International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 04| Apr -2016 www.irjet.net p-ISSN: 2395-0072

PARAMETERS AFFECTING EROSION BEHAVIOUR IN A PULVERIZED FUEL PIPELINE – A REVIEW

Shubham Agarwal [1], Amit Suhane [2]

[1] M-Tech Research Scholar, Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India
[2] Assistant Professor , Mechanical Engineering, M.A.N.I.T, Bhopal, M.P. India

---***---

Abstract - *In the modern world with the increase in population, the demand of various assets have also increased drastically in especially in the past decade. One such sector is the power generation in which the demand for the power has been continuously rising and to meet the increased demands changes has to be brought in the system in terms of fed raw material and the other associated parameters. The aim of the review work is to analyze the erosion behavior in pulverized fuel pipeline due to the changes in these parameters like impact velocity, impact angle, material feed rate, temperature rise etc. and suggest any suitable modification in the process parameters or the plant component design so that the erosion can be brought to its minimum level in an efficient way.*

Key Words: *Tribology, erosion, wear, pulverized fuel, impact velocity, impact angle.*

1. Introduction

Tribology is a Greek work word which is a combination of 'Tribo'+ 'Logy'. It is the study of interaction in between the two surfaces which are in relative motion with each other.

Fig -1: Tribological System [11]

1.1 Wear

Wear is defined as a continuous loss of material from the surface of a body by mechanical phenomenon which could be a contact or relative motion with a solid, gaseous or a liquid body. The different phenomenon of wear are:

1. **Abrasive Wear:** This wear is caused due to rubbing of one surface over the other in absence of adequate lubrication. The softer material is carried away by the harder material when relative motion occurs between them.

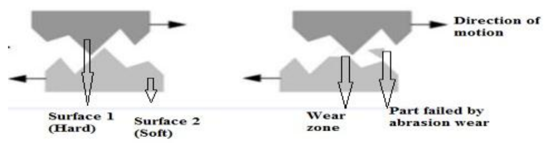

Fig -2: Abrasion Wear [10]

2. **Adhesion Wear**: This wear is caused when the surface of one material adheres on the surface of other and a bonding occurs between them but the bond gets broken due to the motion of the surfaces.

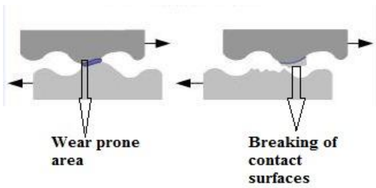

Fig -3: Adhesion Wear [10]

3. **Erosion Wear**: This wear is caused when two surfaces rub against each other in the presence of a fluid medium in between them. The hard abrasive particles are carried by liquid or gas strike surface and produce erosion.

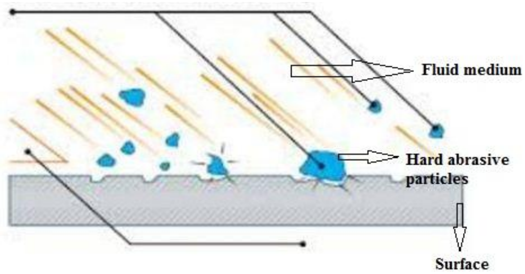

Fig -4: Erosion Wear [10]

The erosion in a power plant occurs at different components. Some of them are :

- Conveyor belt of solid coal
- Coal burner tips
- Hoppers
- Pulverized fuel supply line
- Rollers of the pulverisers in mills
- Turbine blades

The paper reviews the erosion problems in the fuel supply pipe line. The erosion in the pipeline section depends on the following factors:

- Coal feed rate.
- Impact velocity.
- Impact angle
- Orientation of the pipe.
- Pipe material.
- Abrasive properties.
- Temperature Rise. [8]

2. Research Approaches on the effect of different parameters on erosion in P-F line:

Eva Zdravecka et.al [4] carried out the erosion wear test by a stream of SiO_2 sand particles having a size of 0.8 mm and an impact velocity of $50ms^{-1}$ at the different inclinations of the impact angle of 15^0,45^0,90^0 and observed that maximum wear of the ductile materials occurs impact angle ranging from 20 to 40 degrees and that for the white cast iron at an impact angle of 90 degrees.

M. Divakar et.al [7] examined the erosion of the austenitic stainless steel for the particle sizes of 0.1, 0.145, and 0.2 mm respectively and for the experiments he varied the values of impact angles in between 15^0 to 90^0 with a velocity range of $20ms^{-1}$ to $32ms^{-1}$ and concluded that the phenomenon of erosion in the ductile material is cutting and ploughing and that for the brittle material is flake fragmentation.

Bu-Qian Wang et.al [2] used the flyash obtained from thermal power plant with a mean particle size of 0.158 mm, particle density of 2031 kg/m^3 and an impact angle of 30 degrees and 90 degrees with a particle velocity of $30ms^{-1}$ and analysed that the flyash has a higher erosion capacity as compared to the bed ash due to its chemical composition. He also observed that for the ductile material if impact angle is lower than the losses will be higher and in case of the brittle materials the losses will be maximum for higher angle of impacts.

D.Mills et.al [3] experimentally observed the particle size parameter for its contribution in the erosion of pipe line section for fuel supply and concluded that the depth of penetration in the observed erosion pattern was higher for the smaller particles as compared to large sized paticles and on the basis of this it was stated that the fuel pipe line would erode at a faster rate on the flowing the small sized particles through it.

Amit Suhane et.al [1] analysed the erosion in the mild steel pipe and GI bends of 51 mm and 102 mm by using silica sand particles of 0.212 mm particle size and concluded that with the given material the erosion in the ductile material was maximum for an angle of 10 to 20 degrees and that in the brittle for 80 to 90 degrees. The test were performed to determine the erosion rate in the tapered section of the pipe bends as compared to normal geometry and it was concluded that the tapered geometry in the bend section would reduce the erosion rate.

J.G. Mbabazi et.al [5] performed experiments on erosion wear of mild steel by testing with the flyash for parameters like impact velocity and impact angle and concluded that erosion wear increases with increase in impingement angle, maximizes at 30^0 then it further decreases. It was observed that erosion rate follows power law with ash particle impact velocity and the value of exponent depends upon size and shape of ash particle.

M. Divakar et.al [7] examined austenitic stainless steel for erosion by variation of temperature which was the parameter used in the range from ambient to 150^0 and other parameters were kept constant and it was observed that the erosion rate decreased with increase in the temperature upto 0.6 T_m as the ductility of the materials increases so more energy is absorbed by the plastic deformation and also due to formation of the oxide layer on the heated surface which imparts brittle behavior to it.

K.P. Schade et.al [6] used irregular shaped pulverized fuel particles for analyzing the erosion characteristics in different sections of the pipeline and considered the parameters like impact angle and impact velocity for the test on steel with a particle size of 0.15 mm to 0.30 mm and concluded that in the downstream of the pipeline the fuel particles adjust to the changed flow conditions as they have less mass and they made lesser impacts on the target walls on most of the downstream part so comparatively a lesser erosion rate is observed in the later part of the pipeline.

Q.B. Nguyen et.al [9] tested stainless steel as a target material with sand as an erodent for the parameters like hardness, density, shape size and time. It was observed that the erosion rate peaked at t= 120 seconds and gradually reduced further because after sometime the case hardening of the surface reduces the erosion rate. It was also concluded that at very low values of the impact angles the erosion rate shooted up drastically and maximized at about a value of 40 degrees and then further reduces as collision between the incoming and rebounding particles significantly reduced the kinetic energy of the approaching particles.

3. CONCLUSIONS

The paper reveals a review work on the study of erosion rate of different materials based on the parameters like particle size, particle velocity, particle density, impact angle, hardness, temperature and it was found that at lower impact angles the ductile material suffers drastic erosion whereas at higher angles the erosion rate gets maximum in the brittle material. Erosion rate also decreases with increase in the temperature upto a certain limit and it is higher for smaller sized particles.. Subsequently; these results could be suitably used to provide a better design and operating conditions so that erosion can be significantly reduced to the minimum level rendering the power plant operation much safer and subsequent electricity generation much cheaper.

REFERENCES

[1] Amit Suhane, V. K. Agarwal, Effect of bend geometry on erosion and product degradation in pneumatic conveying pipeline systems, IJERA (2012).
[2] Bu-Qian Wang, Erosion-corrosion of coatings by biomass- fired boiler fly ash, Elsevier (1995).
[3] D. Mills, J. S. Mason, Particle size effects in bend erosion, Elsevier (1977).
[4] Eva Zdravecka, Jan Slota, Jana Tkacova, Erosive failure of steel pipeline by solid pulverized particles, Elsevier (2014).
[5] J.G. Mbabazi, T.J. Sheer, R. Shandu, A model to predict erosion on mild steel surfaces impacted by boiler fly ash particles, Elsevier (2004).
[6] K.P. Schade, H.J. Erdmann, Th. Hadrich , H. Schneider, Th. Frank, K. Bernert,Experimental and numerical investigation of particle erosion caused by pulverised fuel in channels and pipework of coal-fired power plant, Elsevier (2002).
[7] M. Divakar, V.K. Agarwal, S.N. Singh, Effect of the material surface hardness on the erosion of AISI316, Elsevier (2004).
[8] R. Nagarajan, B. Ambedkar, Development of predictive model for erosion phenomenon in coal burning boilers. (2009).
[9] Q.B. Nguyen, V.B.Nguyen, C.Y.HLim, Q.T.Trinh, S.Sankaranarayanan, Y.W.Zhang, M.Gupta, Effect of impact angle and testing time on erosion of stainless steel at higher velocities, Elsevier (2014).
[10] www.substech.com
[11] www.tribocoating.de

BIOGRAPHIES

Shubham Agarwal holds a Bachelor's Degree in Mechanical Engineering from UPTU Lucknow, Uttar Pradesh and pursuing M.Tech. in Mechanical engineering (Maintenance engineering and management) from Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh (India).

Dr. Amit Suhane holds a Master's Degree from IIT-D and a PhD. Currently, he is working as an Assistant Professor in the Department of Mechanical Engineering, MANIT, Bhopal, Madhya Pradesh (India) with specialisation in Industrial tribology, machine dynamics, maintenance engineering and automotive applications. He has contributed a significant number of research papers at the international level.