A Study of Heat and Noise Problems in a Drug and Pharmaceutical firm in India

Key words: Heat—Noise—Health hazards—Control measures

A drug and pharmaceutical firm in India has been engaged in the production of vaccines and various other drugs to fight against the diseases inflicted in the humans. The process of drug manufacturing entailed functioning of a 'fermentation' plant along with at least two auxiliary units e.g. air compressor and ammonia compressor. Preliminary investigation revealed the probable synergistic effect of exposure to uncomfortable heat and noise, amongst some other harmful contaminants. Hickish¹⁾ has suggested upper limits for thermal comfort zone for the men workers with light manual activities to be 23.8°C dry bulb or globe temperature, while that by Bhattacharya²⁾ to be 22.2°C. Also safe limit of exposure to broadband noise for eight hours daily over a working life period of 30 years has been suggested to be 90 dBA³⁾. In a controlled climatic chamber study Bhattacharya et al⁴⁾ have indicated elevation of heat rate, oxygen uptake, and various body temperatures as also decrements in human performance due to the combined effects of heat (35°C) and noise (100 dBA). It was, therefore, felt necessary to establish whether the levels and characteristics of heat and noise originating in these plants were so high as to pose a threat to the health and safety of the workforce and if so, to suggest control measures likely to be acceptable as providing a reasonable standard of safe working environment.

A total of 44 fermentors and 33 inoculators were installed on the 2nd floor of the fermentation block, measuring 102 m × 30 m × 4.20 m. Each fermentor was purging steam and air, from time to time, within the workspace, for the technical reasons. Some of the overhead ducts carrying steam had worn out insulations, and the leakage of steam was apparent. A few other ducts had no insulations. The side walls had windows fitted with glass panes, which provided hot air (42°C) on opening them. There was no good mechanical exhaust ventilation except the natural way through the ceiling. There was, however, a provision of cool air supply through overhead ducts with the outlet hoods placed on 3 out of 16 pillars, equidistant to each other, on the corridor and an equal number of the same along the side walls, at a height of 1.70 m from the floor. A group of 60 workers were engaged in each of the three shifts viz, morning (0600–1400 h), evening (1400–2200 h) and night (2200–0600 h), for effective operation and maintenance of the plant. On the whole the fermentation block was noisy, hot, and had strong smell of formalin and spillage of water, grease, oil etc.

The air compressor plant, (36 m × 18 m × 8.40 m), was housed on the 1st floor

of another building. It had three turbo-air compressors with two working and one in spare. The sucking capacity of atmospheric air of each of the compressors was $970 \text{ m}^3/\text{min}$ and the delivery capacity of compressed air to fermentation block and the recovery block was 2.3 kg/cm^2 each. It had a saw-toothed ceiling. Pedestal fans were used for air circulation. Prima-facie observation revealed that the workplace was uncomfortably hot and had high noise fields as well. A total of 18 workers manned each shift.

The ammonia compressor plant ($60 \text{ m} \times 18 \text{ m} \times 12 \text{ m}$) had seven compressors installed, with six working at a time and one in spare. The ammonia was mainly used for air conditioning, cooling of media, refrigeration purposes etc. It also had a saw-toothed ceiling. There was no mechanical exhaust ventilation, except natural ventilation through the doors fitted on the side walls. A total of 14 tanks containing ammonia was radiating heat within the workspace. Six workers in each shift were engaged in various activities. Leakage of ammonia was noted with spillage of oil, grease etc. on the floor. None of the workers was wearing hearing protective devices.

To assess the thermal environment a sling hygrometer, a globe thermometer (0.15 m dia) and a kata thermometer (kata range 54.5 to 51.5°C), all of Cassella & Co, England, were used. A precision integrating sound level meter (Type 2218) and a one third octave filter set (Type 1616) of B & K, Denmark, were used for noise measurements.

The thermal measurements and noise recordings were taken at the locations at which the workers were exposed and at times during which maximum (evening shift) and minimum (night shifts) air temperatures could be recorded. The levels of heat and noise during the morning shift would thus lie within the levels between evening and night shifts. Thermal measurements were also collected in the open outside these plants. All measurements were recorded as per standard procedure for one week consequently.

The means and the ranges of different thermal measurements viz, dry bulb, wet bulb (humidity) and globe thermometer, for the evening and night shifts are presented in Table 1. The air velocity in all the units were within the range of 0.20 to 2.00 m/s . The data for thermal measurements obtained from the three plants have been referred to the standard curves for thermal limits for physiologically safe environments.⁵⁾ It may be noted from Table 1 that the measured dry bulb or globe temperatures in all the three plants have well exceeded the environmental limits for comforts and working efficiency, with the relative humidity being less than the prescribed values given in the curve during evening shifts. This reflects the view that there will be no thermal comfort of the employees and consequently their working efficiency is likely to be impaired to a great extent. In the night shift these values were lower than those of the evening shift, yet they were well above the comfort ranges. The reasons for such high temperatures are attributable to the steam and hot air being released from the various

Table 1. Thermal measurements at the three plants during evening and night shifts

Plant	Evening Shift						Night Shift											
	Dry bulb (°C)			Globe Temp (°C)			Humidity (%)			Dry bulb (°C)			Globe Temp (°C)			Humidity (%)		
	Mean	Range		Mean	Range		Mean	Range		Mean	Range		Mean	Range		Mean	Range	
Fermentation	41.5	38.9–41.7		42.2	40.0–43.6		28.0	27–31		37.5	36.1–37.8		102	38.8–40.6		45	43–47	
Air compressor	41.0	39.7–41.1		42.8	41.7–43.9		28.0	26–29		30.6	28.9–31.7		105	39.7–41.7		42	40–45	
Ammonia compressor	43.1	41.1–43.9		46.1	44.4–47.2		25.0	22–27		33.5	32.2–34.4		107	40.6–42.2		43	41–46	
In the open	40.5	37.8–40.6		40.6	40.0–40.6		27.0	25–28		29.4	28.3–30.6		84.5	28.3–28.9		42	40–45	

* Air velocity in all the plant was within the range of 0.20 to 2.00 m/sec.

Table 2. Measurement of sound pressure levels (re : $2 \times 10^{-5} \text{N/m}^2$) at the three plants during evening and night shifts

Plant	Sound Pressure levels (dBA) range	
	Evening shift	Night shift
Fermentation	100–105	102–108
Air compressor	95–102	98–103
Ammonia compressor	93– 97	94– 98
Primary air filter	104–106	104–109

purging points, within the workplace. The high radiant temperature has also been the result of radiation of heat from the overhead ducts having weak insulations. In addition, the cool air supply was observed to be much too less than that needed for thermal comfort. Apart from this, the fermentors, the air compressors and the ammonia tanks were also responsible for radiation of high heat to the workplace.

Further, the measured air velocity (0.20 to 2.00 m/sec) was higher than the recommended standard of 0.05 to 0.15 m/s. The temperature of air was also high in these plants and a current of hot air was constantly sweeping over the faces and the body of the workers, thereby causing high heat gain in the body. This would induce a feeling of discomfort and degradation in their work efficiency.

The measured sound pressure levels (SPL) in various plants (Table 2) were much in excess the standard SPL of 90 dBA for eight hours exposure daily. The SPLs at each frequency were plotted on the standard noise rating curves⁶⁾. The noise rating curves enable the acceptability level of noise to be measured by taking into account such factors as loudness, speech interference levels, the frequency spectrum, and the sensitivity of ear to different frequencies. The acceptable noise rating number for the three plants (Heavy Engineering) is $R = 70^{(7)}$, the necessary requirement for safety being that the obtained curves should fall below the standard curves. It was seen that the SPLs at frequencies from 250 Hz to 8000 Hz were above the NR curve 70 of "Dangerous Noise" region, while those upto 125 Hz were very close to it. Such high sound pressure levels have originated due to release of a large amount of steam at high pressures through nozzles in the fermentation plant, from the turbines in the air compressor plant and the compressors in the ammonia compressor plant. Thus, the results suggest that the noise originating in the three plants is potentially dangerous for the health and safety of the workers. The threat for inducing hearing disabilities amongst the operatives is specially high. Moreover, the high SPLs at frequencies of 1000 Hz and above are especially prone to induce irreversible hearing loss.

Thus to reduce the heat and noise exposure below the recommended standard the following would be useful: (i) the fermentors and the overhead ducts should

be insulated and the broken and weak insulations be repaired; (ii) purging of steam and hot air should be avoided with the workspace and silencers should be fitted to the steam purging and air bleeding nozzles; (iii) the volume of cool air supply should be increased and distributed evenly (iv) the turbines, the compressors and the ammonia tanks should be insulated (v) leakage of ammonia should be avoided; (vi) acoustically treated cabins for the operatives with provisions of cool air supply may be constructed; (vii) audiometry of the workers should be carried out at least once in a year, (viii) Engineering control of noise should be attempted (ix) maintenance of the motors, agitators and gear boxes should be performed; and (x) operatives should be instructed to wear hearing protection devices.

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