NOISE MONITORING AND CONTROL IN STEEL INDUSTRY AS AN INNOVATION ARM: MINI MILL EAF STEEL PLANT.

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ABSTRACT

The sustainable development goals (SDGs) for the United Nations are the main factors that determine and form the future of industry and economy global wise. Green industry is the key word in any new investment and economic project, which makes the investors working for upgrading and developing the ongoing industries in order to fit with SDGs requirements and principles from one side and to keep the line of following the sustainability requirements for the new projects from the other side. Metallurgical industries are considered the most changing industries to follow sustainability boundaries and SDGs due to the huge amount of natural resources used (raw materials and ores), huge amount o energy (mostly fossil energy) and a plenty of required water. One of the important measures for sustainability as it affects safety and health of labors is the noise. Noise affects the health of workers and can be reason of fatal incidents and be a source of economic drawback in such heavy industry. This article clarifies the research work to evaluate the noise at steel plant and how it'll be studies and consider the methodology to overcome the harms results from it in way to help such important industry to be eco-friendly and sustainable.

Keywords

Noise Pollution, Noise Reduction, Metallurgy, EAF Steelmaking, Best Available Technologies.

1. INTRODUCTION

Noise is one of the main negative factors affecting workers and residents living at the vicinity of metallurgical enterprises.

A study at metal factories has shown that the hazards of noise exposure may cause hearing loss, increasing blood pressure and heart rate. In Russia, it was estimated that hearing loss occurs after 10 years of permanent noise exposure with the level of 90 dB. The noise pollution is emerging as a serious industrial problem. [1, 2, 3]

An Egyptian Law Concerning Environment (Law No. 4 Of the Year 1994 Promulgating A Law Concerning Environment, Amended as Per Law No. 9/2009) states the limit levels at workplaces, in residential building and areas sensitive to noise. The allowed maximum limit of the equivalent level of noise at the places of work (workshops and factories) and the like with shifts up to 8 hours is 85 dB for newer and 90 dB for older factories licensed before 2014. The Law states that the exposure duration shall be reduced to the half with the increase of the level of noise at 3 dB in order not to harm

the sense of hearing along with wearing the appropriate earplugs. The instantaneous level of noise during the period of work shall not exceed 135 dB. Permissible limit of the equivalent noise level at industrial zones with heavy industries should not exceed 70 dB and at residential areas and noise sensitive areas it is limited with 50-60 dB at the daytime and 40-50 dB at night according to the area type [4].

International literature sources report that the equipment that generates the highest noise levels at metallurgical enterprises are crushers (115-118 dB), screens (112 dB), feeders (108-116 dB), steel-smelting arc furnaces (116-129 dB), sandblasting plants (117 dB), grinders (109 dB), compressor and ventilation plants (106-118 dB) and equipment for rolling shops (121-125 dB). It means that the noise limits at workplaces in Egypt could be exceeded up to 18-39 dB. [5, 6]

Therefore, it is extremely important to control noise levels at the workplaces to avoid noise-induced morbidity within the workers and obey noise legislation of Egypt.

1.1. International Situation of Steel Processing Concerning Noise

In recent years, the occupational morbidity of all Russian ferrous metallurgy workers has ranged from 20 to 32 percent. One of the most significant elements affecting employee health is noise, which leads to occupational diseases including hearing loss and has a harmful impact on the digestive and cardiovascular systems. When analyzing equivalent sound levels at the workplaces of Russian steel production factories, it was found that they are estimated as 84-106 dB. The limit value of 80 dB established at the workplace in Russia is exceeded by 4-26 dB [7, 8].

In Europe, the sectors with the highest number of workers exposed to noise with the highest incidence of compensated hearing losses also include metallurgy. The levels of noise are estimated as 81-112 dB at workplaces, i.e. limit values are exceeded by 1-32 dB. There is an improvement in coping with noise exposure due to introduction of sound isolation and sound absorption measures. All sectors report an increase in wearing personal protective equipment and an improvement in risk awareness. [9]

1.2. Noise Measurements

For noise measurements, we use standards that are the most appropriate to the goal of measurements. To evaluate the noise affecting workers ISO 9612-2016 “Acoustics. Noise measurement for the purpose of evaluating human exposure to noise. Method of measurements at workplaces” is used.

The standard ISO 8297:1994 "Acoustics — Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment — Engineering method" is used for multisource facilities to assess noise in the environment.

To evaluate noise emission of the equipment for further elaboration of noise protection we should use ISO 11200:2014 “Acoustics — Noise emitted by machinery and equipment — Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions”. ISO 11200:2014 is intended to select standards from the ISO 11201, ISO 11202, ISO 11203,

ISO 11204 and ISO 11205 group, which are the most appropriate to the machinery family it covers, and which give detailed requirements on mounting and operating conditions for the particular family, as well as the location of the work station(s) and other specified positions.

The number of measurement points depends on the goal of measurements. If we evaluate the effect of noise on workers, we take one receiver at each workplace at the height of 1,2 - 1,5 m above the floor.

For the development of noise protection, we measure at each item of equipment, the amount of receivers depends on the size of the equipment, normally 8-16 for each item that are allocated on the measurement sphere nearby and above the equipment as it is stated in ISO 11201-11205.

2. METHODOLOGY: RESEARCH WORKS TO STUDY NOISE IN METALLURGY IN EGYPT

To achieve the aim of this study; several phases were considered as follows:

- Overview of Egyptian and/or international experience in noise evaluation and reduction in metallurgy,
- Overview of Egyptian legislation in the field of noise measurements and limits,
- Elaboration of noise measurement method based on international, Russian and Egyptian experience,
- Measurements of noise of metallurgical equipment (to make noise measurements by an accredited laboratory),
- Comparison between ferrous metals production technologies regarding noises of electric arc furnaces, induction furnaces, submerged arc furnaces and ladle furnaces,
- Comparison of noise levels in metal working sectors: melting, refining, rolling, forging, machining and different production technologies in each sector,
- Evaluation of noise in foundries.

The first phase of the research will cover a steelmaking plant through a general survey and study the results.

2.1. First Phase of Investigation: Electric Arc Furnace Steel Mill.

This steel mill was established in 1994. It has a production capacity of 1 million tons of rebar per year. This plant includes production facilities as an Electric Arc Furnace (EAF), its charge consists of 80% DRI mixed with 20% high-grade steel scrap, a billet caster, and two rolling mills supported with reheating furnaces. The first rolling mill has the capacity of 60-ton per hour billet reheating furnace and 16 in-line, quick-change mill stands. The second rolling mill has the capacity of 80-ton per hour billet reheating furnace and 18 in-line, quick-change mill stands. Both mills are supported with a 66-meter cooling bed and product cold shears to cut bars to the final dimension (length). The production line is supported also by an automated stacker and associated handling facilities that enable efficient product dispatch and shipping. There are some auxiliary equipment on site as; a power substation, three water treatment plants, two oxygen plants and three automatic generators.

3. RESULTS, OUTCOMES AND RECOMMENDATIONS

3.1. First Phase Preliminary Results from the Steel Plant

Table (1): Results of equivalent noise intensity measurement for first phase preliminary from the steel plant.

#	Site	Noise level (dB)		
		RM#1	RM#2	MS
Working bays (Law limit = 90db)				
1	Billet yard	86	82	-
2	Roughing stage (local box)	91	95	-
3	Intermediate stage (local box)	92	92	-
4	Finishing stage (local box)	93	89	-
5	Cold shear	93	92	-
6	Short bars area	94	97	-
7	Preparation workshop	76		
8	Workshop	89		-
9	Central Workshop	77		
10	Scrap bay	-	-	79
11	EAF/LRF platform	-	-	97
12	CCM platform	-	-	85
13	Mechanical workshop	-	-	79
14	Lubricant area	85	86	-
15	Pumps stations	96	90	94
16	Compressor Stations	101	102	-
17	Oxygen/ compressed air plant	-		100
Abnormal operation condition (Law limit = 90dB)				
18	Diesel generator	103	103	102
19	Fire fighting pump	103	-	-
Control rooms and administration building (Law limit = 60db)				
20	Reheating furnace	70	71	-
21	Main pulpit	70	70	-
22	Finishing stage	71	72	-
23	Administration	76	75	-
24	EAF	-	-	72
25	LRF	-	-	72
26	CCM	-	-	70
27	Oxygen plant	-	-	72
Surroundings (Law limit = 70db)				
28	Melt shop gate (front)	78		
29	Beside DRI store (rear)	73		
30	Security gate 1	66		
31	Security gate 2	70		
32	Security gate 3	72		
33	Cooling bed (RM#1)	68		
34	Finishing stage (RM#1)	67		
35	Cooling bed (RM#2)	75		
36	Finishing stage (RM#2)	72		

37	Security gate (delivery)	70

3.2. Noise Control for Different Steel Processing Technologies

The best available technologies were developed for metallurgical enterprises in Russia. Technologies aimed at reducing the impact of noise by implementing one or a combination of two or more methods as shown in **t**able 2.

Table (2): Best available technologies to reduce noise in metallurgy.

Protection measure	Efficiency, dB
Noise reduction at the factory	
Enclosure of noisy operations/aggregates	up to 20 dB
Vibration isolation of production facilities/aggregates	5-10 dB
Use of internal and external insulation based on sound absorbing materials	5 dB
Sound insulation of buildings (e.g. closing doors and windows in workshops)	up to 30 dB
Application of silencers on discharge pipes and ventilation inlets/outlets	10-15 dB
Soundproofing of ducts and fans	up to 15 dB
Use of soundproofing of machine chambers	up to 20 dB
Installation of sound absorbers at air outlets	10-15 dB
Reducing the speed of streams in channels	18 dB at twofold reduction of speed
Separation of noise sources and potentially resonant components such as compressors and channels	up to 10 dB
Use of rubber shields when crushing coal and transporting pipes	3-8 dB
Noise reduction on the way of sound propagation	
Choosing location for noisy operations (sanitary zone for the dwellings)	6 dB per doubling of distance
Installation of acoustic barriers and/or natural barriers	up to 20-25 dB
Erection of buildings at the way of sound	Up to 25 dB
Planting trees and bushes between the sensitive zone and noisy production	dB

In addition, to reduce noise in metallurgical furnaces, it is recommended:

- for DC electric arc furnaces – to use the pretreatment of charge, use of graphite electrodes and sealing of the furnace;
- in heating furnaces – to use flameless burners and fibrous lining;
- to reduce the noise of tuyeres used in various types of furnaces, it is recommended to use nozzles with ejectors;
- Reduction of external noise of furnaces by means of installation of noise-protective chambers (“dog-houses”).

The noise of rolling equipment is reduced using vibration damping and vibration isolating elements, replacement of metal parts with non-metallic ones, changes in the geometric parameters of the equipment and its elements, the use of casings and soundproof remote control booths.

4. CONCLUSION

Noise pollution is a growing problem across world, especially in developing countries, which many people may not be aware of the impacts of on their health and environment. Noise levels should be brought down to tolerable levels in order to avoid the negative effects of noise exposure.

From the preliminary obtained data, the above-mentioned recommendations can be proposed but further detailed study should be completed to give a detailed description and engineering for the situation and the needed action to control the current noise effects in the metallurgical plants.

5. REFERENCES

[1] Wanis Osiris G., Abd-Elfattah Mohamed A. and Shawky Hany A.: "The Association between Noise Exposure and Blood Pressure and ECG of Workers in Egyptian Factories", The 21st. International Congress on Sound and Vibration, Beijing, China, 13-17 July, (2014).

[2] Saba Kalantary, Ali Dehghani, Mir Saeed Yekaninejad, Leila Omidi, and Mitra Rahimzadeh: "The Effects of Occupational Noise on Blood Pressure and Heart Rate of Workers in an Automotive Parts Industry", ARYA Atheroscler; 11(4): pp. 215-219, July, (2015).

[3] Elise E. M. M. van Kempen, Hanneke Kruize, Hendriek C. Boshuizen, Caroline B. Ameling, Brigit A. M. Staatsen, and Augustinus E.M. de Hollander: "The Association between Noise Exposure and Blood Pressure and Ischemic Heart Disease: A Meta-analysis, Environmental Health Perspectives", Vol. 110 | No. 3 | March, (2002).

[4] Law No. 4 of 1994* PROMULGATING THE ENVIRONMENT LAW Amended by Law No. 9 for 2009, Ministry of State for Environmental Affairs, The official Journal-issue No. 5 on February 3, (1994).

[5] Butorina, I. V.; Butorina, M. V.; Kuklin, D. A. and Shashurin, A. E.: "Innovative Approaches to Noise Reduction in Metallurgy", TIMS Bulletin, Vol. 110, Issue 1, pp. 68-80, January, (2022).

[6] Butorina, I. V. and Butorina, M. V.: "Best Available Techniques for Noise Reduction in the Iron and Steel Industry", Chernye Metally, (9), pp. 70-75, (2022).

[7] Parameswarappa, S. B.* and Narayana, J.: "Impact of Noise on Hearing and Hypertension Among Workers in Steel Industry", International journal of Current Microbiology Applied Science, 4(1): pp. 124-133, (2015).

[8] Farhad Forouharmajd1 and Mitra Shabab, : "Noise Pollution Status in a Metal Melting Industry and the Map of its Isosonic Curve", Jundishapur J Health Sci.; 7(4), October, (2015).

[9] "Code of Practice on Safety and Health in the Iron and Steel Industry", Internatioal Labour Organization Sectoral Activities Program, Internatioal Labour Office, Geneva, (2005).