

ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering

Tome XIV [2016] – Fascicule 4 [November]

ISSN: 1584-2665 [print; online]

ISSN: 1584-2673 [CD-Rom; online]

**a free-access multidisciplinary publication
of the Faculty of Engineering Hunedoara**



¹. Balázs ZELE

HANDLING FIRE ISSUES IN A COAL FIRING POWER PLANT – MÁTRA POWER PLANT IN FOCUS

¹. Óbudai University, Security Doctoral School, Budapest, HUNGARY

ABSTRACT: During the article, we described the basic expressions in connection with fire, then we talked through energetic usage, and finally we mentioned some point of fire accidents, and prevention. That is how we could get an insight from the Mátrai Erőmű Zrt. (Mátra Power Plant) – how they try to prevent fire accidents and how they handle it when it has occurred, and of course, how they use the fire to generate electricity. In connection with fire accidents, we described two of the fire incidents, where according to the fire protocol they made everything right, and the fire was extinguished. Besides the safety protocol and prevention activities in connection with fire we also described the constructive side of the phenomenon – how fire is used in electric power generation in the plant.

Keywords: coal firing power plant, fire accidents, fire protocol, electricity generation

1. INTRODUCTION

Nowadays fire is not as meaningful in people's minds as it actually is. It has always been natural for us, it is present in our life, and we usually do not recognize how many times we use it for different things in everyday life. However, we are much likely to surprise when we cannot use it because of something unusual or unwanted. It is even worse when we are not able to control it and it makes so huge destruction, we could not imagine. During the following article, we are going to write about fire first in common, we are going to describe the basic expressions, and then we are going to speak about how it is used for generating electricity in power plants.

Fire is an active participant of our everyday-life, as we utilize it at several fields. As we have mentioned in the title, fire plays an important role in the life of a power plant: no matter we take into consideration the safe firing processes in the furnaces or fire maintenance at the right spots of the plant.

As we can read it in "Applied chemistry" by Dr. Simon Ákos & Török László E., it is difficult to phrase the concept of fire and burning combustion as all fires are burning combustions but not all burning combustions are fire cases. Thus fire process – as mentioned in the technical literature – is the rapid oxidation of a material in the exothermic chemical process of combustion, releasing heat, light, and various reaction products. It is also harmful to health and human life when it is not controlled. When looking at fire from a safety point of view, it is the phenomenon, which produces flames, glow, ignition, and intensive heat is generated also – all these aspects are harmful and risky without human and technical control. In not controlled, spontaneous fire cases, we can handle these with well organized fire safety protocol.¹

Dr. Antal Penninger writes about fire in his notebook "Fire techniques" as it starts with the rapid oxidation of a material in the exothermic chemical process of combustion. We can divide some other groups inside the phenomenon of fire: depending on its environment, we separate open and enclosed fire cases. When we are talking about combustion materials – especially firing fuel – we separate fuel groups based on their state of matter. We know three fundamental conditions of matter: the solid, the liquid and gaseous states.

¹ Dr. Simon Ákos-Török László E.: Alkalmazott Kémia. 30/2008.

A solid fuel includes sedimentary rocks of organic origin, which are usually the followings: peat soil, lignite, brown coal, black coal and anthracite. Beside all of these, we can also add some renewable energy resources to the list, like straw, wood and other solid materials from agricultural origin. Liquid state fuels are kerosene, gasoline, petrol, diesel oil, paraffin, fuel oil and mazut (crude oil) originate from distillation of petroleum. From renewable energy resources, we can add different alcohols and vegetable oils to the list of liquid states. Last, but not least when mentioning the gaseous states we usually talk about the popular and widely used and known natural gas and its most effective element, butane. Other elements of natural gas are propane and hydrogen. Bio natural gas, which mainly consists of methane, also plays a more and more important role as a renewable energy resource, however it is loaded with CO₂.

Utilizing fossil fuels (coal, petroleum, natural gas) at energy generation takes almost 83% of the energy cake nowadays.²

2. METHODS

As in Mátra Power Plant, considering the actuality of the topic, it is an important and widely, commonly discussed topic in power plants which needs more and more attention with the improving safety techniques. When talking about handling, the fuel coming right from the mines or its transportation at a power plant running on coal or lignite, it is always important to keep all rules written. That is because the most important aspect is keeping

human lives out of danger and only after this comes production and profit generation.

According to the policy of Mátra Power Plant, besides the mentioned aspects above, we can state that no matter we take into consideration the vehicles around the plant or other buildings, it is always the most important rule to keep safety and security measures at all levels. The plant and its examination points have the responsibility of the environmental examination and reparation work of their vehicles, and besides these, they also take care of reparation and refill of the fire extinguishers. Furthermore, besides electric energy generation, the plant also takes environmental issues to the focus, CO₂ emission and other greenhouse gases are on the everyday agenda.³

Looking back to the history of the plant, there has been some fire cases in the past in almost all fields of the plant. Unfortunately, these tend to happen nowadays and counting on them in the future. That is why the plant's fire safety department focuses on mostly prevention, by organizing theoretical and practical trainings and developing their education system on fire safety protection. Naturally, examination is compulsory for all training participants, so the employees have to be up-to-date on fire safety and have to be aware of prevention methods and safety aspects.



Figure 1. Mátra Power Plant



Figure 2. Mátra Power Plant – location in Hungary

² Dr. Penninger Antal: „Tüzeléstechnika” notebook, BME 2011., Budapest, (online) url:

ftp://ftp.energia.bme.hu/pub/Tuzelestechnika/Tuzelestechnika_jegyzet_v17.pdf (24.03.2015)

³ Mátrai Erőmű Zrt. MERT magazine, 2009. url: <http://www.mert.hu/hu/magazin> (15.01.2010)

Before taking the next step to further researches, let us look at the volume of fire cases and the definition of their zones based on literature.

When we talk about the volume of fire, regarding area and caused damage, we divide fire cases into the following three different groups: small, middle and large fire cases. Analyzing the zones of fire, we cannot tell that there are totally separated zones, however we tend to divide zones into the following three groups: firing zone, zone under massive heat load and smoke zone.

Firing zone is the area where the process before the burning takes place, and the flame of fire takes place here. Thermal stress is a characteristic of the zone, which shows how much heat is released from the volume of the firing zone (1m^3) per unit of time (1s).

Speaking of the second, so called zone under massive heat load, due to fire combustion materials are going through chemical changes. After the release of flammable vapours and gases, during fire a great amount of heat is generated and released. That is why safety personnel needs special fire protective equipment and clothing during fire fighting and controlling fire not to spread over on other places.

The final zone is the smoke zone, where gas stated materials are generated firstly after releasing combustion gases and vapours, secondly after incomplete combustion. These gases stated materials are toxic which means a huge hazardous risk for the human health.

3. DISCUSSIONS

Many aspects have impact on how gases are released during fire. It depends on weather, the exact place of the fire and many other aspects, so it is almost impossible to determine the spreading route of the fire in advance.⁴ There were two serious fire cases in 2009 in the power plant, which both involved serious financial harm, as well. The 1st and 4th block of the 5 blocks in the plant were involved in the fire, which did not have any human injury, but massive financial harm occurred. The plant has regulations on compulsory standby fire fighting crew available all the time, especially near the conveyor belts and the fields of transportation system. This is necessary based on the previous history of the plant and based on legal regulations it is necessary to keep personnel who can handle hazardous situations. Besides this, the plant is also secured by automatic fire alarm system, and water deluge systems and fire extinguisher is built into the safety system. However, no matter how serious safety protection the plant has – fire-fighting crew, alarm system, water deluge system, prepared personnel – fire can occur anytime, as in 2009, as well.

Fire has effect on the future, too not only on the current financial situation when it occurs. Such problem can be when the conveyor belt is broken due to the fire and reparation takes time, until then the transportation system cannot be used and supply is not maintained. Due to such breakdowns of the system, the current block cannot operate on its regular basis, so production is pausing. The plant and the reparation team can maintain the continuous production or can tone down the level of damage, if there is a block available, which has been through reparation or overhaul.

In case of the fire, in 2009 we have to examine the status of the current area and its environment. After several examinations, they reported the following: the amount of smoke released during the fire did not have serious effect on the environment of the area. In this case, the fire fighting crew applied the firefighting method, which is based on removing the combustible material. Conveyor belts are included in this group in the professional literature, as they can transport the combustible material to the place of fire, or transporting the already burning pieces to those parts, which are not burning yet. In such situation it is always compulsory to stop the conveyor belt in case it is possible, or removing the already burning material out of the belt to such area which does not include combustible material.^{5 6 7}

In case of another fire case in February 2012, it becomes clear only after the examination that there were some other causing factors besides those I have already mentioned. In this case probably the weather – the massive, long snowing and the continuous cold weather – influenced the fire. When the 4th block of the plant has been connected to the electrical network, the main transformer caught on fire. Thanks to the training and education program in 2009 after the fire

⁴ Dr. Simon Ákos-Török László E.: Alkalmazott Kémia. 30/2008.

⁵ Mátrai Erőmű Zrt. (online) url: <http://www.mert.hu/tuz-a-matrai-eromuben>, (22.04.2013)

⁶ Dr. Simon Ákos-Török László E.: Alkalmazott Kémia. 30/2008.

⁷ Mátrai Erőmű Zrt. Official Index of Figures. Visonta, 2009.

case before they reported that all fire fighting crew – from the plant and from the state departments – had been working well and they had been well prepared. They stopped the fire after one hour of work, thus they could avoid further harms occurring. Personal injury did not happen in this case either, and the fire did not seriously affect the environment.

The plant has made insurance policies in order to avoid such losses in the future. Unfortunately, such happenings have serious effect on the annual revenue of the plant, or any other company in general.^{8 9 10}

Until now, I have been talking about fire in a negative form, when it is not controlled – in these cases it is responsible for all kinds of damages caused. Now I will talk about fire in from a positive point of view, when it is used under control, and how it can be utilized in a power plant.

Firing fuels – in this case, we are talking about biomass, and lignite after mining, are burnt in the furnace after appropriate preparation. Preparation of the fuels before transporting it to the coalbunkers means: mining lignite, pre-crushing it and mixing it with the appropriate mixture of biomass.

It is necessary to take care of monitoring the amount of coal storage available because it is not enough to have continuous supply to continue and fulfill further transportation and firing process. Mainly it is because lignite stocked in a huge amount means the lignite parts get into frictional interaction with each other, and due to inertia of the coal, the different sized lignite parts can spontaneously catch fire. We can read in professional literature, that the spontaneous ignition occurs without any external effect. The material itself due to the heat generation process occurring inside the material generates ignition temperature. The process – warm-up – can occur due to chemical reaction (like the unsaturation of the coal) or biological microorganisms. During the warming process, lignite can reach the spontaneous ignition temperature. That is why there are water-spraying system is installed in the plant during summer to cool down the stocked coal. This way it is easier to avoid fire cases caused by spontaneous ignition.

The Glivitzky test, which is used for examining coal dust, also underlines this, which is based on empirical factors. This means that if such material like coal or lignite can catch fire on or under 150°C during the test, we can say that material tends to spontaneously catch fire under normal circumstances. However, when the temperature is at 180°C or above, we cannot state that fire is caused by spontaneous ignition. As Dr. Ákos Simon and László Török have written, we have to slow down the speed of thermic progression – so first as it goes in Mátra Power Plant after mining, lignite is stored in the storage units, it also gets ventilation and gets older (and easier to burn). It is a common process because the target is to decrease air adsorption by passivating coal by time. Another important factor is to keep the material in a way that it is affected by the least amount of heat.¹¹

From firing technology point of view, we can state that besides the advantageous utilization fields of firing it becomes more and more important to take care of environment, too. During firing the most frequently, produced harmful gases are the following: nitrogen oxides (NO and NO₂), CO, SO₂, SO₃ and different solid elements.

Most of the firing materials consists of combustible and ballast parts. Combustible parts are fuel parts with oxidation, which creates heat. These are carbon (C), hydrogen (H) and sulfur (S). Besides this, the firing fuel can have ingredients like oxygen (O) and nitrogen (N) as well. Ballast consists of moisture and ash – which depending on what kind of fuel we are talking about can be harmful, toxic or stable, harmless.

Appropriate utilization of caloric value of the firing fuel means using the appropriate firing equipments as well, which ensures

- ≡ mixing the firing fuel and the burning air in the adequate way,
- ≡ the needed amount of regulation
- ≡ the perfect possible burning process of the firing fuel.

Heat exchange towards the heat carrier must be ensured by creating the appropriate environment for the firing equipment. Usually closed combustion chambers are used, because emission can be reduced seriously (to 2%).

⁸ ORIGO news portal (online) url: <http://www.origo.hu/itthon/20120215-harommillio-euros-kart-okozott-egy-tuz-a-matrai-eromuben.html>, (03.05.2016)

⁹ INDEX news portal (online) url: http://index.hu/bulvar/2012/02/15/tuz_volt_a_matrai_eromuben (05.11.2015)

¹⁰ NOL news portal (online) url: http://nol.hu/gazdasag/milliardos_baleset_a_matrai_eromuben (20.05.2014)

¹¹ Dr. Simon Ákos-Török László E.: *Alkalmazott Kémia*. 30/2008.

4. CONCLUDING REMARKS

Not adequately controlled firing process can lead to producing such by-products, which can not only be harmful from an environmental point of view, but also cause energetic losses. That is how soot, carcinogenic materials, toxic CO, nitrogen oxides – which increase the ozone concentration near the ground – and hydrocarbons – which are the main cause for greenhouse effect – are produced. In order to avoid creating these not wanted by-products, it is common process to pour more air into the furnace (excess air factor) than it is normally enough and the temperature of the firebox is under continuous control.

It is practical to increase the added amount of plus air until reaching the wanted environmental parameters, as too much air in the system can lead to energetic losses. Excess air factor is the quotient of the used amount of air (L) and the theoretically needed amount of air (L_0).^{12 13}

We can say that there are coal firing power plants built on good-quality coals and on large amount of soot and moisture. It is an important factor during planning to burn coal in an energetically effective and environmentally friendly way. Environment protection demands for flue gases to have low level of local dust, sulfur dioxide and NO, and to pour out as low amount of harmful greenhouse gases as possible.

Furthermore we can ensure the safety protection in power plants by keeping strict rules, educating and training all employees and suppliers around the plant, and finally by continuous monitoring of the current system.

Overall, we can say, fire is an important part of our everyday life – and not only ours, but in power plants' too, where electric energy is generated during a fossil fuel burning method. In these energy-producing processes, it is not only important to maintain the safe energy production, but to be prepared and up-to-date all the time.

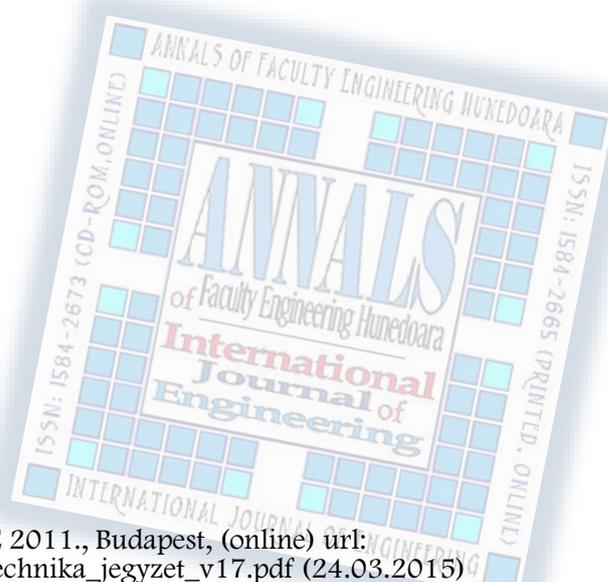
Reference literature

- [1.] Dr. Simon Ákos-Török László E.: Alkalmazott Kémia. 30/2008.
- [2.] Dr. Penninger Antal: „Tüzeléstechnika” notebook, BME 2011., Budapest, (online) url: ftp://ftp.energia.bme.hu/pub/Tuzelestechnika/Tuzelestechnika_jegyzet_v17.pdf
- [3.] Mátrai Erőmű Zrt. MERT magazine, 2009. summer edition
- [4.] Mátrai Erőmű Zrt. (online) url: <http://www.mert.hu/tuz-a-matrai-eromuben>
- [5.] Mátrai Erőmű Zrt. Official Index of Figures. Visonta, 2009.
- [6.] ORIGO news portal (online) url: <http://www.origo.hu/itthon/20120215-harommillio-euros-kart-okozott-egy-tuz-a-matrai-eromuben.html>
- [7.] INDEX news portal (online) url: http://index.hu/bulvar/2012/02/15/tuz_volt_a_matrai_eromuben
- [8.] NOL news portal (online) url: http://nol.hu/gazdasag/milliardos_baleset_a_matrai_eromuben
- [9.] Mátrai Erőmű Zrt. Inside, regular meetings and consultations (Furnaces and Transportation Equipments Maintenance Department). Visonta, 2009.

ANNALS of Faculty Engineering Hunedoara
– International Journal of Engineering



copyright © UNIVERSITY POLITEHNICA TIMISOARA,
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA, ROMANIA
<http://annals.fih.upt.ro>



¹² Dr. Penninger Antal: „Tüzeléstechnika” notebook, BME 2011., Budapest, (online) url: ftp://ftp.energia.bme.hu/pub/Tuzelestechnika/Tuzelestechnika_jegyzet_v17.pdf (24.03.2015)

¹³ Mátrai Erőmű Zrt. Inside, regular meetings and consultations (Furnaces and Transportation Equipments Maintenance Department). Visonta, 2009.