best energy coal, can seriously disrupt the combustion process. It manifests itself by power unit efficiency reduction because of the unburned fuel. Coal pulverizers are working in the groups of devices, which includes the coal feeder, mill, electric motors and fan. Proper cooperation between these elements is important in the context of the proper operation of the power unit. The specificity of the construction of coal mills, and the need to ensure the highest quality and efficiency of the combustion process, generates a lot of operational problems. The rest of this article discusses the most important of them.

2. OPERATING PROBLEMS DURING EXPLOATATION OF COAL MILLS

The specificity of the crunching process, consisting of crushing and breaking coal, causes high stress in components of mills. This leads to wear, which value reaches up to 100 mm/year **[1]**. Grinding elements are usually made of steel with high chromium content, which increases their strength. However, the value of the

DOI: 10.26649/musci.2016.103

tension between the grinding element and a part of the fuel exceed 200 MPa **[2]**, which makes wear of elements an extremely serious problem. Wear do not affect on fuel preparation, but increases power consumption for grinding. This is due to the fact, that the particle size of the coal particle added to the boiler burners is controlled by a separator. Wear can be minimized by reducing the force between grinding rolls and the carbon layer. This value is controlled by a hydraulic system. Reducing the pressure is the reason of the quality loss of crunching process. Therefore, the problem of wear of grinding elements is solved by its replacement and regeneration. Replacement parts usually occurs in extreme situations, for example rupture of the grinding bowl. This is due to the very high price of the parts. Therefore, regeneration process take places more often, by welding defects in the surface of elements. There are also experimented works with using grinding rolls made of high-strength ceramics.

Grinding of coal is high energy consumption process. According to **[3]**, global energy consumption for crunching in power plants and cement factory was in 2004, the 7.26 % of total energy consumption by the industry. References **[4]** also shows that the energy consumption by vertical roller mills is smaller than by tumbling mills operating with the same capacity and the same fuel. Grinding devices for BP-1150 boiler, running at full capacity, consume more than 3.5 MWe of energy. It follows, that even a small decrease in power consumption, can bring significant financial savings. An important parameter is the specific energy consumption for crunching kWh/Mg. It depends on many parameters, including the setting of grinding components and their technical condition. These relationships are often opposed to each other. This means that the increase in the quality of one parameter, can degrade another. An example is shown in fig. 1, characterized the work of the vertical roller mill.

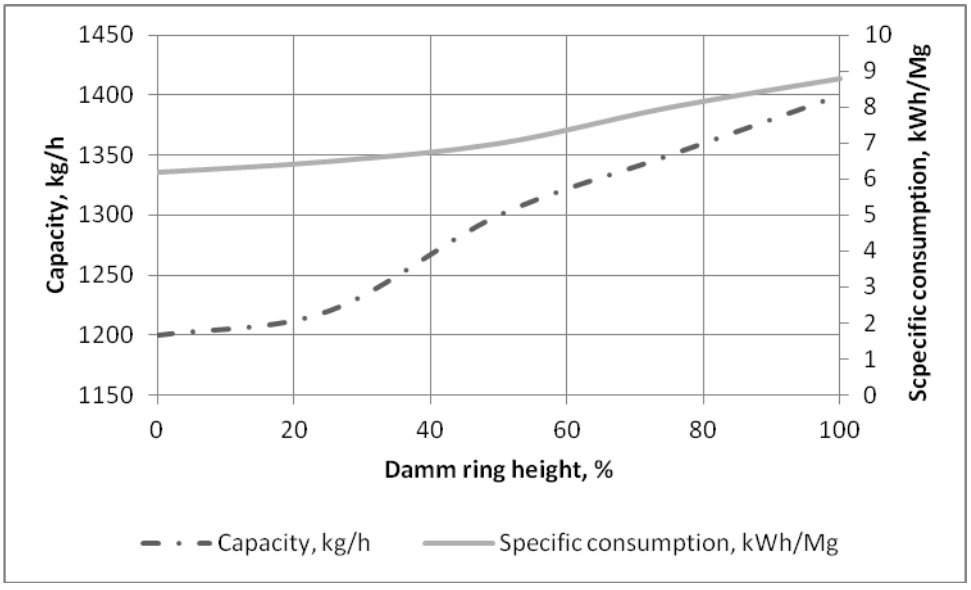

Figure 1. Relationship between selected parameters and the height of damm ring **[6]**

Damming ring, is an element that sets height of the coal layer that is added under the grinding rolls. Raising the position of the ring, increases the height of the layer, allowing a higher productivity. However, this increases the power consumption required to drive the grinding cup, because of friction rise. In addition, a further increase in carbon layer can lead to overflow in the mill, because still supplied fuel can‘t hit under grinding rolls. This situation may result in overheating of the mill and dust explosion.

A similar situation occurs when change the separator settings in order to improve the quality of crunching. Extension of time, that dust particles stay in the mill, accelerating the overflow process of the mill, increasing the power consumption. Energy consumption by a crunching devices is also affected by rotation speed of the grinding bowl. Research **[5]** showed that the vertical roller mill without damming ring, with increasing of rotation speed of the grinding bowls, consumes less energy for ventilation. This is due to reduction of hydraulic resistance. However, with increasing speed of the bowl, obtained lower crunching quality, which will translate into a reduction in the quality of the combustion process and increase pollutant emissions.

The European Union guidelines obliged polish power plants to product part of energy through the combustion of biomass. In order to avoid the costs of building a separate system, in many cases biomass, in the form of wood pellets, is added directly to the coal bunkers. It have an impact on the work of coal pulverizers. In the case of vertical roller mills which are adapted for crushing, the addition of wood, of a completely different mechanical properties, causes a number of problems.

The most important is overflow of the mill, which reduces its maximum capacity. Increasing the power consumption of the unit for crunching. The results of the research presented in **[5]** show that these problems are closely related to the mass participation of biomass in fuel. Moreover, it proved that the addition of unprocessed biomass worsens dynamic properties of the entire power unit by extending the time response to the demand of the National Power System **[7]**, due to interference occurring in the system of automatic control of the feeding screw operation (boiler capacity is controlled by amount of fuel supply).

An important aspect of the combustion process in the boiler is to burn whole fuel. It is necessary to provide a sufficiently long residence time of carbon particles inside the chamber. Currently used scheme of supplying assumed that each of the mills supplies four corners of the combustion chamber to its assigned height – fig. 2. During process, four pulverizers are operated, and the fifth one remains in reserve. Depending on the configuration, average residence time of the fuel particles in the chamber may changed. Coal dust comes from fifth mill is added in the highest part of combustion zone. As a result, emission of dust and unburned fuel are increase, decreasing the efficiency of the boiler. There is also bigger content of combustible particles in ash, which excludes its subsequent development. Accordingly, the power plant service try to avoid supplying the fuel in the highest regions of the combustion chamber.

Previously described operational problems also affect the fineness of ash received from boiler. By fineness of ash can be understood its fragmentation. Desire

to further ash use is predetermined by maximum thickness of grains. According to standard **[8]**, ash used in construction (e.g. as an additive in concrete) must have a residue ≤40 % for wet screening through a sieve with 0.045 mm diameter. Exceeding the maximum size of grain causes make ash not a product for sale, so it becomes waste which must be disposed of. This is a double economic loss. On the fineness of ash affected both the quality of crunching and combustion of dust in the boiler. This fact means that in case of exceeding fineness of the ash, power plant service need to take action contrary to the proper operation of pulvelizer. As already mentioned, improvement of the crunching quality can be achieved by reducing the angle setting of separator. However, this increase overflow and energy consumption.

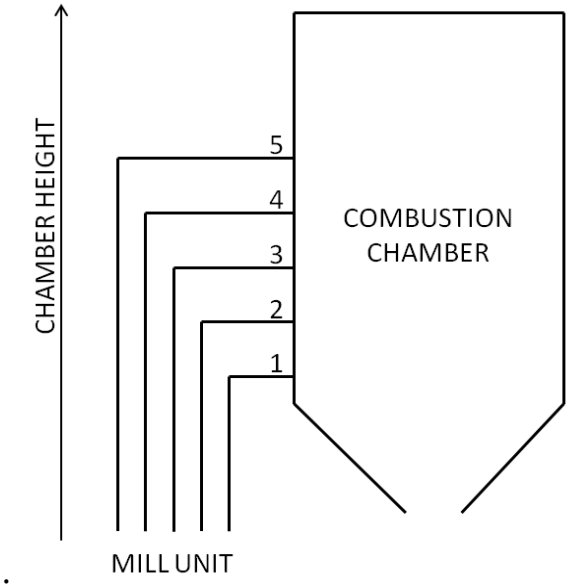

Figure 2. Simplified diagram of fuel introduction into combustion chamber

Exploitation of coal pulvelizer is connected with ash explosion danger , despite the fact that according to standard **[9]**, dust from coal and lignite has been qualified to the low class of explosive. However, into many coal supply devices the concentration of dust in g/m3, is widely over the explosion limits. Moreover, if ash is finer, the area, which can react with air increases, so it become more dangerous. Explosive danger also grow with the decrease in moisture content. This is an important feature, because, as already mentioned, in addition to pulverizers drying ash with hot air. Selected properties of explosive dusts are summarized in table 1.

Table 1
Pulverized coal explosion properties **[10]**.

Pulverized coal	Explosion pressure growth, MPa·(m/s)	Concentration explosion limit, g/m^3	Ignition point, °C
Coal	10	100÷150	447
Lignite	8,5	60	610

Necessary to ignite energy can be delivered in the form of sparks. Its source may be defective electrical equipment, human error during welding or electrostatic interaction between the particles of coal dust.

In order to prevent explosion and minimize its consequences, a large number of devices and protection systems and fire fighting are installed. The first group includes, blowers, which prevent the deposition of dust on the construction. There are also systems for detecting the temperature rise in eg. roller coal conveyor, or a sudden pressure increase in coal distribution channels. Sensors allow very precise location of the threat and launch systems to eliminate it. Fire detection, activates the fire-extinguishing systems, which work by spraying water vapor with parameters p = 0.5 MPa and t = 220 °C **[11]**, or eg., inert gas (eg. nitrogen) is pumped. In the case of the previously mentioned preventive measures are not enough and automation system will register a sudden increase of pressure, which may be the result of the explosion, decompression holes, located in the coal bank, will by open. These holes allow a pressure reduction in the tank and withdrawing a shock wave outside the danger zone. The constant threat posed by the use of pulverized coal for energy purposes may resemble dust explosion in polish power plant "Dolna Odra" in 2010, which resulted in the death of one person.

CONCLUSION

The article presents selected issues related to the problems of coal pulvelizers operating. It quoted the genesis of the most important operational problems and ways of solving them by the services staff.

One of the main problems is the wear of grinding elements due to the stresses generated on the surface between the layer of fuel. Grinding elements should be regularly reviewed and regenerated, before the major damage appears.

It has been shown that the major difficulty in the use of coal pulvelizers is the need to find each time when changing their working conditions, such values, that give balance between economic benefits and increase in energy consumption for own needs.

Exploitation of coal pulvelizers also brings danger of coal dust explosion which entails use of automation measurement and control systems, which mission is to timely detect and neutralize threats.

Desire to reduce the use of fossil fuels demands increasing level of using biomass. Often coal is directly enriched with biomass, which causes problems manifested, by overflow of mill. The use of biomass also has a negative impact on the quality of the ash due to the increase in the thickness of the grain, which excludes the possibility of further using this material in construction.

Full analysis of the processes that take place inside the pulvelizers is impossible due to hard inside conditions (high temperature, dust) and complexity of the physical phenomena. Consequently, the possibility of mathematical modeling of physical processes and analysis of experimental devices in the laboratory may not constitute a reliable basis to describe the phenomena occurring in the industrial units.

REFERENCES

[1] Jansen L. R. D., Møller P., Jespersen M., *Corrsion of high chrome wear part materials used in vertical roller mills*. Corrosion Enegineering. Science and Technology. 7(46) 2011 790-795.

[2] Jensen L. R. D., Fundal E., Møller P., Jespersen M., *Wear mechanism of abrasion resistant wear parts in raw material vertical roller mills*. Wear 271 (2011) 2707-2719.

[3] Wang J., Chen Q., Kuang Y., Lynch A. J., Zhou J., *Grinding process within vertical roller mills: experiment and simulation*. Mining Science and Technology. 19(2009) 0097-0101.

[4] Boehm A., Meissner P., Plochberger T., *An energy based comparison of vertical roller mills and tumbling mills*. International Journal of Mineral Processing. 136 (2015) 37-41.

[5] Pospolita J., *Wybrane zagadnienia eksploatacyjne średnio bieżnych młynów węglowych*. Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego. Opole 2007.

[6] Reichert M., Gerold C., Fredriksson A., Adolfsson A., Lieberwirth H. *Research of iron ore grinding in a vertical-roller-mill*. Minerals Engineering 73 (2015) 109-115.

[7] Bielaczyc A., Lasota S., Fennig W., Kielian R., Lipiński M. *Wpływ współspalania biomasy na pracę UAR obciążenia bloków 200 MW wraz z koncepcją ich modernizacji na przykładzie Elektrowni „Kozienice" S.A*. Energetyka. 10 (2009) 1-7.

[8] PN-EN 451-2

[9] EN 14737:2005.

[10] Kordylewski W., *Spalanie i paliwa.* Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2008.

[11] FPM S.A. 2011, *Dokumentacja Techniczno-Ruchowa młyna wentylatorowego MWk-16*. Mikołów 2011.